THURSDAY, JANUARY 30, 1913.

PROBLEMS OF SOIL FERTILITY.

Crops and Methods for Soil Improvement. By Alva Agee. Pp. xv + 246 + plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1912.) Price 5*s.* 6*d.* net.

THE Pennsylvania State College, of which the author of this book is acting director, is one of the classical research stations of the United States, and one in which students of agricultural science are always interested. A book written by so prominent a member of the staff of the institution as Prof. Alva Algee is, therefore, sure of a welcome.

The volume before us is intended for practical men, and sets out in simple, straightforward language the essential facts which the college has been trying to inculcate. The four causes of infertility most common in Pennsylvania, as in other parts of the eastern States, are lack of lime, inadequate drainage, lack of organic matter and of plant food. These are, therefore, discussed in some detail.

Lack of lime is a perpetual source of trouble in the eastern States, and, it might be added, in this country as well. It has furnished the reason for some of the best-known work in the States, including the researches of Dr. Wheeler, at the Rhode Island Experiment Station, and the long-continued limestone-fertilised plots at State College. Advice and demonstrations in connection with this subject absorb much of the time and energy of the expert advisers. The simple directions given by Prof. Agee should go far to facilitate matters; the farmer is shown that his land needs lime when it tends to cover itself with alsike, sorrel, plantain and "red top" (*Agrostis alba*), and he is advised as to the proper method of application.

When lime or limestone has been added and the land drained, it becomes possible to grow clover. This has a two-fold advantage: it increases the amount of animal food produced on the farm and, therefore, the amount of saleable produce and of manure; and it also enriches the soil in nitrogenous organic matter. Considerable space is devoted to this latter effect and to alternative ways of bringing it about, such as the growth of lucerne, temporary grass mixtures, &c. This method of soil treatment is the basis of the plan worked out in the States for restoring fertility to their worn-out soils.

The improved land will now produce more maize than before. Dean Hunt has adduced evidence to show that the whole prosperity of the eastern States would be increased if the area of land under this crop were increased. Maize has twice the energy value of the other crops grown in the rotation, and it affords green food for dairy cattle and for fatting animals. Further, the use of artificial manures is justified on this improved land.

Such is the main outline of the author's thesis. How successful the method is in practice is shown by the high crop returns at the experimental stations. Pennsylvania contains some of the best farmed land in the States, but even the best of its farmers will be able to learn much from Prof. Agee's book.

E. J. R.

THE OAK AND ITS LORE.

The Oak: Its Natural History, Antiquity, and Folk-Lore. By C. Mosley. Pp. ix + 126. (London: Elliot Stock.) Price 5*s.* net.

THE editor of "White's Selborne" has given us a most dainty and chatty little volume on the "monarch of the woods." It is adorned on its cover with a panel of real oak, and furnished inside with beautiful illustrations specially produced for this work by the author. The book is divided into chapters on the oak in general; its economic value; historic and veteran oaks; the enemies and parasites of the oak; the oak in myth and folk-lore; and the oak in Holy Writ. On such a subject, the most important chapter, from a sentimental point of view, is the one on "Mistletoe-Oaks and Oak-Mistletoe." We learn, as leading facts, that the mistletoe grows on oak only "in odd instances." The known instances are given as the result of careful search and inquiry, and the only present instance, it seems, occurs in the neighbourhood of Eastnor Park, Herefordshire. The only English species of mistletoe is *Viscum album*, which grows extensively on apple-trees. In the south of Europe *Viscum aureum* or *Loranthus europaeus* grows in abundance on oak trees. Important information on the same subject is given by Sir Norman Lockyer in his "Stonehenge" (second edition, pp. 26, 27), and from the facts the following deductions seem natural and reasonable.

The mistletoe of the Druids was *Viscum aureum*. The Druids came from a south country where that species grows on the oak. The rarity of even *Viscum album* on oak in the north accounts for the extraordinary trouble and ceremony with which the Druids obtained the mistletoe for their purposes. As the apple-tree ranked next to the oak in the Druids' estimation, it is to be inferred that the apple-tree-mistletoe was deemed satisfactory for ordinary ceremonials.

Such facts and deductions constitute circumstantial evidence bearing on the theory that the Druids came from the south, while the British Celts came from the east; that they, or their representatives, were in Britain before the Celts—that is, in the Neolithic age or the age of the megalithic monuments; and that the Druids of the times of Cæsar and Pliny were priests or professors of a Celticised Iberic system. As evidence, the southern origin of the oak-mistletoe association would agree admirably with some syntactical peculiarities of British Celtic speech which are distinctly non-Aryan, and have been traced southward through North African dialects to ancient Coptic.

JOHN GRIFFITH.

FAGNANO'S MATHEMATICAL WORKS.

Opere Matematiche del Marchese Giulio Carlo de' Toschi di Fagnano. Pubblicate sotto gli auspici della Società Italiana per il Progresso delle Scienze dai soci V. Volterra, G. Loria, D. Gambioli. Volume Primo. Pp. ix + *a*–*q* + 474. Volume Secondo. Pp. xi + 471. Volume Terzo. Pp. xi + 227 + 2 plates. (Milano, Roma & Napoli: Albrighi, Segati e C., 1911 and 1912.) Price 40 lire (complete in three volumes).

GIULIO CARLO DEI TOSCHI DI FAGNANO was born in Senegal on September 26, 1682, and died there on May 18, 1766. In his boyhood he composed poetry; later on he was attracted to the study of philosophy and became a follower of Leibniz and Newton. At the age of fourteen he went to college at Rome, but his taste for mathematics only developed later, and he had to devote himself to its study without assistance out in Senegal. Although he became absorbed in his mathematical studies sometimes for days at a time, he also occupied himself with administrative work, and gave expert advice to the Pope Benedict XIV. regarding the safety of the cupola of St. Peter's at Rome. In return, the Pope promised to publish his "Mathematical Productions," but for some reason the promise was not fulfilled, and they were not published until 1750.

The best-known original work of Fagnano is that referring to the rectification of curves. "Fagnano's Theorem," relating to certain properties of arcs of ellipses, has frequently figured in English text-books, and is now recognised as the starting-point from which sprang the modern theory of elliptic functions. That such was actually the case is confirmed in the preface to these volumes, where it is stated that the work of Euler and Jacobi was initiated by the examination of a presentation copy of Fagnano's works, received by the Berlin Academy of Sciences.

This and other circumstances led the Italian Association for the Advancement of Science to undertake the publication, not only of Fagnano's "Mathematical Productions," but also of his unpublished writings and correspondence, the work being placed in the hands of Profs. Volterra, Gino Loria and Gambioli.

The first two volumes contain the "Produzioni," as originally published by Fagnano. The greater part of vol. i. is taken up with a treatise on the geometrical theory of proportion, which includes the whole of the propositions in Euclid's fifth book. In addition, we have papers on the solution of the cubic and biquadratic and on the mathematics of gambling, with special reference to lotto—a subject of considerable importance in Italy, where the Banca di lotto is a source of revenue to the State. The second volume contains a treatise on rectilinear triangles, and Fagnano's contributions to the study of analysis. These latter, unlike the former, consist of a series of short papers which perhaps constitute the most important of Fagnano's works. The third volume consists of work not included in Fagnano's *opus magnum*, namely, articles published after the appearance of the "Productions" in 1750, as well as correspondence. The collection of the material for this volume is due to Prof. Gambioli. A biography of Count Fagnano forms a fitting conclusion.

The series of volumes forms a useful addition to the archives of mathematical history. That the original work of this mathematician still opens up fields for investigation is shown by a recent paper on elliptic trammels and Fagnano points, contributed to *The Mathematical Gazette* for May and July, 1911, by Mr. Percy J. Harding.

G. H. B.

GEOLOGY IN THE SOUTHERN HEMISPHERE.

(1) *South African Geology.* By Prof. E. H. L. Schwarz. Pp. 200. (London: Blackie and Son, Ltd., 1912.) 3*s*. 6*d*. net.

(2) *Geology of New Zealand.* By Dr. P. Marshall. Pp. viii + 218. (Wellington, N.Z.: J. Mackay, Government Printer, 1912.)

(3) *An Introduction to the Geology of New South Wales.* By C. A. Süssmilch. Pp. xii + 177. (Sydney, N.S.W.: W. A. Gullick, Government Printer, 1911.) 5*s*.

THESE three books are written with an educational purpose, and are kept within the limits of size suitable for schools. They alike bear witness to the prominent place taken by geology in the outlook of settlers in the southern hemisphere. Where human history may be traced back into prehistoric anthropology through the brief period of two centuries, the earth itself, the land that is still in process of exploitation, makes a very natural appeal. The Geological Survey in such countries takes the place of an Academy of Inscriptions, and now the laboured memoirs of the surveys are being condensed for students who are to take their stand as citizens. South Africa, Australia, and New Zealand, armed with such accurate knowledge, will soon offer little field for those spirited romanticists, the company promoters of the mining world.

(1) Prof. Schwarz, however, is himself romantic. He stands among the prophets, and is apt to perceive the sunburst where some of us still remain doubtful of the dawn. A touch of adventure is imparted to the present volume by his unhesitating acceptance of the very attractive planetesimal hypothesis, and of the far more dubious conclusions of Brun in the volcanic field. We are invited by him to a well-planned arena, where nineteenth-century champions may be seen rolling in the dust. Apart from this, he sets out very justly to teach elementary geology in South Africa by South African examples. His treatment is so sound that we resent the introduction of the European Zechstein and Kellaways series, and so forth, in the table following p. 124, however necessary these trifles may still be in examinations conducted on traditional lines.

The author starts in his preface with the fact that brooks are unknown to his students, and by p. 34 we have a description of boulder-streams after torrential rains, on p. 35 we talk of vleys and vloers, and on p. 64 we realise, from a modern subtropical instance, the origin of our own "crystalline sandstones." The African climate permeates such chapters, and we must not complain if the pumpkin-like *roches moutonnées* on p. 43 and the treatment of glaciation on pp. 40 to 44 appear to European minds defective. There are some slips in the writing which suggest haste, as when a bore-hole is stated (p. 54) to be 6000 ft. thick, and when melilite-basalt (p. 63) is described without mention of the mineral melilite.

In an account of heat-weathering, which is very properly emphasised on p. 71, we are told that the corners of a block expose a larger surface to the sun than the flat sides. The matter is better expressed in Prof. Marshall's "Geology of New Zealand" (p. 46). Prof. Schwarz concludes with an account of the stratified series in the South African provinces and in Rhodesia, illustrated by maps and drawings of fossils, and full of interest for European as well as African readers.

(2) Prof. Marshall's book, coming so soon after Prof. Park's larger treatise, reminds us at once of the stratigraphical controversies that still await settlement in New Zealand. Dwellers in the British Isles find it hard to comprehend the vast series of rocks in other lands that may be devoid of fossil evidence; but it is equally hard to comprehend why an unconformity should be demanded as a proof of the distinction between two successive geological systems. This seems the main point with those who, like Prof. Marshall, reject the view that the Waipara series is Cretaceous, and insist on giving us a Cainozoic group which begins with Cretaceous types of life (p. 197). An author who believes "that too much attention has been paid in the past to the palæontological evidence" seems to mark out his systems on older grounds than those put forward by William Smith.

The book is very well illustrated by photographs, and, like that of Prof. Schwarz, introduces students to geology by means of the features of the home-country in which they live. Glaciers and recent volcanoes are brought in as present witnesses, and the geographer and geologist in other lands will welcome this convenient and well-printed volume. One does not demand a full treatment of rocks or minerals in a book that has another and a special aim; but the chemical formulæ on pp. 12 to 20 require a good deal in the way of correction and punctuation.

(3) Mr. Süssmilch's book, also in the same convenient *format*, is issued by the Department of Public Instruction of New South Wales. It presupposes a knowledge of geological principles, and brings together a large amount of matter that is distributed through official reports. This treatment allows of greater detail than can be introduced into the volumes on South Africa and New Zealand. We find pleasure, however, in comparing the account of the Glossopteris flora (p. 91) or the Palæozoic glacial beds (pp. 61 and 96) with the remarks of Prof. Schwarz on similar occurrences in South Africa; and there is no doubt that the three books should stand near together in our libraries. Through its design, that on New South Wales is naturally the most informing.

G. A. J. C.

OUR BOOKSHELF.

The Twenty-Seven Lines upon the Cubic Surface. By Prof. A. Henderson. Pp. vi + 100 + 13 plates. (Cambridge: University Press, 1911.) Price 4*s*. 6*d*. (Cambridge Tracts in Mathematical Physics. No. 13.)

THIS volume is a record of an individual attempt to construct numerical models of the cubic surface, founded on the lines of the surface; it is carried through with great earnestness, and so far as possible with the simplest materials; its obvious sincerity cannot fail to be inspiring to anyone who will be at pains to understand it. It would be a mistake to criticise the earlier half of the book as if it were a treatise on the cubic surface; it is the author's assembling of his materials for the constructions which follow, and the very want of elaboration which it occasionally exhibits is a proof, if an incidental one, of the independence with which the author has carried out his research. Perhaps the analytical investigation of the double-six theorem, which occupies pp. 16 to 19, is an extreme case; a geometrical proof might have been given, though the author's is simple and self-contained.

The book is accompanied by reproductions of elaborate diagrams, carefully drawn to scale. They would have been more interesting if not so much reduced in size. There is a long bibliography of the general literature in regard to the cubic surface, which is likely to be useful. Under 1902 there should certainly be the entry, "Beziehungen der allgemeinen Fläche dritter Ordnung zu einer covarienten Fläche dritter Classe," by Th. Reye, *Math. Annalen*, Bd. lv. Also the paper of G. Kohn, "Ueber einige Eigenschaften der allgemeinen Fläche dritter Ordnung," *Wiener Sitzungsberichte*, Bd. cxvii., p. 66, should be referred to, and a recent paper by Prof. W. Burnside in the Camb. Phil. Proceedings, on double-sixes with projective transformations.

Medizinisch-chemisches Laboratoriums-Hilfsbuch. By Dr. Ludwig Pincussohn. Pp. xi+443. (Leipzig: F. C. W. Vogel, 1912.) Price 13.50 marks.

ONE cannot say that Dr. Pincussohn's book fulfils any real need, seeing that laboratory guides of the same nature are already numerous. The author was formerly assistant to Prof. Albderhalden, and is well known as an original worker in the field of physiological chemistry. The book he has produced is a very good one, and is specially useful because of the tables of physical and chemical data which occupy its last hundred pages. The introductory chapters deal with general chemical methods, and the remainder, as the title indicates, with that portion of the science which it is the fashion to call bio-chemistry. The analytical and other methods of research selected are up-to-date, and are described in a clear and interesting way.

W. D. H.

Books that Count. A Dictionary of Standard Books. Edited by W. Forbes Gray. Pp. xx+315+lviii. (London: A. and C. Black, 1912.) Price 5s. net.

OF the fourteen sections into which this dictionary is divided, one deals with science, and some others are concerned with such kindred subjects as education, geography and travel, philosophy and sociology. The sections are necessarily incomplete, for the editor intends his lists chiefly for the use of young students and ordinary readers. The work should, however, be very valuable for reference to notable books in many departments of knowledge.

LETTERS TO THE EDITOR.

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

Luminous Halos surrounding Shadows of Heads.

THE phenomenon referred to in a note in NATURE of December 12 (p. 419), as observed in rice-fields of Japan, can also be seen on grass when the sun is low in the sky. The presence of dew, I believe, increases the intensity of the halo, but it is perfectly distinct also on dry grass.

If the grass surface is near to the observer, a faint halo is seen to surround the shadow of his head, and this is more easily perceived if he is moving than if standing still; my attention was indeed first attracted to the phenomenon when bicycling.

In this mountain region I have frequently seen the halo projected on a grassy slope a mile or more distant, and under these conditions it appears as a circular or elliptical patch of light without the central shadow, the diminution of intensity due to the penumbral shadow of one's head being, of course, quite inappreciable at such distances. It is difficult to determine the size or shape of this patch, owing to irregularities in the brightness of the background; but I have been able to compare it with the nearly full moon rising immediately above it, and should judge it to be at least 2° in diameter, and probably elliptical in shape with the long axis vertical. The light appears to emanate from the grass itself, which apparently reflects more light in the direction of incidence than in other directions; it is certainly not due to dust or haze in the intermediate column of air. I am unable to say whether a smooth rock surface would give the same appearance, but a dense white cloud certainly does so, with the addition of a faintly coloured ring surrounding the white patch. This I presume is allied to the "Brocken spectre," seen when the illuminated cloud or fog is near to the observer.

The analogy of this elliptical bright patch opposite the sun with the Gegenschein is so striking that one cannot help believing both to be due to the same cause, and that matter outside the earth's orbit and beyond the limits of the earth's shadow reflects more sunlight in the direction of incidence than in other directions. That the Gegenschein usually covers a much larger angular area than the 2° patch seen on these hills may be accounted for by the much more favourable conditions in which it is seen, with a dark and uniform sky-background.

J. EVERSHED.

Kodaikanal Observatory, South India, January 4.

EXACTLY a month ago to-day, in the Betul district, Central Provinces, I had set out on field work at dawn, with my colleague, Mr. H. Walker, and two chaprasis (Indian servants). I happened to be watching our shadows as we passed along the edge of a field of young green wheat, when, to my surprise, I noticed a halo of light round the shadow of my own head and neck. Looking at the other shadows, I was still more surprised to see that only my shadow was invested with this halo. I directed the attention of Mr. Walker and the chaprasis to the phenomenon, and found that each could see a halo round his own head only. Whilst we were investigating the matter our camp passed on the march, and inquiries made both from our servants and from local people showed that none of them had previously noticed the phenomenon.

The conditions were obviously special, although frequently obtainable to one who deliberately set out with the purpose of finding them. The sun was at a low altitude on our left, and the wheat was soaking wet with dew on our right. The dew speedily dries up in the morning sun, and although I have kept on the look-out for this phenomenon during the past month I have never happened to pass a wheat-field again with the conditions of time, situation, and wetness repeated.

I had, therefore, intended writing to NATURE to inquire whether the occurrence of these halos had been previously recorded, and consequently was greatly interested to read the note on p. 419 of your journal (December 12, 1912) concerning *Inada no goko*, or halo in the ricefield. I have not seen the Japanese journal referred to, and consequently am not aware if Profs. Fuchino and Izu direct attention to the fact noted above, that each observer sees the halo round his own head only. This fact indicates that the observer perceives those elements of a narrow cylinder of the sun's rays enclosing his head that happen to be reflected back to his eyes by the dew-drops and wheat blades; the major portion of the cylinder of light is reflected back along the cylinder, and consequently a given observer is not in the line of vision for the halo round another observer's head. The explanation advanced by the Japanese observers that the halo "is caused by the reflected light from the sun-images formed on the green blades by the passage of the sun's rays obliquely through the dew-drops" is doubtless correct. I presume that their investigations show that the farther a drop is from the edge of the shadow of the head the smaller is the proportion of the light reflected from the sun-images that can reach the observer's eye; for the boundary of the halo is not sharp, the brightness diminishing somewhat gradually with distance from the shadow. Assigning to the head in the shadow the actual diameter of the head, I estimated the noticeably bright part of the halo as roughly 10 in. wide all round the head, dying out on the shoulders.

A close inspection of the green blades showed that at or near the tip of each blade was one pearl of dew, whilst the whole of the remainder of the blade was coated with a film of minute dewdrops. It is the minute drops that give rise to the major portion of the effect.

The fact that each observer sees only his own halo obviously precludes this phenomenon from having been the origin of the halos recorded in sacred writings round the head of Christ and others.

L. L. FERMOR.

Geological Survey of India, Camp, Korea State, Central Provinces, January 4.

Procryptic Coloration a Protection against Lions.

THERE has been some interesting correspondence in recent numbers of *The Field* on the question of the procryptic coloration of big game, some writers taking one side and some another in the controversy. Now although there is a certain amount of evidence, scattered through sporting literature, showing that some species of African antelopes and zebras are hard for human beings to detect in particular surroundings, there is, so far as I am aware, scarcely any testimony, based upon observation in the jungle, to prove that the sight of predatory carnivora is baffled in the same way by colour assimilation.

This question has such an important bearing on the theory of the evolution, through natural selection, of obliterative coloration that I venture to repeat the following story, told by Mr. F. C. Selous (*The Field*, January 18, p. 141), which I hold to be one of the most valuable contributions to the subject ever published, and worthy, as such, of being made known to a much wider circle of zoologists than is comprised by readers of *The Field*. Mr. Selous says:—

"I once wounded one [a lion]—a very savage lion, I think—which at once came round to look for me. I was sitting on the side of a large ant-heap, and no doubt my bare sunburnt arms and legs, and the dirty old shirt and towel in which I was dressed, assimilated well with the colour of my surroundings, for although the lion came and looked straight at me, he could not make me out. I had not had time to reload my single-barrelled rifle, but had a cartridge in my right hand ready to slip into the open chamber if the lion charged. But when he came towards me and then stood looking at me, I did not make the slightest movement, and he could not make me out, and presently turned and looked the other way. . . . I am perfectly certain that had I made the slightest movement . . . this lion would have charged."

Mr. Selous is a staunch opponent of the theory of the survival value of obliterative coloration in big game, and his experience, above recounted, gains force from the fact that it was described in an article in which he was combating the double claim that the equine and most of the ruminant mammals of Africa are procryptically coloured and are benefited thereby. But we shall probably have to wait many years before we get a more cogent piece of evidence in favour of the value to antelopes and other game of a combination of assimilative patterns with stillness.

R. I. POCOCK.

Zoological Society.

Animal Coloration.

AN article by Dr. Francis Ward, illustrated by the author's excellent photographs, appeared in the December number of *The Salmon and Trout Magazine*, which should not be missed by anyone who is interested in the problem of animal coloration. Without attempting to discuss or give any *résumé* of the paper, there is one point to which I should like to direct the attention of zoologists.

Most visitors to the Natural History Museum at South Kensington know of the ingenious device by which Dr. Thayer demonstrated his theory of the coloration of water birds. Two models representing ducks are so arranged and painted that one of them (A) is invisible until the observer comes close to the case; the other (B) is plainly to be seen from a considerable distance. A has been coloured dark above and light below, characteristic of most water birds, B the reverse. Hence it is suggested that the colours of aquatic birds are mainly protective against enemies on the shore, and to a certain extent against raptorial birds also. This theory has, I believe, met with much favour from ornithologists, even if they have not entirely accepted it.

Dr. Ward's results, however, seem to show that the coloration of flesh-eating aquatic birds is rather of an aggressive than of a protective nature, and that the light colour on the underside of such birds renders them invisible to their prey beneath the water. Certainly his photographs are distinctly striking, especially that of the heron and black-headed gull. It is much to be hoped that Dr. Ward will continue his observations "From the Fish's Point of View."

M. D. HILL.

Eton College, January 21.

The Reflection of the X-Rays.

MESSRS. LAUE, Friedrich, and Knipping's remarkable photographs taken through a crystal with X-rays have opened a new field of research. Mr. W. L. Bragg has shown that much stronger photographs are produced by a grazing reflection from mica. We have recently used the latter discovery to study the reflected beam electrically. We find that it resembles ordinary X-rays. Just like the primary rays it ionises air and helium and produces a soft radiation when it strikes metals. The variation of its ionisation in air with pressure is also similar. We have so far obtained effects as great as 1 or 2 per cent. of the primary beam. In some cases the measurements in helium were magnified by ionisation by collision.

The same absorption of the reflected beam was produced by aluminium, whether the rays passed through it before or after the reflection. In one case the absorption coefficient for either position was 6 $cm.^{-1}$, whereas for the primary beam it was 9 $cm.^{-1}$. This indicates that the character of the rays is unaltered by reflection, but that the amount of reflection increases with the hardness.

As Prof. Bragg has shown, the behaviour of the X-rays in connection with ionisation strongly suggests that their energy is concentrated as if they were corpuscular. Since the rays are reflected, they must be some kind of pulse with an extended wave-front, yet after reflection they retain their corpuscular character. Thus the energy of the X-rays appears to show the contrary properties of extension over a wave-front and concentration in a point.

H. MOSELEY.
C. G. DARWIN.

Victoria University, Manchester, January 21.

Emission of Particles by Heated Metals.

REFERRING to Prof. Valentiner's article on "New Facts in Physics," in NATURE of January 9, you note that Messrs. Reboul and Dr. Bollement have found that copper and silver eject particles at 500° C. in a vacuum, in air, oxygen, and carbonic acid, which forms deposits on the walls of the containing vessel. Pure silver, and several alloys having a chief content of silver, were found by me to emit particles or an emanation of some sort when heated in air to a bright red, but well below their melting points. The facts were observed during an inquiry to ascertain the cause of the sudden failure of the platinum pins of porcelain teeth, and were briefly noted in *The Dental Record*, September, 1911.

In the presence or proximity of silver at a red heat two kinds of effects on other bodies were observed: (1) a yellow to brownish-yellow staining on the surface of various porous "investments" (plaster of paris, pumice-stone, whiting, French chalk, asbestos, and mixtures of these) against which the silver or silver alloy had been heated; (2) porcelain was rendered weak and almost friable to a varying depth from the surface in contact with silver, the deteriorating effect penetrating to a depth of 3 or 4 mm. during half an hour's heating.

Gold, platinum, copper, zinc—singly or in combination—did not produce those effects, but when silver was present the staining was copious, and the weakening or "fritting" of porcelain in at least some degree always resulted. No analysis was made, but the inference seemed well founded that in those cases silver at a bright-red heat emitted something that gave rise to the effects noted.

D. M. SHAW.

Eltham, S.E

Thermal Efficiency of Gas and Electricity.

OUR attention has been directed to a short paragraph in your issue of January 16 (p. 551) regarding the progress of electric cooking, in which the following sentence occurs:—"The present year should see a reasonably cheap and economical electric oven put on the market to compete with the everyday gas-cooker, which at present, on account of its low initial cost, still holds the field against the electric oven among the general public."

Please allow me to point out that it is not merely a question of comparative cost and upkeep of apparatus, but the more important point of comparative efficiency. The heat equivalent of one unit of electricity (costing at least one penny) equals 3410 British thermal units, while the heat equivalent of 33 cubic feet of gas (costing in London one penny) equals 16,500 British thermal units. No science can obtain from a given quantity of energy or fuel more than the maximum amount of heat it produces when completely consumed, and it is therefore apparent that electricity, so far as heat production is concerned, can never economically compare with gas.

W. M. MASON,
Secretary.

The British Commercial Gas Association,
47 Victoria Street, Westminster, S.W.,
January 21.

Research Defence Society.

IT is said that the fifth year in the life of any society is the critical period of its fortunes. The Research Defence Society was founded on January 27, 1908. To all who are interested—and who is not?—in medical research, we beg you to let us say that the society has its hands full of work, and only wants more money to do more work. Much has already been done, by lectures and by distribution of literature, to bring home to people the truth about experiments on animals in this country, and the great value of them, not only to mankind, but also to the animal world. The expenses of our society are heavy; but the good results of our work are extended far and wide. We have lately opened a bureau and exhibition at 171 Piccadilly (opposite Burlington House). We are exhibiting pictures, portraits, charts, anæsthetics and inhalers, germs in pure culture, tsetse-flies and mosquitoes, and so forth. This little exhibition, every day, and all day long, displays to "the man in the street" the facts of the case. We are the only society which is doing work of this kind; but, of course, it cannot be done without money. Our record for the last four years gives us the right to hope for a great increase of our membership, and of our funds, in the coming year.

DAVID GILL, President.
F. M. SANDWITH, Hon. Treasurer.
STEPHEN PAGET, Hon. Secretary.

21 Ladbroke Square, W., January 24.

Retinal Shadows?

IF, in the early morning, when the eyes are first opened, one looks at the white ceiling, branching lines are to be seen resembling blood-vessels. These figures only persist for about one second. It seems necessary for the eyes to be closed, and have a long rest, to show them clearly. In the daytime quite a long rest is necessary for them to be visible at all.

So far as I can judge they always have the same form. It would appear from this that they are really the shadows of the blood-vessels; but why they should only be visible for about a second after opening the eyes, and then only after a long rest, does not seem clear.

It may be that the phenomenon is well known, but, if so, I have not chanced to hear of it.

R. M. DEELEY.

Abbeyfield, Salisbury Avenue, Harpenden,
January 21.

A UNIVERSITY IN THE TROPICS.

THE TIMES of January 23 devotes one of its leading articles to the important question of the need of establishing a university in the tropics for the study of tropical agriculture. The subject is dealt with in a very interesting and forcible manner, and it is to be hoped that it may not be long before the proposal is realised.

At present, beyond the few facilities which exist at the Imperial College of Science and Technology, there is no place within the British Dominions where men who aspire to a tropical post, or have to deal with tropical estates, can learn more than a smattering of either the nature or magnitude of the problems which await solution. Yet men are constantly being sent out as agricultural officers to fill highly important and responsible posts, and they are expected to be able at once to cope with the difficulties which are presented from all sides.

Did we but stop to count the cost of our want of foresight in this matter we should realise that the expenditure in establishing a proper training centre in the tropics would long ago have been repaid by the increase of efficiency in the officers and the resultant improvement in agricultural operations.

The paramount advantage of a university or college of science established in some tropical colony would be that it would provide a centre where questions relating to soil, plant and animal breeding, plant and animal pathology, economic zoology, and various chemical and other questions could be investigated under tropical conditions by a highly competent professorial body, and where advanced instruction could be given to students—whose preliminary training had been received elsewhere—destined to fill agricultural posts in one or other of our tropical colonies. If the need of such an institution be admitted the question then arises, Where should such a university be stationed? Before suggesting an answer to this question it is necessary to point out that in view of the two-fold nature of the proposed institution, three points must be kept in mind. In the first place it should be situated in a colony offering the greatest possible scope for diverse agricultural pursuits; secondly, the healthiness of the colony should, so far as possible, be beyond reproach; and thirdly, the spot chosen for the university should be within easy access of the British Isles.

This last point is perhaps the most important one of all, since not only is it desirable on behalf of the students from home that the expenditure of time and money should not be unduly large, but also it is of paramount importance that the professors and lecturers should be able to have the opportunity of frequent intercourse with home, and so reduce to a minimum the possibility of stagnation and loss of vigour which might be liable to occur if personal intercourse with fellow-workers at home were rendered difficult by distance and expense.

This danger of stagnation would also tend very effectively to be obviated if the tropical university or college of science could be definitely linked with an institution at home. Such an institution should be either a university especially interested in agricultural matters or an institution of university standing, such as the Imperial College of Science and Technology.

If then it be agreed that the points which have been urged, in considering the requirements of an agricultural institution in the tropics, must be regarded as conditions essential to its success, it would seem clear that the site for the institution must be sought in the Antilles. Nowhere among these islands do we find all the requisite conditions so fully met as in the easily accessible and beautiful island of Trinidad.

THE NATURAL HISTORY COLLECTIONS OF THE BRITISH MUSEUM.[1]

TO those familiar with the natural history collections in the old British Museum in Bloomsbury the work of Dr. Günther must revive many pleasant associations of the 'fifties and 'sixties of last century—when the insect room was frequented by naturalists of note in various departments. Thus, besides the staff of the museum, which then included the brothers J. E. and R. Gray, Dr. Günther himself, F. Smith, and foreign naturalists, one met such men as Dr. Bowerbank, Mr. Busk, Dr. Carpenter, Mr. John Gould, and such ladies as the charming Mrs. Alfred Gatty—all eager to absorb as well as impart information. No marine laboratories then existed, so that marine, as well as terrestrial, natural history centred in the great museum. In the historical treatise heading the list, which no one could write so well as Dr. Günther, we are brought face to face with all the conspicuous additions to the vast collections, which in 1868 were close on a million and in 1895 two millions, the changes in the staff, the nature of their work, the financial allowances, and, more than all, the remarkable task of transporting the collections from the old museum to the new quarters in Cromwell Road.

Few have any notion of the vast stores in every department of zoology which have been assiduously collected in one way or another by the trustees, or of the labour entailed on the staff, for instance, by the receipt of 63,000 specimens of a particular group at once, especially if they were not carefully named and labelled. Besides the task of incorporating the rare or new species, duplicates have to be selected and treated differ-

[1] "The History of the Collections contained in the Natural History Departments of the British Museum." Vol. ii. Appendix. General History of the Department of Zoology from 1856 to 1895. By Dr. Albert Günther, F.R.S. Pp. ix+109. (London: British Museum (Natural History); Longmans and Co., 1912.) Price 5*s*.

Catalogue of the Mammals of Western Europe (Europe exclusive of Russia) in the Collection of the British Museum. By Gerrit S. Miller. Pp. xv+1019. (London: British Museum (Natural History); Longmans and Co., 1912.) Price 26*s*.

Catalogue of the Collection of Birds' Eggs in the British Museum (Natural History). Vol. v. Carinatæ (Passeriformes completed). By W. R. Ogilvie-Grant. Pp. xxii+547+22 plates. (London: British Museum (Natural History); Longmans and Co., 1912.) Price £2 7*s*. 6*d*.

Catalogue of the Chætopoda in the British Museum (Natural History). A. Polychæta: Part I. Arenicolidæ. By Dr. J. H. Ashworth. Pp. xii+175+xv plates. (London: British Museum (Natural History); Longmans and Co., 1912.) Price 27*s*. 6*d*.

ently, whilst if the collection is unnamed or of great rarity, a descriptive account in a catalogue may be necessary.

Moreover, whilst the collections remained in Bloomsbury the great library was at the command of the staff, but the transference to South Kensington wholly altered the situation. Even before 1882–3, indeed, a departmental library was known to be a necessity for facility in working out the collections. Accordingly, in 1879–81, a commencement was made, and soon the library comprised 1700 titles, while at the end of the period embraced in Dr. Günther's history, and largely by his unceasing efforts, there were 10,036 separate works, or 16,238 volumes. The library is not only indispensable to the staff, but many zoologists outside—both British and foreign—have had their labours lightened by the conveniences thus afforded of consulting rare books, as well as by the courtesy of the staff.

But the care and custody of the nation's natural history collections form only a part of the duty of the staff, for, besides the select series for exhibition to the public, another for study by students (using this term in its widest sense) has to be arranged for, so as to leave those in the public galleries untouched; indeed, the exigencies of space, as well as the importance of the system, had caused Dr. Gray to adopt it so early as 1858. Moreover, descriptive catalogues, great and small, with plates and text-figures of every group, have to be prepared for publication—for example, the great, and to workers the indispensable, catalogue of fishes in many volumes, by the keeper himself (Dr. Günther). Single volumes of some of these publications, *e.g.*, that on monotremes and marsupials, by Mr. Oldfield Thomas, represent the labour of three years. Popular guides to the various galleries, on the plan proposed by the author of the history, that is, of a kind not only useful to every intelligent visitor, but in most cases of value to students of the department as well as to those in charge of other museums, have likewise to be prepared by the staff. Thus the collections of the great museum are utilised from various points of view.

As we read those terse and pregnant pages of Dr. Günther's, a procession of great naturalists and their collections passes before us in kaleidoscopic variety, and the familiar names of Sir Joseph Banks, Mr. Cuming, Col. Beddome, Dr. Jerdon, John Gould, A. R. Wallace, Mr. Hewitson, A. Hume, Messrs. Godman and Salvin, George Busk, Joshua Alder, Dr. Sclater, Dr. Gwyn Jeffrys, F. Day, Dr. John Anderson, and Lords Tweeddale, Lilford and Walsingham, and many others recall in each case a life-long devotion to particular groups.

Further, a long series of expeditions by sea and by land—from the Arctic to the Antarctic regions, as well as in the neighbouring waters and countries, besides the circumnavigating voyage of H.M.S. *Challenger*—have poured their riches into this great museum, which also received notable increments from the collections made by the East India Company, the Linnean Society, and the great Fisheries Exhibition of 1883. Mammals, from the huge whales, elephants and giraffes to the tiny marsupials, rodents and insectivores, find their place in this vast array, and so throughout the orders of mammals, the endless series of birds, reptiles, amphibians and fishes. The vast numbers of invertebrates, from cuttle-fishes and shells, insects and crabs to corals, sponges and foraminifera, can only be estimated by the records in this volume. Not a few collections typify the Colonial possessions and dependencies of the Empire—from New Zealand to South America, Canada, Egypt, and India; whilst the native animals—land, fresh-water, and marine—have each a place in the series.

The period embraced by this treatise is of special interest, since it covers the erection of the fine Natural History Museum at South Kensington and the preparation of the plans for the furniture and fittings by the keeper, as well as the removal of the vast collections from their old quarters in Bloomsbury to their new premises in South Kensington. This task, carefully planned and skilfully carried out in about six months by Dr. Günther, without appreciable injury, is one that redounds to the credit of the keeper—whether in respect to the delicacy of many of the specimens, or the distance to be traversed in the streets of a busy city. The larger forms, perhaps, gave less anxiety than the dried and brittle corals, echinoderms and sponges, and, still more, the 52,635 jars and bottles of all sizes containing specimens in spirit. Dr. Günther thus well merited the congratulations of the trustees on this feat. In the material of the cases of the new museum a change from metal (recommended by the keeper) to mahogany was made by the trustees, probably on the grounds of economy; and for the same reason the reduction of the size of the separate building for the spirit collections, as Sir R. Owen, Dr. Gray and Dr. Günther foresaw, caused an extension of double the amount ten years later. A cetacean room had also to be improvised for these huge mammals.

Further, the system whereby the selected duplicates in every group, from primates to protozoa, are distributed to home and to Colonial museums was put in active operation, and not a few university and other museums have reason to be grateful to the trustees for this great privilege.

The three volumes following Dr. Günther's are typical examples of the important publications of the museum. The catalogue of mammals of Western Europe, by Gerrit S. Miller, of the United States National Museum at Washington, is a laborious and exact treatise, the origin of which is largely due to the efforts of Lord Lilford, Mr. Oldfield Thomas and Major Barrett-Hamilton. All the mammals except the cetaceans, seals and introduced forms, like *Simia sylvanus*, from the Rock of Gibraltar, are entered, and the manner in which the task has been executed is worthy of all praise—in regard to both descriptions and figures. As an instance of modern nomenclature, *Orycto-*

lagus cuniculus would puzzle not a few zoologists. The second treatise is the catalogue of passeriform bird's eggs, by Mr. Ogilvie-Grant, so well known in the department, and it is the fifth volume of the series. Both in text and plates—of which there are twenty-two, all coloured—it is worthy of the reputation of the author. The value of such a work to all ornithologists is sufficiently obvious, and the trustees have to be congratulated on this addition to the series. The third catalogue, that of the Arenicolidæ, by Dr. J. H. Ashworth, is really a monograph of the family, containing as it does the results of years of labour by the author on the structure of the group, and admirably illustrated by text-figures and fifteen plates. By his devoted and varied researches on this family and its allies, the author is rightly regarded as one of the chief authorities on the subject, and this task for the trustees of the British Museum still further emphasises that view.

From the narrative of Dr. Günther, and the three works which form the latest additions to the long roll of important publications, it is clear that the great national zoological collection is one of which the country may justly be proud; and a tribute may well, in addition, be paid to the staff, whose courteous aid is ever at the disposal of zoologists of every nation. W. C. M.

PAUL GORDAN.

THE death of Paul Gordan, which occurred on December 21, has removed a mathematician of pre-eminent rank in his own particular field. When the calculus of invariants and covariants was started it was taken up with great vigour in Germany, and very important developments were effected by Aronhold, Clebsch, and Gordan respectively. Aronhold invented the symbolical method, Clebsch gave brilliant applications of it to geometry, and Gordan, besides collaborating with Clebsch, wrote numerous papers on the purely algebraic part of the theory.

Gordan's best-known, and perhaps greatest, achievement is his proof of the existence of a complete system of concomitants for any given binary form. In its original shape the proof was very laborious and difficult to grasp; even in the simpler form to which he and others reduced it, it is still very hard, and is not, perhaps, the proper and natural demonstration. However that may be, to have given the first strict proof of the theorem is an algebraic feat of the highest order. Gordan also worked out in detail the theory of transvection and "folding," ultimately arriving at formulæ which provide a sort of engine for establishing the syzygies connected with any particular binary form.

Among Gordan's other work may be mentioned his papers on finite groups, and in particular on the simple group of order 168, and its associated curve $y^3z+z^3x+x^3y=0$. His book on binary forms is very valuable, and easier to read than most of his papers. The joint papers of Gordan and Clebsch are admirable: for instance, the memoir on ternary cubics in Math. Ann., vi., should be read by everyone who has mastered the easier parts of invariant-theory.

Gordan was born at Breslau in 1837, ultimately became professor at Erlangen, and was a corresponding member of the Paris Academy of Sciences. M.

NOTES.

THE President of the Board of Agriculture and Fisheries has just appointed a departmental committee to advise the Board as to the steps which could be taken with advantage for the preservation and development of the inshore fisheries. The committee consists of Sir E. S. Howard, chairman of the Wye Board of Conservators; Sir K. S. Anderson, chairman of the Orient Steam Navigation Company; Sir S. Fay, manager of the Great Central Railway Company; Sir Norval Helme, M.P., a manufacturer; the Hon. T. H. W. Pelham, of the Harbours Department of the Board of Trade; Mr. Norman Craig, M.P.; Mr. W. Brace, a Labour M.P.; Mr. J. W. Beaumont Pease, vice-chairman of Lloyds Bank; Mr. C. Hellyer, a trawl-vessel owner; Mr. S. Bostock; and Mr. Cecil Harmsworth, M.P. Commerce and finance on the great scale are thus well represented, and no doubt the committee will be able to supplement the knowledge of the inshore fisheries which it may not possess by accepting evidence from those who do possess it. The interests of the inshore fishermen are opposed to those of the steam-trawling industry on one hand, and of the salmon fisheries on the other, and this is, no doubt, the reason why the only two fishery members of the committee are a prominent owner of steam fishing vessels and the chairman of a very important board of salmon fisheries. Those who know the highly technical occupations of the inshore fishermen will also know that the whole question of the decadence of these industries must by and by involve a scientific knowledge of the natural conditions under which inshore fishing is carried on. Yet the committee does not contain a scientific man, and it is unlikely that its members can acquire second-hand, from expert evidence, that knowledge of the "inwardness" of technical marine biology which can alone render their advice to the Board of permanent value.

SIR WILLIAM TILDEN, F.R.S., has been elected a corresponding member of the Imperial Academy of Sciences, St. Petersburg.

THE death is announced, at seventy years of age, of Prof. R. Collett, professor of zoology in the University of Christiania.

THE subject selected by Dr. A. J. Jex-Blake for his Goulstonian lectures, to be delivered before the Royal College of Physicians on February 25 and 27 and March 4, is "Death by Lightning and Electric Currents."

THE Mexican Minister has desired the Secretary of State for Foreign Affairs to announce in this country that the Astronomical Society of Mexico has decided, beginning from 1913, to offer a medal and diploma to any astronomer who discovers a comet. The medal will bear the name of "Carolina Herschel Medal."

The Archduke Rainer, the oldest member of the Imperial Austro-Hungarian family, who died on January 27, at eighty-five years of age, owed much of his popularity to his keen interest in all forms of scientific and artistic activity. From an obituary notice in *The Times*, we learn that at the Vienna Academy of Sciences, of which he was curator, he never missed an important sitting, while the Austrian museums owed their development largely to his support.

The interest in birds which has been aroused in this country to a very considerable extent of recent years continues to spread, and more and more use is being made of nesting-boxes. At an exhibition arranged by the Brent Valley Bird Sanctuary Committee, to be held in the offices of the Selborne Society at 42 Bloomsbury Square, W.C., on February 1–15, the tried forms and new designs of nesting-boxes may be seen, as well as other apparatus connected with the attracting of birds.

The death is reported of Dr. G. A. Koenig, professor of chemistry since 1892 at the Michigan College of Mines. He was born in 1844 in the Grand Duchy of Baden, and was educated at schools in Lausanne and Karlsruhe, and at the Universities of Heidelberg and Berlin. He went to America in 1868, and held appointments at the Tacony Chemical Works, Philadelphia, and at the University of Pennsylvania, before joining the Michigan faculty. He discovered a number of new minerals, and took out patents for an assay furnace, and for the chlorination of low-grade silver and gold ores. One of his latest works was the preparation of artificial crystals of arsenides.

The death of Prof. Augustus Witkowski, on January 21, at fifty-eight years of age, deprives the University of Cracow of a highly honoured member. Trained under Lord Kelvin (whose admirer he ever remained), Prof. Witkowski, after the tragic death of Wroblewski in 1888, was appointed to the chair of experimental physics in the Jagellonian University. In this position he did genuine service to the cause of science in Poland. In a series of papers he dealt with the thermodynamic properties of air and other gases at very low temperatures. The work, which appeared in the Bulletin of the Cracow Academy (and was partly reprinted in *The Philosophical Magazine*), is a model of patient and accurate research. He wrote a comprehensive treatise (in Polish), "Principles of Physics" (three volumes), which is highly praised for its lucidity and precision of statement. To Prof. Witkowski's efforts the University of Cracow owes its fine physical laboratory building, opened in March, 1912.

The Year Book for 1912 of the Indian Guild of Science and Technology has now been published. It contains much interesting information of the progress made by the guild, the object of which, it will be remembered, is to cooperate in promoting the knowledge and application of pure and technological science in India, with a view to the improvement of the methods of economic production and the amelioration of the sanitary condition of the people. The president, Prof. A. Smithells, F.R.S., and committee of the guild are making a public appeal on behalf of the society, to enable them to extend and develop its work. Prof. Smithells will be pleased to receive donations. In addition to the annual report, the Year Book contains a varied selection of original papers on pure and applied science.

In accordance with the recommendation of the Select Committee of the House of Commons on the Marconi Contract, the Postmaster-General has appointed a committee "to report on the merits of the existing systems of long-distance wireless telegraphy, and in particular as to their capacity for continuous communication over the distances required by the Imperial chain." The committee will consist of:—Mr. Justice Parker, chairman; Mr. W. Duddell, F.R.S., president of the Institution of Electrical Engineers; Dr. R. T. Glazebrook, C.B., F.R.S., director of the National Physical Laboratory; Sir Alexander Kennedy, F.R.S.; and Mr. James Swinburne, F.R.S. The committee has been requested, as desired by the Select Committee, in view of the urgency of the question, to report as soon as possible, and in any case within three months from the present date.

The Zoological Society of Scotland, which, for the past three or four years, has been devoting itself to the establishment of a Scottish Zoological Garden of a type in which modern ideals may find expression, is now making rapid headway with its scheme. The council of the society gave its attention, in the first place, to the selection of a thoroughly suitable site, a matter in which, in addition to the expert knowledge of the eminent zoologists who form its vice-presidents, it had the guidance of Dr. Chalmers Mitchell, of London, Dr. R. F. Scharff, of Dublin, and Herr Carl Hagenbeck, of Hamburg. After a very careful consideration of all the available sites in the vicinity of Edinburgh, the council, a few months ago, decided on the estate of Corstorphine Hill House, lying close to the city on its western side. This estate, which extends to seventy-four acres in all, lies on the south-western slope of the hill, and, with its parks and gardens, its fine growing timber and outcropping rock, forms one of the most beautiful situations that could be chosen for the display of a zoological collection. The society holds an option to purchase it at the price of 17,000*l.*, of which about 7000*l.* has been subscribed in little more than a month. The society wishes to raise 25,000*l.* before May next. The honorary treasurer is Mr. T. B. Whitson, C.A., 21 Rutland Street, Edinburgh.

Kinematography in "natural colours" followed as a matter of course as soon as possible after the monochrome projection of moving pictures. We recorded a few years ago the first successful method by which this was accomplished as the result of the work of Mr. G. A. Smith in conjunction with Mr. Charles

Urban, two colours only being used, and the film passing at a double rate, so that the alternating coloured pictures blended as perfectly in the eye as in the non-coloured projection. Such films have been shown for a considerable time at the Scala Theatre and elsewhere, and are well known. Inventors have continued to be very active in this direction, and a demonstration of "chronochrome" films was recently given at the Coliseum, London. These films are in three colours instead of two, as theory indicates to be necessary. The triple pictures are produced by taking the red, green, and blue-violet constituents simultaneously in a single camera, and they are projected on the screen in a similar way, where they are superposed to form the coloured picture. There is no need to enlarge upon the advantage of three colours as compared with two, and if the mechanical difficulties that must have arisen have been fully overcome, as they appear to have been, this process must prove to be a notable advance in colour projection. It would seem, however, that the two-colour method referred to may continue to hold its own because of its greater simplicity.

IN vol. xliv. of the Transactions of the New Zealand Institute, Prof. J. Macmillan Brown criticises the theory of Polynesian migrations advanced by the late Prof. Finck in the Transactions of the Royal Scientific Society of Göttingen for 1909. Prof. Finck's theory was largely based on philological considerations, and postulated a movement from the southern Solomon Islands eastward to the northern fringe of Polynesia. To this Prof. Macmillan Brown objects that, while there is a striking similarity between the languages of Polynesia, Melanesia, and Malaysia, there is a phonological gulf between the Polynesian dialects, on one hand, and the Malaysian, and, still more, the Melanesian languages, on the other. The same difficulty arises from a consideration of physical characteristics and culture. "We get," he objects, "into the region of the miraculous when we start a patriarchal, tribal, genealogy-loving, chiefly Caucasian people from a matriarchal, kin-divisioned, short-memoried Negrito island; and still nearer the miraculous when we start off, for nearly ten thousand miles of open oceanic wandering, a canoe expedition right in the teeth of the only constant winds, the trades that blow eight or nine months of the year, from an island that had only shallow shells of canoes, unfit for crossing anything but fairly narrow straits in calm weather or a favourable wind." These criticisms must be taken into serious account in any future attempt to settle the tangled problems of Polynesian wanderings.

A CONSIDERABLE addition to the Indian fresh-water fish fauna is made by Mr. B. L. Chandhuri in vol. vii., part 5, of Records of the Indian Museum. The new species, which are illustrated in four plates, are all referable to previously known generic groups.

IN *The American Naturalist* for January Mr. E. L. Michael discusses the bearing of the Chætognatha (Sagitta) of the San Diego region on "Jordon's law," namely that, in the case of land animals, the nearest relative of any given species is to be found in a neighbouring district, separated by some kind of barrier. In the case of the pelagic Chætognatha this law is only partially true when tested by vertical distribution, allied species being isolated, but inhabiting situations remote from one another.

IN the January number of *The Museums Journal* the Rev. Henry Browne points out (in a paper read before the Dublin Museums Conference of 1912) how museums may cooperate in placing the study of the classics on a more modern and satisfactory basis. This, it is suggested, may be accomplished by exhibits illustrative of the private and public life, art, &c., of the ancient Greeks and Romans, thereby combining education by means of tangible object with education by literature. Those who are of opinion that no Englishman can know his own language properly without a knowledge of the classics will welcome the suggestion. The natural history museum of St. Andrews University forms the subject of an article in the same issue by Prof. McIntosh.

So long ago as 1887 the late Prof. Marsh proposed the name *Eobatrachus agilis* for remains of a supposed frog or toad from the Como Jurassic of Wyoming. The two type-specimens were, however, never properly described or figured, and the determination has consequently been ignored. An examination by Dr. R. L. Moodie (*Amer. Journ. Sci.*, vol. xxxiv., p. 286, 1912) of these remains indicates that Marsh's diagnosis was perfectly correct, and that they really represent a tailless batrachian, and that, too, of a modern type. Indeed, it is suggested not only that it may belong to the family Bufonidæ, but possibly even to the existing genus Bufo. In stating that the American Jurassic toad is the only known Mesozoic tailless batrachian, the author appears to have overlooked the description in 1902 by Mr. L. M. Vidal (*Mem. R. Ac. Cienc. Barcelona,* ser. 3, vol. iv., (p. 203) of remains of a frog from reputed Kimeridgian strata of Montsech, N.E. Spain, referred to the Oligocene and Miocene genus Palæobatrachus, under the name of *P. gaudryi.*

THE classification of the various forms of cultivated rice is a task that has been attempted by several botanical and agricultural writers, with varying degrees of success. An elaborate system of classification is set forth by S. Kikkawa in vol. iii., No. 2, of the Journal of the College of Agriculture, Tokyo, in a memoir of more than a hundred pages, largely occupied by closely packed columns of measurements, and representing a vast amount of labour. In framing his classification, the author lays down the sound principle that in dealing with cultivated plants it is necessary to take into account not only the relatively constant morphological characters, but also those characters which, though not very constant and often fluctuating considerably, may yet be of great importance for agricultural purposes. The memoir is accompanied by four plates of photographic illustrations.

PROF. C. J. CHAMBERLAIN has contributed to *The Popular Science Monthly* (November, 1912), an extremely interesting account of his recent round-the-world botanical excursion under the auspices of the

University of Chicago. The trip was undertaken for the purpose of making a scientific investigation of the cycads of the eastern hemisphere, and the principal places visited included the Sandwich and Fiji Islands, New Zealand, Australia, and South Africa. The cycads are a gymnosperm family, of which the remote ancestors were abundant in the Palæozoic age and the less remote ancestors were abundant and had a world-wide distribution in the Mesozoic. Only nine genera now remain, confined to tropical and subtropical regions, and even there are very local in their distribution. Of the four western genera, one ranges from Florida to Chile, two occur only in Mexico, and one only in Cuba; of the five eastern genera, one ranges from Japan to Australia, two are found only in Australia, and two only in South Africa. Prof. Chamberlain has during the last twelve years made detailed studies on the American cycads, and with the material now available intends to make a similar study of the Oriental forms, which should yield valuable results, especially since the Palæozoic ancestors of the family are becoming well known through the researches of various English palæobotanists, and the Mesozoic forms are being cleared up by Prof. Wieland, of Yale University.

THE interbasaltic iron ores and bauxites of the north-east of Ireland have long been objects of interest and speculation to geologists and others. The Geological Survey of Ireland is therefore to be congratulated on the production of its latest memoir, which is devoted entirely to these rocks. The new memoir is a well-illustrated volume of 220 pages, giving full details of these formations. Dr. Moss contributes a chapter on the plant remains, and in another chapter a large number of analyses have been collected. Two good colour-printed maps, showing the outcrops of the ores and clays and the associated basalts and rhyolites, are enclosed in a pocket. In an extremely interesting introductory chapter Prof. Cole discusses the nature and origins of these beds and the formation of laterite, bauxitic clays, and bauxitic iron ores in general. The typical downward succession within the interbasaltic beds in the county of Antrim is (1) *pisolitic iron ore*; (2) "*pavement*," a material varying from a siliceous iron ore to a lithomarge, with a false appearance of stratification, due to coloured streaks connected with the decomposition of residual blocks of basalt; (3) *lithomarge*, decomposed basalt retaining the original joint-structure, and often showing pseudomorphs after the felspars of the ground-mass. This passes down into a basic lava of the Lower Basaltic Series. The *pale bauxites* are derived from the rhyolites of the interbasaltic epoch. Some of this rock has been laterised *in situ*; elsewhere it has first been detrital. The main mass of the laterites and lithomarges of north-east Ireland are to be regarded as typical examples of soils and subsoils, formed under conditions now prevalent in regions of seasonal rains, near the equator.

IN *Symons's Meteorological Magazine* for January Dr. Mill gives an interesting account of the rainfall of the British Isles for the year 1912, prepared from a preliminary examination of part of the vast mass of data at his disposal. The following extracts may be useful in supplementing the summary already given in our columns (NATURE, January 16, p. 555), compiled from another source. The rainfall over the whole of the country was in excess of the average, with the exception of very limited areas; generally speaking, the least excess lay round the coast. England and Wales had an excess of 21 per cent., Scotland 7 per cent., and Ireland 9 per cent. The wet months were January to March (the latter having an excess of 63 per cent.), June (+81 per cent.) to August (+58 per cent.), and December (+43 per cent.). Of the remaining months, April and September had only about half the average. In England and Wales, April had only about one-fifth of the average, and in the south of England it was one of the driest months ever known; in Ireland September had only 23 per cent. of the average. There were four axes of high fall, exceeding 20 per cent. above the average, running parallel to one another across the United Kingdom from S.W. to N.E. The most important of these occupied the centre of England from Cornwall to Yorkshire, and reached the south coast also in Sussex. Within this area there was a strip stretching from Land's End to Norfolk where the rainfall was more than 30, and at places as much as 40 per cent. in excess of the average. For the British Isles generally the yearly excess was 14 per cent. above the average.

THE *Bulletin de la Société d'Encouragement*, cxvii., 3 (Paris, 1912), contains a short report on an ingenious chemical balance devised by M. A. Collot, in which the weights used in weighing are attached or detached by pressing buttons, the whole operation of weighing taking place after the case containing the balance has been closed. The sensitiveness is maintained constant by keeping the total load constant and removing the weights from the side on which the scale-pan containing the object is situated.

IN a short paper in *The Electrician* for January 10 Dr. Eccles shows how the efficiency of transmission from the sending to the receiving aërial in any system of wireless telegraphy may be calculated. He applies his method to the original plain aërial of Marconi, the first tuned aërial of Lodge, the recent coupled circuits of Marconi, and to an ideal system sending out a continuous train of waves. He comes to the important conclusion that the present systems of coupled circuits actuated by sparks have efficiencies of transmission about 90 per cent. of that which would be obtained by the use of a continuous generator of electric waves; hence the introduction of such generators can only lead to a small increase of the efficiency of transmission.

IN "The Space-time Manifold of Relativity" (Proc. American Acad. of Arts and Sc., vol. xlviii., No. 11, 1912), Profs. E. B. Wilson and G. N. Lewis give a full and very interesting account of their attempts to construct systematically a peculiar kind of non-Euclidean geometry suitable for the representation of the fundamental parts of the modern theory of relativity, along with its applications to mechanics and electromagnetism. Their scheme is in its essential idea similar to Sommerfeld's four-dimensional vector-algebra and analysis (*Annalen d. Physik*, vol. xxxii.–xxxiii., 1910), but is more radically vectorial, introducing, instead of a mere juxtaposition of four scalars, a formal sum of four vectors corresponding to as many mutually perpendicular unit vectors, with six "2-vectors" and four "3-vectors" to match. Another chief characteristic is that, while Sommerfeld has developed a vector algebra and analysis of essentially Euclidean four-dimensional space, Wilson and Lewis give us from the outset a non-Euclidean system, which suits better the requirements of relativity. Especially interesting as regards novelty of ideas is a discussion, given as a preliminary to "Electromagnetics and Mechanics" (art. 45–47), of the possibility of replacing conceptually continuous and discontinuous distributions by one another, and of a case in which such a substitution is impossible. To make the whole system more accessible to a wide circle of non-specialists, the authors proceed by developing their new geometry first in two, then in three, and, finally, in four dimensions. Another feature of the paper is an uncommon brilliancy of exposition. With but one caution regarding a certain statement about the "extended momentum" (p. 479), which possibly is erroneous, we can recommend the paper warmly, both to freshmen in relativity and to specialists.

THE Clarendon Press has published a translation by Mr. A. S. L. Farquharson of Aristotle's "De Motu Animalium de Incessu Animalium," at the price of 2*s*. net. This booklet completes the fifth volume of the English translation of the works of Aristotle which is being issued under the editorship of Messrs. J. A. Smith and W. D. Ross. It was the desire of the late Dr. Jowett, as formulated by his will, that the proceeds from the sale of his works, the copyright in which he bequeathed to Balliol College, should be used to promote the study of Greek literature. In a codicil to his will he expressed the hope that the translation of Aristotle's works begun by his own translation of the "Politics" should be proceeded with. The volumes to which the present part is a contribution represent the result of the cooperation of Balliol College and the delegates of the Clarendon Press to carry out Jowett's wishes.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR FEBRUARY:—

Feb. 2. 8h. 43m. Jupiter in conjunction with the Moon (Jupiter 5° 17′ N.).
3. 6h. 38m. Mars in conjunction with the Moon (Mars 4° 13′ N.).
4. 13h. 56m. Uranus in conjunction with the Moon (Uranus 4° 1′ N.).
5. 4h. 14m. Mercury in conjunction with the Moon (Mercury 2° 9′ N.).
10. 0h. 13m. Venus in conjunction with the Moon (Venus 0° 51′ N.).
12. 2h. 0m. Venus at greatest elongation E. of the Sun.
,, 11h. 0m. Mercury in superior conjunction with the Sun.
14. 3h. 33m. Saturn in conjunction with the Moon (Saturn 6° 20′ S.).
Feb. 16. 6h. 0m. Saturn at quadrature to the Sun.
18. 0h. 11m. Neptune in conjunction with the Moon (Neptune 5° 30′ S.).
25. 16h. 44m. Mars in conjunction with Uranus (Mars 0° 26′ S.).

THE REPORTED BRIGHT METEOR OF DECEMBER 18.—From notes published by Mr. J. H. Elgie in *The Yorkshire Weekly Post* we learn that the bright object, mentioned in these columns on January 2 as having been seen near Manchester on December 18, was also seen by several observers in Yorkshire. Mr. Platts describes it as being spherical, the diameter being about half that of the moon, and as leaving a bluish trail. After travelling some distance the meteor divided into two portions, the smaller appearing to fall earthwards, while the larger continued in the original path; other observers describe the object as being of exceptional brilliance. Several further letters appeared in the Manchester *Daily Dispatch*, but contain no more precise data than that already given here. Mr. Elgie suggests an atmospheric, rather than a cosmic, origin, and the more precise details necessary to determine the true nature and path of this object would be of scientific interest and value.

CATALOGUE OF CELESTIAL OBJECTS.—We have received the second part of M. G. Raymond's catalogue, "Les Merveilles du Monde Sidéral" (Paris: G. Thomas), which gives brief descriptions, positions, &c., for all peculiar objects between vih. and xiih. right-ascension. This catalogue will be found extremely useful by amateur observers, the objects being arranged in right-ascension, and a brief description given for each; thus one constellation may appear in several different sections, but the different units may be successively examined in the order given. A large number of the descriptions are those of the author himself, others are quoted from different authorities, and in regard to those for double and coloured stars it is possible that some of the hues given are subjective, due to contrast, retinal fatigue, and "dazzle tints," as suggested by Prof. Louis Bell.

THE VAGARIES OF ENCKE'S COMET.—An interesting article discussing the peculiar variation of the period of Encke's comet is contributed by Mr. E. V. Heward to the December number of *The Oxford and Cambridge Review*. Mr. Heward recounts the results obtained from the various calculations of Encke which led him to the idea of a resisting medium in interplanetary space, and briefly discusses the arguments for and against the existence of such a medium. Until the 1867–71 return the acceleration of the comet's motion was fairly constant, but it then suddenly diminished by nearly one-half, only to return to its earlier value at subsequent revolutions. Mr. Heward points out that the theory promulgated by Dr. Backlund, viz. that the comet encountered a stream of meteors of varying density when near perihelion, satisfactorily explains the vagaries of period and is not a negation of the resisting medium idea.

RELATIVE PROPER MOTIONS OF 162 STARS NEAR THE ORION NEBULA.—While spending the year 1911–12 at the Yerkes Observatory Dr. A. van Maanen measured a number of plates of the neighbourhood surrounding the Orion nebula, which were taken on different dates between 1901 and 1912, with the 40-in. refractor. The results show the advantage of using a long-focus instrument, the mean probable errors of the final proper motions being only $0{\cdot}060''$ in α and $0{\cdot}0047''$ in δ. One hundred and sixty-two stars were discussed, and the proper motions are nearly all very small, only three exceeding $0{\cdot}100''$ per annum. (*Astronomical Journal*, No. 642.)

THE AVIATION EXHIBITS AT THE SCIENCE MUSEUM, SOUTH KENSINGTON.[1]

THE aviation exhibition which is open until the end of February at the Science Museum, South Kensington, illustrates, in many cases by means of actual flying machines, the more important scientific principles underlying the practice of flying. Aviation is a new art, and it comes almost as a shock to a visitor to the exhibition to find that so long ago as 1844–5 a model of a flying machine was made by Henson, which, from the illustrations (Figs. 1 and 2) will be seen to bear a striking resemblance to recent monoplanes. For a moment at least a doubt arises as to the assumed progress of the science in recent years, especially when it is realised that one of the greatest difficulties confronting Henson and his co-pioneer, Stringfellow, was the provision of a powerful and sufficiently light engine. The doubt as to our present progress is removed on further inquiry, although we can quite realise that the science of aërodynamics has, for at least half a century, waited for the development of the light petrol engine.

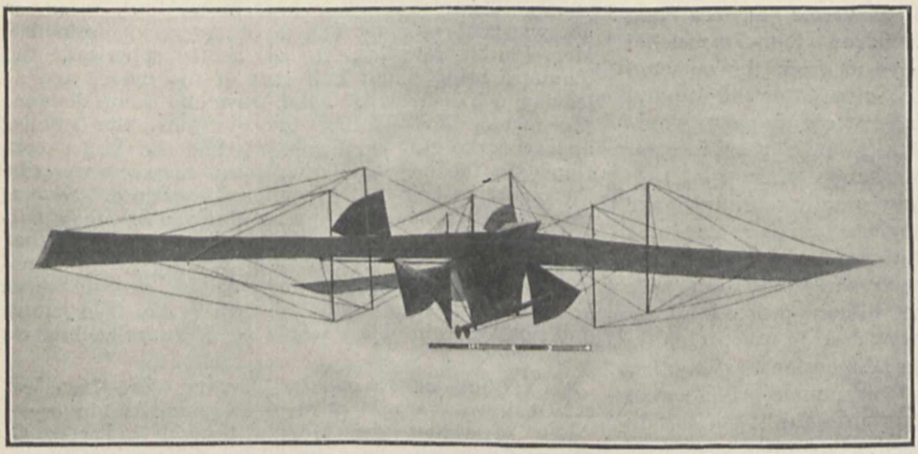

FIG. 1.—Henson's proposed flying machine, 1844–5.

Such differences as occur between Henson's proposed machine and those of the present day are essentially those which have been introduced since aëroplanes lifted themselves from the ground and aviators found themselves under the necessity of balancing their machines in more directions than for any previously known form of locomotion.

The quantitative side of the science of aviation received its beginning and a powerful initial impulse from the work of Langley. As a result of his experiments prior to 1896, Langley calculated the size of wings necessary to carry a small steam engine, and made models which flew for considerable distances. Lilienthal afterwards introduced a universally accepted modification into the shape of the wings by giving a camber to the section, but the calculation of the size of the wings necessary to support a given weight at a specified speed still rests substantially on the same data as were obtained by Langley.

Besides having the proportions of a good lifting surface, the Henson model is further interesting in that it has a body carefully shaped so as to offer a small air resistance, a point of design now receiving much attention. Such a surface, unless carefully placed, might, however, make the machine liable to rolling instability, a point of difficulty which remained for nearly two years after power-driven aëroplanes capable of carrying an aviator had left the ground. The method of control introduced by the Wright brothers, and shown in the exhibition by the actual working of the mechanism of a "Baby" Wright biplane and a skeletonised Wilbur Wright control, made flying for longer periods than a few minutes a regular performance, and has now been universally adopted. Before this stage of progress had been reached, Lilienthal and Pilcher, whose machines are exhibited, lost their lives in an attempt to obtain stability by the motion relative to the wing surfaces of a considerable mass.

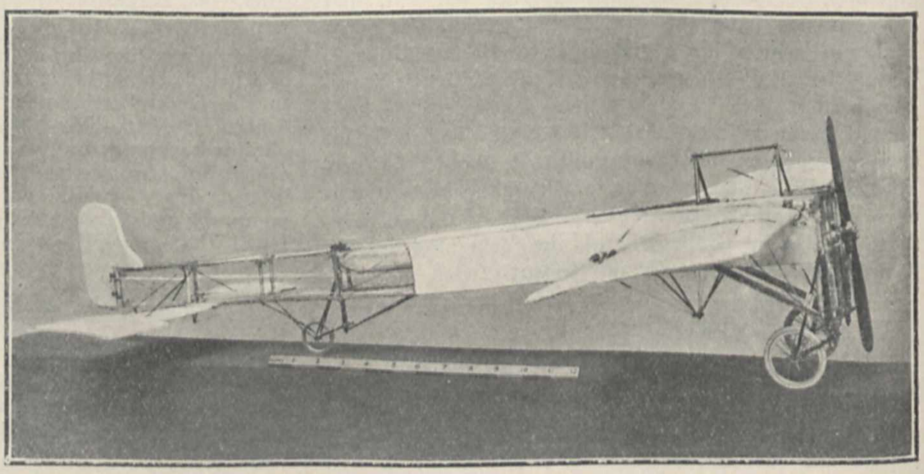

FIG. 2.—Blériot monoplane, 1909.

Their experiments were carried out on gliders, *i.e.* machines which obtained the necessary energy for motion from a descent under the action of gravity, and the aviator's body was the mass moved. This method of control has been entirely superseded by the invention of the Wright brothers.

How far the modern aëroplane is able to look after its own safety and how far it is dependent on the skill of its pilot is still a subject for investigation. The tendency appears to be to try to obtain stability

[1] The illustrations which accompany this article are from the Catalogue of the Exhibits, and are reproduced with permission of the Controller of H.M. Stationery Office.

by means of rigid surfaces, the stability asked for being somewhat similar to that of a Canadian canoe, which allows rolling up to a certain inclination for very small movements of the occupant, but offers great resistance to any motion beyond that limit. Such stability, if realisable, would leave the aëroplane sensitive to the pilot's control except in cases of emergency, when the aëroplane had departed considerably from its position of equilibrium, when it would assist the pilot to regain control. If, alternatively, it should ultimately be decided that the pilot must be assisted automatically, then some such device as the Clarke Johnson gyroscopic control exhibited might be used.

SCIENCE AT RECENT EDUCATIONAL CONFERENCES.

IN a previous article (January 23) reference was made to the teaching of physiology and hygiene in schools. At the London County Council Conference of Teachers a considerable portion of the programme was concerned, directly or indirectly, with these subjects. Prof. Starling presided at the fourth session, and referred to the training in physiology of the teacher and the training in physiology or hygiene of the child. It was sufficient if the child was brought up with the knowledge of the rules of right living, but these rules were founded on physiology, and the teacher must have reason for the faith that was in him. On that ground the Physiological Society had appealed to the Board of Education to provide additional facilities for the study of physiology by teachers, and to make such study compulsory.

At the same meeting Prof. Leonard Hill gave an address on open-air and exercise, Mrs. Truelove read a paper on instruction in infant care in girls' schools, and Mr. A. J. Green discussed the value of the open-air school. It is further to be noted that, at each of the three preceding sessions of this conference, subjects bearing closely on the health of the children were brought forward, and the medical profession figured prominently in the discussions. As we are all aware, the tendency to pay regard to the physical welfare of school children is prominent in the programmes of other educational meetings—*e.g.* British Association, Section L. Why this exceptional solicitude at the present time?

It may be granted that administrative and political factors have given much strength to this movement, but there are perhaps somewhat deeper reasons for the ready response of teachers to the call now made upon them to regard their work as one of the agents in determining the health of the nation in years to come. One of these deeper reasons is that biology, with her handmaiden evolution, is come into her own. The child is viewed as an organism; teachers and administrators are thinking biologically. The old platform tag, *mens sana in corpore sano*, implied a duality of mind and body, whereas to-day we recognise that the *mens* and *corpus* are educationally inseparable. The psychology of McDougall and the newer school is the offspring of a union of the old psychology with biology—it is not a mere change of the old, but a new-born science. And of this new source of inspiration teachers are drinking in increasing numbers.

The papers of the third session of the L.C.C. Conference were devoted entirely to an exposition of the modern teachings of psychology on the subject of attention. Prof. Spearman, who presided, stated the relations between psychology and education as those of "equal allies who had a joint mission—perhaps the greatest national mission—the making of the nation itself." The words just quoted give the clue to the other great influence which, side by side with psychology—the thinking biologically of the individual—is now influencing the trend of educational ideals and progress. This second influence is to be found in the growing sense of social and economic interdependence—the thinking biologically of communities—the viewing of the State as an organism, and even of world-commerce as an organism. Hence the feeling that an education lacks an important essential which neglects that promising avenue of human progress—the study of economics. There also flows from this sense of social solidarity an increased sense of responsibility for the economic conditions affecting the lives of the poorer classes.

These trends of thought and feeling found respective expression in the educational conferences in the discussions on economics for schoolboys at the L.C.C. Conference, when secondary education was being discussed, and in those on household economics of the poor, at the meeting of Teachers of Domestic Subjects. At this meeting Mr. J. Wilson proposed to weave the two threads of State and domestic economics when he suggested that, in the allocation of the State Development grants, the claims of investigation into possible improvements of methods or appliances used in household work should receive consideration.

That thousands of teachers assembled during their Christmas holidays in twenty conferences in order to "talk shop" shows to every thoughtful person that the teaching profession is spiritually sound. This article fails if it does not indicate, however imperfectly, that the profession is studying its calling with the methods of science, and is no longer satisfied with empiricism. The growth of a body of educational workers thus animated with scientific purpose is the best warrant, if not of the present existence, at least of the imminent development, of a science of education.

G. F. DANIELL.

MODERN MICROSCOPICAL OPTICS WITH SPECIAL REFERENCE TO FLUORITE OBJECTIVES.

GAUSS'S theory of lenses and other optical systems, which was published in 1840 in his "Dioptrische Untersuchungen," and subsequently largely extended by many other investigators, rendered it possible to apply the cardinal theorems relating to the formation of optical images to the most complicated systems of lenses, of which already in Gauss's time the microscope objectives furnished a good example. This theory paved the way for the computation of microscopic objectives and furnished a means of studying the optical principles of the microscope as a whole and the objective and eyepiece considered separately.

Even before Gauss, Fraunhofer in 1820 had succeeded in devising a complete system, enabling him to compute telescope lenses, and a little later Seidel and Steinheil evolved a similarly complete system for the computation of photographic lenses.

Prof. E. Abbe, who in 1866 became associated with the optical establishment of Carl Zeiss in Jena, was the first to venture upon a complete calculation of the microscope objective by applying the theory of Gauss. After a series of futile attempts, he established a system by which a microscope objective could be computed in every detail. The methods by which he applied his system to practical computations have not been made known.

A further valuable contribution to practical optics was made by Helmholtz and Abbe, who, by discovering the sine condition, showed the means by which an object and its image can be made geometrically similar. It is, however, a great mistake to suppose that these achievements in the mathematical equipment of the microscope inaugurated a brilliant epoch in the history of the microscope, and that enormous progress was made henceforth. In the first place, it was found that by a carefully developed trial-and-error system opticians had succeeded in producing objectives which in a high degree satisfied the conditions postulated by mathematical theory. Thus it was found that all objectives tested by Abbe completely satisfied the sine condition, although until then this had been unknown in principle.

The investigations of Helmholtz and Abbe (1873–4) showed by the formula of the former, $\epsilon = \frac{\lambda}{2 \sin \alpha}$, and Abbe's formula, $\epsilon = \frac{\lambda}{2n \sin \alpha}$, that the optical performance of the microscope is confined within definite limits. In these formulæ ϵ denotes the smallest distance separating two successive particles of an object which can be differentiated under a microscope; λ is the wave length of any given ray of light, as defined by Helmholtz, in air or any other medium intervening between the object and the front lens; α is the semi-apertural angle of the objective, and n the refractive index of the medium between the objective and the cover glass. In dry lenses the value of n is accordingly 1·0, in water-immersion it is 1·33, and in oil-immersion lenses $n = 1·52$. The denominator in Abbe's formula, $n \sin \alpha$, has been named by him the numerical aperture of the lens; it furnishes the principal criterion of the optical capacity of the microscope. When these factors, which determine the optical resources of the microscope, were discovered, the microscope had already been brought to a very high degree of perfection by purely empirical means, and in practical respects the formula had already been satisfied to a very considerable extent, and but little scope was left to the investigator and computor. The apertural angle had already attained very considerable magnitudes; water-immersion and oil-immersion lenses were already in existence, and accordingly the element n in Abbe's formula had already received practical consideration, whilst in the formula enunciated by Helmholtz the wave length of a ray in air had become reduced to a quotient $\frac{\lambda}{n}$, by which the wave length was shortened in proportion to the refractive index of the medium.

Amici in Italy, Spencer in America, Fraunhofer, Kellner, Oberhauser, and Hartnack in Germany, Chevalier in France, and Ross and Powell and Lealand in England had all done a great deal to perfect the microscope objective. In medical research a new era had been inaugurated by the achievements of microscopic observations; histology and pathology had been placed upon a firm basis; and Pasteur had already planted the beginnings of bacteriology and identified a number of pathogenic germs. In the face of the difficulties and limited possibilities with which the optician had to contend, it would be interesting to form an estimate of the results which opticians had been able to achieve from the time that they commenced to apply the resources of scientific research. The formula given above made it clear that there was no possibility of extending the capacity of the microscope by increasing without limit its magnifying power. Means had indeed been found to increase the angular aperture α in a measure as the magnification rose higher and higher, but there was a limit beyond which it was impossible to increase the magnifying power of a lens without reducing the free distance between the object and the front lens to an impracticably small amount, which did not even provide room for a thin cover glass. Continued attempts were made to extend the power of the microscope by increasing its magnifying power. It was soon found that lenses having such extremely short focal lengths as 1/20 in. 1/50 in., and even 1/75 in., in which there was no corresponding increase of the angle of aperture, were in no wise superior in their optical capacity to lenses of lower power, and the trouble expended upon them was clearly wasted. These extremely high powers, of which many examples were produced by the opticians of fifty or forty years ago, have now been entirely discarded, and one rarely meets now objectives having a shorter focus than 1/16 in.

Opticians then proceeded to concentrate their efforts upon increasing the numerical aperture. Dry lenses had already then been made with apertures of 0·90, and this value has not been exceeded even in these days. Water-immersion and oil-immersion lenses, with their theoretical apertural limits of 1·32 and 1·52, were, however, still far removed from what was practically attainable; in fact, they did not exceed 1·0 in water-immersion and 1·2 in oil-immersion lenses. To carry the aperture further it was necessary to endow the lenses with a greatly improved spherical correction, and much higher demands were made upon the skill of the optician, both in the matter of lens grinding and mounting. By the exercise of an extraordinary degree of skill in the mounting of the front lenses and by clamping them by their extreme ridge, the practical optician has come very near to the theoretical limits, and has been able to realise apertures up to 1·2 in water-immersion lenses and 1·4 in oil-immersion lenses. These were momentous achievements, and it is to lenses of high aperture that bacteriological research owes the greater part of its success. When the limit had been thus reached in both types it was thought to increase the power of the lens by introducing a medium of higher refractive power. Since the transition of light from air ($n = 1$) to water ($n = 1·33$), and that from air to oil ($n = 1·52$) had furnished such striking results, it was expected that the transition to a more highly refracting medium having a refractive index of 1·66 would furnish a means of increasing the aperture still further.

An objective of this kind, in which the immersion medium was monebrome naphthalin, was computed by Prof. Abbe and made by Carl Zeiss in 1889. Its numerical aperture was 1·60. To secure the full advantage of this large aperture it became, however, necessary to satisfy an extensive range of conditions. The condenser must have a similar aperture, both it and object slide required to be joined by a stratum of monebrome naphthalin, and the slide as well as the cover glass had to be made of glass having the same refractive index as the immersion medium, and the object itself had to be mounted in a powerfully refracting medium.

Dr. Van Heurck (Van Heurck, "Le Microscope," 1891, p. 63), who used this objective for a considerable time, and obtained with it many remarkable photographs, including striking photographs of *Amphipleura pellucida*, whilst praising the great resolving power of the objective, described it as scarcely adapted for regular practical use, both on account of the enormous difficulties which its use entails and its inordinately high price. Of the chief causes which militate against the use of the objective, and indeed render it almost impracticable, Czapski remarks in the *Zeitschrift für wissensch. Mikroskopie*, vol. viii., 1891, p. 149, as follows:—Organic preparations require from their very nature to be embedded in media which in the majority of cases have a much lower refractive index than the immersion fluid for which the objective has been computed. This excludes all these preparations from observation with the monebrome naphthalin lens, since one of the principal conditions for the successful use of the lens remains unfulfilled. Even the difficulties which attend the use of the objective and its high price could never have been regarded as a sufficient reason for dispensing with its services if any considerable range of objects existed which could bear being embedded in the media having the requisite optical properties, and in which the capacity of the lens could be turned to full account. As it is, the objective is only known by the photographs taken by Van Heurck, and, as a matter of fact, the lens has long ceased to be manufactured.

There is yet another way of enhancing the working capacity of a lens, as will be seen from the formulæ of Helmholtz. The wave length of light may be reduced by working with white light having a wave length of 0·00055 mm., or blue light having a wave length of 0·00043 mm., or ultra-violet light having a wave length of 0·00028 mm. Blue light reduces by about 1/4–1/5 of its original value, whilst ultra-violet light reduces it to about one-half. A few years ago Dr. A. Koehler investigated successfully what might be accomplished in this direction by the use of light of extremely short wave lengths (*Zeitschr. f. wiss. Mikr.*, vol xxi., 1904, p. 129 *et seq.*). An elaborate new apparatus was required to obtain tangible results from the application of very short waves. Even the best glasses that will transmit ultra-violet light did not suffice for the purposes of this investigation, and the only materials which transmitted ultra-violet light of sufficient intensity were fused quartz and fluorspar. The condenser, the object slide, cover glass, objectives, and eyepieces had all to be made from either of these materials, whilst glycerin served as the immersion fluid. Only a limited number of mounting media were available for use with this apparatus. The lacking intensity of this light rendered it impossible to apply it visionally, and recourse was accordingly had to the photographic method. The difficulties encountered in focussing the object have been overcome by the application of fluorescent light.

The greatest difficulties were encountered in the construction of the objectives. Owing to the limited choice of materials it was impossible to attempt to make the lens achromatic, and indeed this was scarcely a matter of importance, seeing that the light used is almost monochromatic. On the other hand, the use of simple lenses made it impossible to secure spherical correction with respect to more than a small central aperture. This applies at least to a high power dry lens and to an oil-immersion lens of lower power.

There is another circumstance which was found to be a serious drawback, in that the lenses of the objectives had necessarily to be mounted without the usual adjustments by means of which departures in the radii, thickness, distance between the lenses, and irregularities in the homogeneity of the glasses may be allowed for, since it is almost beyond the resources of a workshop to apply any direct test to lenses corrected with respect to the ultra-violet light. It will be readily appreciated that an objective which is made exclusively on the strength of data obtained by calculation without the controlling aid of the optician's art must necessarily be of the nature of chance products. In these circumstances one may either dispense with the highest degree of perfection by accepting an objective as it leaves the optician's hands, or one may from one of a series of several lenses select the one which is best, by direct observation with a fluorescent screen, with a fluorescent eyepiece, or by photographic tests, but such a proceeding would be inordinately costly. Koehler's investigations have the merit of having clearly demonstrated the almost insuperable difficulties with which one has to contend when attempting to apply ultra-violet light. The photographs which have been obtained so far with the aid of ultra-violet light have scarcely furnished any new aspect of the structure of microscopic objects.

Apochromatic and Fluorite Lenses.

The labours of Abbe and Schott in the study and production of optical glasses, which were begun in 1881, were to a certain extent completed in 1886. In the technical laboratory established by them under the title of Schott und Genossen, they brought out, in addition to the crown and flint glasses then in use, an extensive series of glasses having markedly improved optical properties and of a different chemical composition. By introducing phosphoric acid and boric acid as components of glass smeltings, in addition to silicic acid, they succeeded in producing new crown and flint glasses, the so-called phosphate and borate glasses, in which the rate of change of the dispersion is remarkably proportional, so that it appeared possible by the combination of these glasses partly to eliminate the secondary spectrum, which hitherto it had been impossible to eliminate to any appreciable extent. In the course of time the Schott works introduced an extensive selection of optical glasses, which greatly simplified the computing optician's work. The list includes glasses of similar refringent properties but widely different dispersion, and others again having a similar dispersion but covering a wide range of refractive indices. This was a great advance over the old glasses, in which any increase of dispersion was attended with a rise in the refractive power.

A valuable feature of the new glasses is that the glass works were able to reproduce very closely any of the types specified in their catalogues, and, in addition, every new pot was examined with the spectrometer and its constants recorded. This relieves the computer of the task of having to determine for himself the optical properties of the glasses, and likewise the optician working on the trial-and-error principle was enabled more easily to attain his purpose by a judicious variation of the glasses in accordance with their refractive properties and dispersions. These glasses were used for the first time in apochromatic objectives as originated by Zeiss. This would indeed have been a stupendous achievement if, as the makers of these lenses maintained at first, their success had been solely due to the use of the new phosphate and borate glasses. Unfortunately, as we shall have occasion to show, it was the introduction of fluorite into the composition of the lenses which was responsible for these achievements.

The new objectives, which were completed in 1886, proved a great advertisement for the glass works of Messrs. Schott und Genossen. Of the use of fluorite, however, not a word was uttered, even in a lecture delivered by Abbe on the subject before a scientific gathering and published in the Transactions of the *Jenaische Gesellschaft für Medizin und Naturwissenschaften*, under the title, "Ueber neue Mikroskope," or, as it appeared in a subsequent reprint, "Ueber Verbesserung des Mikroskops mit Hilfe neuer

Arten optischer Gläser." Again, not a word was said of fluorite in a paper entitled, "On Improvements of the Microscope with the Aid of New Kinds of Optical Glass," which appeared in the Journal of the Royal Microscopical Society, vi., 1886, p. 20, *et seq.*; neither was it mentioned in a publication prepared for French readers, and entitled, "Nouveaux Objectifs et Oculaires pour Microscopes construits avec les verres spéciaux de la Verrerie scientifique (Schott et Cie.), par Carl Zeiss, Atelier d'Optique à Iena."

Four years passed before the true facts of the case were made known by the firm of Zeiss in an article published in the *Zeitschrift für Instrumentenkunde*, 1890, p. 1, under the heading, "Ueber die Verwendung des Fluorits für optische Zwecke." Long before the publication of this paper other firms, having failed to produce lenses equivalent to the apochromatic lenses with the aid of the new glasses only, had realised that the great advances in achromatic correction embodied in the apochromatic lenses were not due in the first instance to the use of the new glasses but rather to that of fluorite. Doubtless Abbe had set himself the task of achieving chromatic correction of a higher order by means of the new glasses only, but he failed in accomplishing any very striking results with the aid of these glasses only, and, moreover, the optically most trustworthy glasses could be used in a very restricted sense only, owing to their lack of resistance to atmospheric influences.

We will now briefly discuss the conditions under which glasses combined to form crown and flint glass pairs will furnish a means of securing a more or less complete degree of spherical and chromatic correction.

The older lenses of the achromatic type are composed of two doublet lenses for the lower and moderately high powers, with one or two front lenses of crown glass added for the high powers. The doublet lens consists of a negative flint glass component and a positive crown glass component cemented thereto. The spherical correction is in the main effected at the surface of contact between the components of the doublets. The magnitude of the difference in the refractive indices of the flint and crown glass components governs the curvature of the cemented surfaces, and it should be as high as possible to flatten the surface and to adduce favourable conditions for the correction of the spherical aberration and for securing a high aperture. To eliminate the chromatic aberration the glasses are so chosen that the dispersion of the highly refracting flint may be considerably greater than that of the less refringent crown glass. A good gauge of the dispersive properties of a glass is furnished by the formula $\frac{nD - 1}{nF - nC} = \nu$; nF, nD, nC denote the refractive indices with respect to the rays corresponding to the F, D, and C lines of the spectrum; $nF - nC$ stands for the mean dispersion; $\frac{nF - nC}{nD - 1}$ supplies an expression for the dispersive power, whilst its reciprocal value, usually denoted by the letter ν, is known as the efficiency of the optical medium.

In the list of glasses made by Messrs. Schott and Co. the glasses are arranged in a progressive order of ascending values of the efficiency ν. Glasses in which the value of ν ranges from 75 to 55 are usually classed as crown glasses, whilst those in which ν has a smaller value go by the name of flint glasses. The combination of a positive crown glass lens with a negative flint glass lens affords a means of correcting the chromatic aberration.

A higher degree of achromatisation can be attained, *i.e.* the secondary spectrum may be eliminated and rays made to meet in a point with respect to more than two colours, if glasses are chosen in which the dispersions proceed by proportional steps. The degree to which this requirement is satisfied may be ascertained by dividing the difference of the refractive indices for two fixed lines of the spectrum, say F and G', *i.e.* the so-called partial dispersion, by the difference of the refractive indices for the interval C to F the so-called mean dispersion. A pair of crown and flint glasses, in which the quotients $\frac{nG' - nF}{nF - nC}$ differ least will be best adapted for the achromatisation of an optical combination with respect to a third colour.

	nD	ν	q	Δq
Achromatic Lenses.				
Crown 0·60	1·5179	60·2	0·566	43–49
Flint No. 36–38 ...	1·6202–1·6489	36·2–33·8	0·609–0·615	
Pantachromatic Lenses.				
Phosphate crown I.	1·5159	70·0	0.5[illegible]2	15–31
Borate flint	1·5521	53·8	0·567	
,, ,, ...	1·6086	44·3	0·583	
Apochromatic Lenses.				
Fluorite	1·4338	95·4	0·561	2–10
Boro-silicate crown.	1·5100	64·0	0·559	
Barium-silicate crown	1·5399	59·4	0·566	
Dense barium-silicate crown	1·5726	57·5	0.571	

The above table shows in the first section a pair of glasses such as are used to produce an achromatic lens, and it will be seen to what extent the refractive indices of the components nD and the values of ν should differ to effect the requisite spherical and chromatic corrections. It will be seen that the quotients given in the column headed q, viz. $\frac{\text{partial dispersion}}{\text{mean dispersion}}$, differ by an amount $\Delta q = 43$ to 49 units. With this difference remaining there is still a pronounced secondary spectrum, since the imperfect proportionality in the configuration of the spectra due to the glasses renders it impossible to bring three colours to a point.

The second section typifies the new glasses which were employed to effect a higher degree of correction in achromatic lenses. In the first place, the difference in the refringent properties of the phosphate crowns and borate flints was not sufficient to obtain such flat lens curvatures as are needed to ensure a large aperture, at least not with a single pair of glasses. The quotiental difference, Δq, is in these glasses brought down to 15–31. This signifies already a very marked advance, and to improve still further upon it one would have to have recourse to denser flint glasses of greater refractive power so as to obtain better conditions for correcting the spherical aberration by flattening the curvative. Even if it had proved possible, by complicating the formula, to evade the presence of pronounced curvatures and to use glasses of a small quotiental difference only, there would still have remained an insurmountable difficulty in that all borate and phosphate glasses are so little permanent as to exclude their use in lenses. An objective containing elements made up of these materials, whilst produced at a greatly increased cost, could not have failed to become useless in a very short time. Those lens-makers who used these glasses before they had had time to realise their peculiarities had to pay dearly for their subsequent experience.

The third section of the table comprises fluorite and a number of glasses with which it may be associated to form achromatic pairs. The difference in the refractive properties of fluorite and these glasses is not less than in the ordinary glasses, such as enter into the composition of the well-proved older achromatic lenses, and it is sufficiently great to insure the flat curvatures needed for spherical correction. The difference in dispersion is at least equal to that occurring in the achromatic lenses, and hence no obstacles are encountered in bringing two colours to a point. The significant result derived from the use of fluorite is that the difference of the quotients q reduces to 2–10 units, and almost disappears even in some combinations, so that in addition to rays corresponding to the D and F lines of the spectrum a ray of yet another colour, corresponding to G′, can be brought to a point. The immense utility of fluorite lies in the fact of its low refractive index being coupled with an extraordinary small dispersion, by which it differs in a striking degree from the glasses, whilst yet the quotient is similar to that of the existing crown glasses. The use of fluorite in the place of the usual crown glass component rendered it possible to replace the ordinary flint component with its disproportional dispersion by a crown glass having either a quotient agreeing with that of fluorite or at least differing but slightly from it.

The older silicate crown glasses, which had so far been used in the composition of achromatic lenses, contain a number of glasses which differ widely from one another in their refractive and dispersional properties, whilst their quotient is much the same as that of fluorite. By combining fluorite with these crown glasses a means was obtained of producing more perfectly achromatic lenses without the need of a new glass.

It will thus be seen that the new glasses were quite a subordinate element in the composition of apochromatic lenses. There is no doubt that their greater range of variety has made it easier to produce apochromatic lenses, but it is not essentially owing to them that apochromatic lenses have come into existence. In 1891 Leitz made an attempt to produce lenses of a higher degree of correction by the use of glasses only. These were the so-called pantachromatic lenses, the optical qualities of which were intermediate between those of the achromatic and apochromatic lenses. The attempt, however, had soon to be discontinued since those glasses which had proved the best means of endowing the pantachromatic lenses with a higher degree of colour correction proved to be liable to deterioration. Within the last ten years several opticians have introduced a new class of objectives, the so-called fluorite lenses, in which the qualities of the former pantachromatic lenses are realised with the aid of fluorite.

These objectives have, so far as the author is aware, the simple composition of the achromatic lenses, and do away with the necessity of introducing a triple lens, which renders them much less costly than the apochromatic lenses. In their degree of colour correction they approximate to apochromatic lenses in proportion to the number of fluorite lenses used in the system. Dispensing, however, with the triple lens, they cannot be rendered equivalent to apochromatic lenses, even when the number of fluorite lenses is the same in both systems. On the other hand, it is the presence of the triple lens which adds materially to the cost of the apochromatic lenses.

Reviewing the results achieved within the many years during which the practical optician has been guided and aided by the resources of science, it cannot be said that any epoch-making progress has been made. Yet it cannot be denied that modern men of science and practical opticians have manifested an extraordinary activity in their keen desire to improve the power of the microscope and to extend our knowledge of the instrument.

Comparing the performance of modern lenses with those of thirty years ago one cannot fail to realise that steady progress has been made. An objective of numerical aperture 1·40 is a remarkable piece of work, and there is scarcely a modern lens that does not bear testimony to the fruitfulness of recent efforts. New types of objectives have likewise been devised for the needs of the photographer, and various new devices for observation by dark-ground illumination, especially Leitz's dark-ground condenser, have developed this method of observation in a surprising manner. The indefatigable activity of opticians as well as physicists has elucidated the nature of the problems relating to the limits within which it is possible to improve the microscope, and has given us a better insight into the *modus operandi* of the instrument. It may suffice to remind the reader of Abbe's theory of optical instruments.

To what extent the study of microscopic optics has occupied the minds of research workers is eloquently borne out by the vast literature which during this period deals with the microscope. Of journals devoted to the study of the microscope we may mention the *Zeitschrift für wissenschaftliche Mikroskopie,* the Journal of the Royal Microscopical Society, and the Journal of the Quekett Microscopical Club. The microscope forms also the subject of extensive works, amongst which one may mention those of Abbe, Dippel, Lummer and Reiche, van Heurck, Wright, Spitta, and Carpenter. A number of meritorious works have been published which, whilst dealing with optical matters in general, go far to further the development of microscopical optics. Of the authors who have written on geometrical optics and optical instruments we may mention Ferraris, Herman, Maxwell, Lord Rayleigh, Heath, Gleichen, Drude, Czapski, von Rohr, Whittaker, Gullstrand, Leathem, Schwarzschild, Maclaurin.

It has often been said that the microscope has reached the limits of its resources. Certain it is that it has needed the application of the utmost skill and the most strenuous efforts to enhance the powers of the microscope during recent years. There is, however, every prospect that the ever-extending use of the instrument, the increasing demands made upon it, the intense scientific attention bestowed upon its development, and the fine training of the modern optician will not fail to maintain progress.

C. METZ.

SOME OF THE NEXT STEPS IN BOTANICAL SCIENCE.[1]

WHEN one who has worked long in any field of science speaks before an audience such as this he is expected to say something about the condition of his branch of science when he began work with meagre and poorly adapted apparatus, to contrast it with its greatly improved condition to-day, and to dwell with pride upon the finely equipped laboratories with costly apparatus, especially designed for particular experiments, to be found by the twentieth-century scientific student.

In order that we may properly orient ourselves with reference to the area covered by the science of botany to-day, we shall have to go back a few decades to understand what additions have been made to its territory during this period of expansion.

Consider for a few minutes the botany of forty years

[1] From an address delivered before the American Association for the Advancement of Science at Cleveland, Ohio, December, 1912, by the retiring president, Prof. C. E. Bessey.

ago, when you could count on the fingers of one hand the American colleges that had chairs of botany. And here I use the term chair advisedly, for they were literally chairs and not departments, much less laboratories. And everywhere else in the colleges of the country the chairs of botany were represented by what Holmes so aptly called "settees," from the number of subjects taught therefrom. The botany dispensed from these chairs was the delightful study of the external morphology of the higher plants, especial emphasis being laid upon the structure of flowers and fruits.

And with this external morphology there was always associated the classification of the higher plants, in its simpler form the pleasurable pastime of identifying the plants of the neighbourhood, and in its more advanced form represented by the work of Torrey and Gray, and Vasey and Engelmann. We should judge systematic botany of that day by the work of these masters, and not by the diversions of its amateurs; and you will agree with me that, so judged, the systematic botany of that period will not fall short of any standard we have set up in these later days.

The botany of that day was not without its laborious investigations and its tangible results. That was the day of the founding of many small botanical gardens, and small local herbaria, some of which, having served their purpose, disappeared long since, while others have grown into the great and flourishing institutions of to-day.

And what of the botany of to-day? The *personnel* of botany has greatly increased with the great increase in the territory it now includes. This *personnel*, it must be said, is still quite heterogeneous. Some of us are largely self-taught, so far as the major part of the subject is concerned. We brought to our work the results of the meagre teaching of the old-time college class-rooms, and year by year we have enlarged the borders of our own departments as we have added to our own knowledge of the subject by means of our laboratories and libraries. Thus we have built all kinds of superstructures upon the foundations supplied by our teachers. As a consequence the science is yet largely unorganised and lacks consistency in plan and purpose.

This difference of opinion as to what constitutes botany results in the absence of united effort. In its simplest aspect it takes the familiar form of uncertainty as to the content and value of the work done by the student elsewhere when he transfers himself from one college to another. As a matter of fact, there is yet no agreement as to what is a standard first-year's course in college botany. What teacher has not been sorely puzzled to know to what courses to admit men who came from another college with credits in botany! Ignorance is no valid excuse for the scientific man, and in science everything is worth while. It is to our shame as botanists that we acknowledge our inability hitherto to frame a standard first-year course in college botany. When the science is definitely formulated in the minds of botanists the present disagreement will no longer exist. Surely we now "see as through a glass darkly."

Again, it may be remarked that we are to-day placing great emphasis upon the applications of botany to some of the great human activities, especially to agriculture. Witness the agricultural experiment stations with their botanists of all kinds, from those who study weeds and poisonous plants, to the physiologists, pathologists, ecologists, and plant-breeders. And as we look over the work they do we are filled with admiration and pride that they have individually done so well. But it is not the cumulative work of an army of science; it is rather the disconnected, unrelated work of so many individuals. They are doing scientific work in an unscientific way. Botanical science which should have guided and directed these laudable applications has not kept pace with them, and we have the spectacle of these economic botanists, physiologists, pathologists, plant-breeders, and others working apart from the botanists proper, and sometimes even disclaiming any allegiance to the parent science. Nothing but confusion and disaster can result from such a condition.

Contrary to what is sometimes affirmed, botanists are still studying the flora of the country. In some quarters there has been expressed the fear that field botany has disappeared from the schools and colleges, but this is far from true. While it no longer claims the larger part of the student's attention, it is still an essential part of the training of every botanist, and it is probably true that in some cases there is even more field work required to-day of young botanists than its importance demands. Certainly in one kind of field work I should like to see some of the energy and ability now given to the discovery of means for splitting old species turned towards the solution of problems pertaining to growth and development and reproduction. But the careful field study of what plants grow here and there, and why they do so, is greatly to be commended. The sociology of plants, or, as we call it, ecology, has given in the last few years a new reason, as well as a new direction to field botany.

The systematic botany of to-day continues to concern itself more with the distinction of species than with their origin, and this has brought to this department of the science an increased narrowness which has greatly injured its usefulness. On the other hand, plant-breeding, which should be the experimental phase of systematic botany, has had no connection with it. And, strangely, systematic botany, which should welcome plant-breeding as an ally in its quest as to the meaning and origin of species, has been scarcely at all interested.

Let us turn now to the future of botanical science, and endeavour to trace its more profitable course of development during the next one or two decades. What are seemingly to be the demands of modern society upon this science? What are to be some of the next steps in its evolution? For whatever we may say in regard to the independence of science we cannot escape the fact that it must serve its "day and generation." No science can hope for support or recognition that does not respond to the demands of its age.

My first inquiry may well concern itself with the content of botanical science in the immediate future. As we become better acquainted with it and recognise more clearly its relations to the activities of the community we shall be able to define its proper content with more accuracy. And let no man attempt to belittle the importance of such an undertaking. I am well aware of the impossibility of absolutely delimiting botany from every other science, and especially of doing so with reference to many of its applications, and I am fully aware of the fact that the limits of any science are subject to change with the progress of human knowledge. Now and then there must be a "rectification of the frontier" in respect to the boundaries of a science. So without doubt we shall have to add to or subtract from the area now allotted to botany.

It still is true that the field of botany may be considered in three parts—structure, physiology, and taxonomy. Beginning with such structures as are obvious to our unaided eyes, we have carried our studies to the minute structure of the tissues, and the cells which compose them. We are able now to peer into the protoplasmic recesses of the living cell, and while we cannot say that we have seen life, we have seen where life is, and what it does. Cytology, histology, and morphology in our modern laboratories have greatly changed our conception of the structure of the plant. It is no longer made up of forms to be compared because of their general similarity of outline, or of position in the plant body. The plant as a whole is a community of variously differentiated living units, just as is each of its organs. It is a complex community in which there is a measure of individual independence of the units, along with much of mutual dependence.

This leads me easily to that portion of the field of botany that has to do with the activities of plants and their organs—physiology—the scope of which has been so greatly extended in these later years. Here such inquiries as those pertaining to nutrition, growth, sensibility, reproduction, are of primary importance. The introduction of the experimental method of inquiry has made this a favourite department of the science. Who does not enjoy catching a plant, tying it up in a corner, and compelling it to do something, while we watch for the result? This kind of study appeals especially to those who are looking for demonstrations, and for this reason plant physiology has been increasingly popular. Some botanists, indeed, have gone so far as to insist upon giving first place to physiology. Yet it is well for us to remember that the plant is first of all a structure the complexity of which may well challenge the most acute minds. We find it far easier to record the responses of plants to our planned stimuli than to unravel a structural complex, and so no doubt we shall continue to entertain ourselves and our students with what are too often futile experiments.

In this part of the botanical field are pathology, which grew up from our observation that organs may not respond normally; ecology, which developed from the observation that plants tend to live in communities; and phytogeography, having to do with the means for, and the results of, distribution.

Taxonomy, or, as we used to call it, classification, occupying the third division of the field of botany, long received the almost exclusive attention of botanists. And even to-day it is the pretty general opinion of our non-botanical friends that we are constantly employed in collecting specimens, and in some intricate and mysterious way determining their classification and affixing to them their proper Latin names. And it must be admitted that every botanist does a good deal of just such work.

When the doctrine of evolution came into botany it brought with it the idea of descent, and thereafter taxonomy included phylogeny. To-day the taxonomist is no longer content to stop with a knowledge of the structural differences between plants; he must know how this structure arose from that; he must know which is the primitive structure and which the derived. Phylogeny has so far entered into taxonomy that it has given new meaning to the work of the systematic botanist, and it is bringing into this department of the science something of the philosophical aspect which was nearly wanting heretofore. That this must be the direction of the development of the taxonomy of the future is without question, and we may look confidently for a marked expansion and enlargement of the phyletic idea in botanical taxonomy.

And here I may pause for a moment to advert to a part of taxonomy with which some biologists have little patience, without good reason, as it seems to me. I refer to the matter of taxonomic nomenclature, which has vexed the souls of many botanists, especially during the past one or two decades. However, since every science must have its nomenclature it is childish for us to wish to ignore it in botany.

This contempt for nomenclatural questions is symptomatic of a much-to-be-deprecated state of mind, quite too common among scientific men, especially those who have engaged in special lines of work. I believe in specialisation in botany, but specialisation should not degenerate into narrow bigotry.

Quite easily this leads to a consideration of the personality of the botanist of the immediate future. What manner of man will he be? What will be his training? In other words, what will the future demand of the botanist? For it does not need argument to show that the men engaged in botanical work in the future will be developed and fashioned in response to the demands of the community.

If I interpret aright the movement of modern society as a whole, it is going to result in a demand for two things that by many are thought to be opposite and antagonistic—specialisation and breadth. The first it will demand of its experts, the men who are set aside to solve particular problems for the community. In most cases these will be economic problems of immediate importance to the community, but there is no reason why in the most intelligent communities they should not be scientific problems, of more remote importance. No doubt there will be a demand for many such experts, each of whose tasks will be restricted to but one problem. The only requirement laid upon these men will be that they can do the work to which they have been assigned, and the more restricted the problem the narrower may be the preparation of the expert.

But while the community is certain to increase its demand for botanical experts, we must not overlook the fact that with this demand will come another much more imperative for men of far greater breadth and depth of knowledge, who, in addition to training the botanical experts of various kinds for the community, are able to bring the science as a whole before the youth of the land as a part of the scientific culture which modern society requires. These must be men of the broadest training; men whose sympathies are not bounded by the one science which they know, much less by one phase of botanical science; men who, knowing well their one science, know also much of the related sciences; men who, in addition to a knowledge of science, bring to their students and their community the results of that broader view which relates botany to the life and activities of the community. Such men bear the name of botanists worthily, and justify the contention of scientific men that science may contribute more than material good to the community. These are Lord Bacon's "lamps" and "interpreters of nature."

Turning now to the institutions of learning—the colleges and universities—where botany holds a place as one of the sciences, let us ask what we may look for in regard to its development. In every proper college the department of botany exists primarily for its teaching function, and this is true also for nearly every university. And while we may hope to make every such department a centre of investigation also, it is true now, and it must always be true, that in our educational institutions the teaching of the science must be the primary object of every one of its scientific departments. So the future will call for much more of definiteness as to the content and sequence of the science, as well as the manner of its presentation; its pedagogics, if you please.

The college and university departments of botany in the near future will arrive at a clearer notion as to the essentials of the science as a subject of study. It seems to one who carefully looks over the field that there is often only the most vague notion of the relative importance of the known facts in regard to plants, those of trivial importance receiving as much weight, perhaps, as those of profound significance. Especially is this true of the more elementary courses, in which there is also the greatest diversity in the presentation of the subject-matter. It should not be long until this vagueness and doubtfulness as to substance and manner in the presentation of botany in the high school, and in the college, and the university, will be a thing of the past. And I appeal to botanists to take up seriously the task of so arranging and coordinating our work that botany shall no longer suffer the reproach of being the most chaotic of the primary sciences.

But the college and university departments are by no means all that are engaged in botanical work. Within the past twenty-five years many stations have arisen in which botanical investigations are made. Under various local names they are, in fact, "investigation stations," and while their results have not been uniformly trustworthy, it is a most hopeful sign of progress that they exist at all. Foremost among these are the fifty or more agricultural experiment stations to which I have already briefly referred, with assured support from the States and the national Government for all time to come, in which botanical investigation forms no inconsiderable part of the work undertaken. If I read aright the tendencies in these stations, it will not be long until their scientific output will be wholly trustworthy, as indeed it is now in some cases. This condition will be fully realised when these stations are wholly under the direction of men of broad scientific training.

We must recognise the agricultural experiment stations as permanent parts of the botanical equipment of the country. They will be with us in the future, and their results will continue to be added to botanical knowledge. We must accept them as a part of our scientific equipment, and help to make them more efficient. It will not do for us to stand aloof, and decry their results as not accurate, and as agricultural instead of botanical. When we fully realise that we have in these experiment stations so many institutions of endowed research, we shall not hesitate to welcome them to the ranks of science.

Already we have stations for the study of plants under particular environments, as our seaside stations, our mountain stations, and a single desert station. I take it that these are suggestive of what are to come in the future. Instead of trying to make seaside conditions away from the sea, we go to the sea and there set up our laboratories. So when we want to know how plants behave in the desert we go to the desert. And this is no doubt to be the direction of botanical investigation. We are going to study plants under their natural environment, and to the seaside laboratories we shall add (as indeed we have already to a limited extent) lakeside laboratories, riverside laboratories, swamp laboratories, forest laboratories, field laboratories. Already the tropical laboratories, in Java, Ceylon, and Jamaica, have justified themselves, and no doubt to these we shall soon add Arctic and tundra laboratories. All this signifies that more and more we are going to see what the plant is doing in its natural environment, and then we can undertake intelligently to watch it under a changed environment. So the future is to witness a great increase in the number of these laboratories, and how far it will go can only be conjectured.

Yet when we think of these botanical stations the laboratories of which are taken afield, as it were, we must not suppose for a moment that the old-time laboratories on the university campus are to be abandoned. Far from it. As the work in the field laboratories is enlarged there will be still greater need of the far more exact work that can be done only in laboratories where every factor can be perfectly controlled. There will still be need—greater need I might say—for perfectly constructed plant-houses in which we may observe plants under controlled conditions.

Another kind of station, of which we have now only the beginnings, is one which will carry the results of plant-breeding into the domain of phylogeny. Of this we have now some faint suggestions, which must grow into far-reaching results under the direction of men who know more of the subject than we do now. In such laboratories we shall be able to see how evolution has contributed to the present wonderful diversity of form and size and colour and habit among related plants. Such laboratories will enable us to answer the demand formerly so often made, but less often heard now, for a demonstration of cases of actual evolution.

I am assured as I consider the trend of scientific thought that there will be greater unity of action among the botanists of the country. At present we are still in the guerilla stage of botany, in which every man acts independently and for himself. Although we profess to be botanists acting for the best interests of science, we have actually no uniform standard by which we may measure our actions. In one particular we have tried to set up a standard, in certain international rules pertaining to nomenclature; and yet, after several congresses of botanists, we have the humiliating spectacle of a set of laws that nearly everybody disobeys!

As I look into the future a vision rises before me of the scientific army, working harmoniously like well-drilled soldiers, and not wasting their strength by turning their guns on one another. In this army of science I see a company of thoroughly disciplined botanists, who, in orderly fashion, plan their campaign. And, from the many doing severe garrison duty in the small colleges to the heavy artillerymen in the big university fortifications, and the few isolated scouts along the frontier of special investigation, all are actuated by a common spirit of scientific patriotism and loyalty.

This, my botanical brothers, is what the future is bringing us—a united, harmonious body of trained men, whose endeavour is to carry forward the banner of science, not for personal advantage, but for the glory of the science to which we have dedicated our lives.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Prof. Charles Lapworth has expressed the desire to vacate the chair of geology in the University at the end of the current session. The council of the University has resolved to engross and present to him the following resolution:—"That in accepting the resignation of Prof. Lapworth, first professor of geology, the council remember that he was appointed to the chair so long ago as 1881, that he has had full charge of the department ever since, and built it up into the most prominent and successful chair of geology in any British university. The Geological Surveys of the Empire also owe some of their methods to Prof. Lapworth's genius, and his name is of more than European reputation. They thank him for his long and assiduous services, continued to a period late in life, and hope that he will long enjoy the comparative leisure and still useful work that they anticipate await him in the future."

CAMBRIDGE.—The Gordon Wigan income for 1912 at the disposal of the special board for biology and geology has been applied as follows:—(*a*) 20*l*. to Prof. Hughes for research among the Pleistocene deposits of the Cambridge district; (*b*) 50*l*. to Prof. Punnett in order that the Botanic Garden Syndicate may continue to offer special facilities for plant-breeding experiments; (*c*) 50*l*. to H. Scott, curator in entomology, for the care and development of the collections of insects; (*d*) 30*l*. to Prof. Langley, towards the cost of an X-ray installation in the new physiological laboratory.

It is proposed to confer the degree of master of arts, *honoris causâ*, upon Mr. G. Udny Yule, University lecturer in statistics.

The Right Hon. Lord Walsingham, of Trinity College, Dr. Shipley, master of Christ's College, and Prof. Punnett have been nominated to represent the University at the ninth International Congress of Zoology, to be held at Monaco in March.

LIVERPOOL.—The council of the University on January 28 appointed Dr. J. W. W. Stephens to the Sir Alfred Jones chair of tropical medicine, vacant through the resignation of Sir Ronald Ross. Dr. Stephens has held the Walter Myers lectureship in tropical medicine at the University, and has been associated in the teaching work of the Liverpool School of Tropical Medicine for ten years.

LONDON.—At the meeting of the Senate on January 22, Dr. Frederick G. Donnan, F.R.S., was again appointed to the chair of general chemistry, tenable at University College, recently vacated by Sir William Ramsay, F.R.S. Prof. Donnan was appointed to this chair some months ago, but for private reasons was unable to accept the appointment.

The anonymous benefactor who presented 30,000*l*. for additional buildings in front of University College has increased his original benefaction. He will now bear almost the whole cost of the buildings in question.

OXFORD.—The Herbert Spencer lecture will be delivered by Prof. D'Arcy Thompson on Friday, February 14, and not on February 13 as previously announced.

Prof. Poulton, F.R.S., Prof. Bourne, F.R.S., and Mr. E. S. Goodrich, F.R.S., have been appointed to represent the University at the International Congress of Zoology, to be held this year at Monaco.

THE fifteenth annual dinner of the Old Centralians—the City and Guilds College Old Students' Association—will be held on Saturday, February 15, at the Trocadero Restaurant, Piccadilly Circus, W. The chair will be taken at 7.30 p.m. by Sir John Wolfe Barry, K.C.B., F.R.S., the president of the association. Further information and tickets (price 6*s*. 6*d*.) can be obtained from Mr. G. W. Tripp, 4 Fairfield Road, Charlton, Kent.

A REUTER message from Capetown states that the South African University Bill, which has now been published, provides that the Cape University shall become the national residential University for South Africa, and that its central seat shall be located on the late Mr. Rhodes's estate at Groote Schuur. It permits local as well as central faculties, prohibits religious tests, and provides for instruction and examination with either English or Dutch as medium. It also permits the sale of the Frankenwald estate at Pretoria, presented by the late Mr. Alfred Beit for educational purposes, the proceeds being applied to the University. The Bill further renounces Mr. Beit's gift of 200,000*l*. towards a Johannesburg University.

A COURSE of weekly lectures on mining hygiene and mines rescue work began on January 27 at the University of Leeds. Most of the lectures will be given by Mr. R. Veitch Clark, assistant medical officer for Leeds, but those on rescue appliances and the organisation of rescue work will be entrusted to Mr. David Bowen, acting head of the department of mining in the University. The course has been arranged to meet the needs which have arisen out of recently enacted mining regulations. The Coal Mines Act of 1911 has made it incumbent upon coal-owners to provide sanitary conveniences in mines, both above and below ground. It requires, moreover, that when any rock-drill work by mechanical power is used in a mine, a spray of water must be worked in conjunction with the drill, to prevent the escape of dust into the air, with the view of assisting the prevention of miners' phthisis. The Act, too, empowers the Home Secretary to require the maintenance of rescue and ambulance appliances and the formation of rescue and ambulance brigades. Serious efforts are demanded if ankylostomiasis is to be stamped out, and nystagmus prevented among the miners. It is hoped that the course of lectures, by educating masters and men engaged in the mining industry, will assist very materially in improving the conditions under which miners work. Arrangements have also been made in the University for a special course of lectures on the economic aspects of mining.

THE fifth annual dinner of old students of the Royal College of Science, London, held on January 25 at the Monico Restaurant, was rendered memorable by a speech from Sir William Crookes, O.M., F.R.S., who presided, in response to the toast of the evening, proposed by Sir David Prain, F.R.S. Sir William Crookes recalled the position of scientific investigation when he was a student of the Royal College of Chemistry sixty-five years ago. Of special interest was his personal recollection of Faraday's experiment at the Royal Society in 1850, when he demonstrated the magnetic character of oxygen. He predicted that the practical side of chemistry in the future would be synthetic, and on the philosophic side the investigation of the constitution of matter would make the greatest progress. Miss E. N. Thomas proposed "The Guests," to which Dr. R. T. Glazebrook, F.R.S., and Sir Robert Morant, K.C.B., replied. The latter appealed in eloquent terms for the cordial co-operation of old students in the great educational developments which were imminent in London. He said that the College of Science was obviously destined to be one of the great strong elements of a vivifying kind in the higher education of London. The guests included also Sir Amherst Selby-Bigge and Sir Alfred Keogh, and, among some seventy old students present, Sir Thomas Holland, F.R.S., Sir Alexander Pedler, F.R.S., Prof. A. Fowler, F.R.S., Dr. A. E. Tutton, F.R.S. (the newly elected president of the Old Students Association), and Prof. W. Watson, F.R.S.

THE Chadwick Trust, founded in 1895, under the will of the late Sir Edwin Chadwick, K.C.B., has arranged for a series of public lectures to be delivered during this year, in London and certain provincial towns. The object of the trust is the promotion of sanitary science in all or any of its branches in various ways indicated by the founder, or otherwise at the discretion of the trustees. The first of the courses of lectures will be given on Friday evenings, February 7, 14, and 21, at the Royal Sanitary Institute, Buckingham Palace Road, by Mr. H. Percy Boulnois, on hygiene of the home. In April Dr. J. T. C. Nash will give three lectures at the London County Hall, Spring Gardens, on the evolution of epidemics. In June Dr. F. W. Mott, F.R.S., will give a course at the Royal Society of Arts, under the title of "Nature and Nurture in Mental Development." Among the lectures in contemplation for the provincial cities are those on the public milk supply—some criticisms and suggestions from the public health point of view—by Prof. Henry R. Kenwood, at Manchester, and on water supply, with exhaustive consideration of sources, collecting works, conveyance, and distribution, by Mr. E. P. Hill, at Birmingham. All the lectures will be free and open to the public, but will be of a character to attract post-graduate and advanced students of engineering, medicine, and other cognate sciences. The secretary to the trust, to whom all communications should be addressed, is Mrs. Aubrey Richardson, 8 Dartmouth Street, Westminster.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 16.—Sir Archibald Geikie, K.C.B., president, in the chair.—Lord **Rayleigh**: The effect of junctions on the propagation of electric waves along conductors.—W. B. **Hardy**: The influence of chemical constitution upon interfacial tension and upon the formation of composite surfaces.—Hon. R. J. **Strutt**: Duration of luminosity of electric discharge in gases and vapours.—Rev. P. J. **Kirkby** and J. E. **Marsh**: Some electrical and chemical effects of the explosion of azoimide. The experiments consisted in exploding azoimide gas (HN_3) at low pressures between two insulated coaxial cylinders, of gilded brass, connected to the terminals of a battery of about 105 volts. The quantity of electricity that reached one of the cylinders was measured by a ballistic galvanometer and compared with the quantity of gas exploded. The results show that, in every case, the number of molecules of gas exploded was more than 100,000 times the number of pairs of gaseous ions observed. This disproportion indicates that the atoms of the gas when separated by the explosion do not carry electric charges. The gaseous ions are probably produced by favourable collisions of free atoms in the process of forming the products of the explosion.—Dr. G. J. **Burch**: Negative after-images with pure spectral colours. The results obtained by Mr. A. W. Porter and Dr. Edridge-Green in their experiments on negative after-images and successive contrast with pure spectral colours (Proceedings B, vol. lxxxv., p. 434) can be explained in accordance with the theory of Thomas Young if the "stray light" referred to by the authors is taken into account. Thus fatigue by red light renders the blue and violet of a spectrum projected on a screen in an imperfectly darkened room darker and bluer along the line of the after-image, because it removes the red constituent of the "stray light" with which they are contaminated. The results of fatigue with other spectral colours may be similarly explained.—H. **Hartridge**: Factors affecting the measurement of absorption bands.—Dr. G. **Barlow**: A new method of measuring the torque produced by a beam of light in oblique refraction through a glass plate. According to theory, the torque produced on a glass plate by the nearly normal passage of a beam of light is directly proportional to the angle of incidence and always tends to turn the plate further from the normal position. The period of small torsional oscillations of a plate suspended by a quartz fibre should therefore be increased when the plate is traversed by the light. An experiment is described in which this change in period, actually an increase of about $\frac{1}{5}$ per cent., was measured. The observed change agreed within 3 per cent. with that calculated from theory.—Dr. F. **Horton**: The positive ionisation produced by platinum and by certain salts when heated. The emission of positive electricity from platinum and from several samples of aluminium phosphate and of sodium phosphate has been investigated at different temperatures, observations being made of the variation of the emission with time and with the pressure of the surrounding gas.—Clive **Cuthbertson** and Maude **Cuthbertson**: The refraction and dispersion of the halogens, halogen acids, ozone, steam, oxides of nitrogen and ammonia, and the causes of the failure of the additive law. The refraction and dispersion of the elements and compounds named in the title have been determined between $\lambda = 6708$ and $\lambda = 4800$.—R. **Donald**: Liquid measurement by drops. To apply measurement by drops to various serological and bacteriological estimations of liquids and liquid suspensions, the author has worked out a system of using practically uniform easily-made pipettes of any size under any required constant pressure. The pipettes of suitably drawn-out glass tubing are simply gauged in, *e.g.* the Morse drill and wire gauge. The constant pressure is obtained by a column of mercury flowing as a piston to and fro in a suitable glass tube held at any required angle in a stand, or, for less exact work, in the hand.—Prof. W. H. **Young**: The new theory of integration. The present communication is a sketch of a mode whereby the modern theory of generalised, or Lebesgue, integration may be developed without the aid of the theory of sets of points.

Mineralogical Society, January 21.—Dr. A. E. H. Tutton, F.R.S., president, in the chair.—T. V. **Barker** and J. E. **Marsh**: Optical activity and enantiomorphism of molecular and crystal structure. The general nature of enantiomorphous structures accompanying optical activity in the liquid and crystalline conditions was discussed, and it was pointed out that, since the optical activity observed in crystals of six substances, including epsomite and sodium chlorate, cannot be referred to the crystal structure, it must be due to an enantiomorphous configuration of the atoms within the molecule. Suitable enantiomorphous configurations have been deduced on chemical grounds, the constitution of the compounds being based on a modification of Werner's theory of co-ordination. The symmetry of the new spatial formulæ is in many cases identical with the symmetry of the crystal, and, in particular, sodium nitrate can best be regarded as a racemate due to a mutual interpenetration of optical antipodes having spatial configurations similar to those suggested for the active forms of sodium chlorate, the symmetry of the double molecule being identical with that of a rhombohedron. The same type of molecular structure presumably exists in calcite and the rhombohedral form of sodium chlorate which crystallises at high temperatures. It is concluded that many cases of dimorphism are of an analogous character, and, more generally, that polymorphous change is preceded by a rearrangement of the atoms within the molecule.—H. **Collingridge**: Note on the determination of the optic axial angle of crystals in thin-section. In the case where one optic axis is visible in the field of view the position of the second axis may be determined more conveniently than in the Becke and Wright methods from the optic axial plane and the extinction direction through the centre of the field.—Dr. G. F. H. **Smith**: Graphical determinations of angles and indices in zones. Two methods were described, which, unlike the moriogram, are not restricted to right-angled zones. In one a double tangent scale is placed on a pencil of lines spaced as in a gnomonic projection on a zonal plane in such a way that the 01 and 11 lines cross the scale at the given angles; the angles corresponding to any indices, or *vice versâ*, are read off directly within the limits of the scale. In the second method a double diagram is employed, of which one-half is a new form of the moriogram, and the other is a representation of angles the cotangent of which is the difference of the cotangents of the given angles; the method is general and unrestricted in its application.—Dr. J. **Drugman**: The Goldschmidt apparatus for cutting models of crystals. The mechanism was described and the method of using it explained.—Prof. H. L. **Bowman**: A nodule of iron pyrites. The octahedral shape and the striations on the faces truncating the coigns of the tiny crystals point to their being pyrites and not marcasite, as usually stated.

PARIS.

Academy of Sciences, January 20.—M. F. Guyon in the chair.—A. **Lacroix**: The mineralogical and chemical constitution of the volcanic lavas of the centre of Madagascar. Analyses of twenty-seven typical rocks are given. The materials derived from the two volcanic centres are analogous but not identical.—Pierre **Duhem**: The adiabatic stability of equilibrium.—Paul **Sabatier** and M. **Murat**: Preparation of the three cymenes and the three menthanes. The ortho-, meta-, and para-dimethylcresylcarbinols were prepared by three different methods, these dehydrated by passing over thoria at 350° C., and the cresyl-propenes, $CH_3.C_6H_4.C(CH_3)=CH$, reduced with hydrogen in presence of nickel to the three cymenes, $CH_3.C_6H_4.CH(CH_3)_2$, and ultimately to the corresponding menthanes, $CH_3.C_6H_{10}.CH(CH_3)_2$. The physical properties of all these compounds are given.—Paul **Richer**: The identification of the supposed skull of Descartes by its comparison with portraits. The skull preserved at the museum corresponds very closely with the portrait of Descartes by Franz Hals.—Henri **Chrétien**: The general magnetic field of the sun.—G. **Fayet**: The next return of the Finlay comet; disturbance of the orbit due to the action of Jupiter. An approximate calculation of the orbit after passage of the comet within the sphere of attraction of Jupiter. In its changed position the conditions of visibility will be very unfavourable.—Georges **Giraud**: Certain functional equations and the permutable transformations.—M. **Nörlund**: The problem of Riemann in the theory of equations of finite differences.—Louis **Bachelier**: Semi-uniform probabilities.—Ét. **Delassus**: The various forms of Dalembert's principle, and the general equations of motion of systems submitted to linkages of any order.—M. **Mesnager**: A paradox of uniformly loaded rectangular plates.—E. **Fichot**: The production of static tides of the second kind in an ocean obeying any law of depth.—Vasilesco **Karpen**: The flight of birds without motion of the wings.—Émile **Borel**: The theory of relativity and kinematics.—C. **Dauzère**: Isolated cellular vortices.—J. **Guyot**: Differences of contact potential between a metal and electrolytic solutions.—E. J. **Brunswick**: Predetermination of the characteristics of continuous-current dynamos.—A. **Leduc**: Latent heats of evaporation and maximum pressures. An application of the Clapeyron formula to the calculation of latent heats, the specific volume of the saturated vapour being calculated by methods previously described by the author. Figures are given for water, ether, and benzene; the deviations from the experimental results are considerable.—E. **Briner** and M. **Boubnoff**: Chemical reactions in compressed gases. Study of the decomposition of nitric oxide. The decomposition of nitric acid is accelerated by pressure. The products of the reaction at 300° under high pressure include N_2, N_2O, N_2O_3, and NO_2.—Victor **Henri** and René **Wurmser**: The law of elementary photochemical absorption. The law is enunciated that the photochemical susceptibility of a body depends on that part of the absorption spectrum which corresponds to the same molecular groupings as those on which the reaction is produced.—Daniel **Berthelot** and Henry **Gaudechon**: Action of the middle and extreme ultraviolet rays on ethyl aldehyde: acidification, polymerisation, resinification. In the absence of oxygen the ultra-violet rays cause a simultaneous oxidation and reduction. The production of the polymers, metaldehyde and paraldehyde, and some aldehyde resin was also proved.—J. **Bougault**: Phenyl-α-oxycrotonic acid.—E. E. **Blaise** and E. **Carrière**: Succinic acid aldehyde. An attempt to clear up some discrepancies between the work of Carrière and that of Harries on the polymers of the acid aldehyde of succinic acid.—A. **Mailhe**: The nitro-derivatives of the oxides of orthocresyl and orthocresylene.—M. **Trabut**: The infectious chlorosis of the Citrus. This is transmitted by grafts, but numerous attempts to find a bacillus to account for the disease have proved fruitless.—M. **Chantemesse**: Preventive vaccination against typhoid fever in the navy. A comparison between vaccinated and unvaccinated persons, subjected to the same environment, shows that about 1 per cent. of the unvaccinated contracted typhoid fever, whilst not a single case occurred amongst the vaccinated.—M. **Rappin**: Antituberculous vaccination in the guinea-pig.—Raphael **Dubois**: Anæsthesia by the digestive canal. Anæsthesia caused by the rectal injection of chloroform ought to be rejected.—M. **Pézard**: Measurement of the reflex excitability of the spinal marrow and its variations under the influence of injections of solutions of calcium chloride.—Etienne **Rabaud**: The cryptocecidia of *Balanius nucum*, and the biological signification of galls.—A. **Labat**: The presence of bromine in the normal state in human organs. Bromine is normally present in the thyroid gland and in the urine.—Charles **Lepierre**: The non-specific action of zinc as a biological catalyser in the culture of *Aspergillus niger*. Its replacement by other elements. Cadmium has precisely the same influence as zinc in the growth of this mould.—Gabriel **Bertrand** and M. and Mme. **Rosenblatt**: The activity of Koji sucrase in presence of various acids.—R. **Fosse**: The formation of urea by two moulds. *Aspergillus niger* grown on a modified Raulin solution containing ammonium nitrate contains urea in its cells; *Penicillium glaucum* behaves similarly.—H. **Bierry**: The diastatic hydrolysis of glucosides and galactosides.

BOOKS RECEIVED.

Scottish National Antarctic Expedition. Report on the Scientific Results of the Voyage of s.y. *Scotia* during the Years 1902–3–4, under the Leadership of Dr. W. S. Bruce. Vol vi., Zoology. Parts i. to xi., Invertebrates. By Dr. C. Vaney and others. Pp. viii+353+plates. (Edinburgh: The Scottish Oceanographical Laboratory; Oliver and Boyd.) 30*s*.

A First Book of Experimental Science. Arranged By W. A. Whitton. Pp. vii+137. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Das meteorologisch-magnetische Observatorium bei Potsdam. Pp. 81+plate. (Berlin: Behrend and Co.) 3 marks.

Terminologie der Entwicklungsmechanik der Tiere und Pflanzen. By Profs. C. Conrens, A. Fischel, and E. Küster. Edited by Prof. W. Roux. Pp. xii+465. (Leipzig: W. Engelmann.) 10 marks.

Royal Society of London. Catalogue of Scientific

Papers, 1800–1900. Subject Index. Vol iii., Physics. Part i., Generalities, Heat, Light, Sound. Pp. c+500+vii. (Cambridge University Press.) 18*s.* net.

Geological Literature added to the Geological Society's Library during the Year ended December 31, 1911. Pp. 164. (London: Geological Society.) 2*s.*

The Positive Evolution of Religion: its Moral and Social Reaction. By F. Harrison. Pp. xx+267. (London: W. Heinemann.) 21*s.* net.

Researches in Colour Vision and the Trichromatic Theory. By Sir W. de W. Abney. Pp. xi+418+v plates. (London: Longmans and Co.) 21*s.* net.

Egyptian Government. Almanac for the Year 1913. Pp. vii+212. (Cairo: Government Press.) P.T.5

The Gas, Petrol and Oil Engine. Vol. ii., The Gas, Petrol and Oil Engine in Practice. New and Revised Edition. By Dr. D. Clark and G. A. Burls. Pp. viii+838. (London: Longmans and Co.) 25*s.* net.

Year Book of the Indian Guild of Science and Technology, 1912. Pp. 193. (Letchworth: The Letchworth Printers.)

DIARY OF SOCIETIES.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—The Formation of Usually Convergent Fourier Series: Prof. W. H. Young.—The General Theory of Elastic Stability: R. V. Southwell.—A Spectro-photometric Comparison of the Emissivity of Solid and Liquid Copper and of Liquid Silver at High Temperatures with that of a Full Radiator: C. M. Stubbs.—A New Analytical Expression for the Representation of the Components of Diurnal Variation of Terrestial Magnetism: G. W. Walker.—An Investigation into the Magnetic Behaviour of Iron and some other Metals under the Oscillatory Discharge from a Condenser: Prof. E. W. Marchant.—The Spontaneous Crystallisation and the Melting and Freezing-point Curves of two Substances which form mixed Crystals and the Freezing Point Curve of which exhibits a Transition Point. Mixtures of p. Bromonitrobenzene and p. Chloronitrobenzene: Florence Isaac.

ROYAL INSTITUTION, at 3.—Recent Research on the Gas Engine: Prof. B. Hopkinson.

CONCRETE INSTITUTE, at 7.30.—The Settlement of Solids in Water and its Bearing on Concrete Work: Dr. J. S. Owens.

SOCIETY OF DYERS AND COLOURISTS, at 8.—The Possibilities of a Standard Light and Colour Unit: J. W. Lovibond.—A Simple Method for Detecting Silk, Cotton and Wool Fibres in Admixture in Textiles: W. P. Dreaper.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—The Poetry and Philosophy of George Meredith: G. M. Trevelyan.

MONDAY, FEBRUARY 3.

SOCIETY OF ENGINEERS, at 7.30.—The Bus *v.* Tram Controversy, and other Aspects of the London Traffic Problem: Wm. Yorath Lewis.

ROYAL SOCIETY OF ARTS, at 8.—Liquid Fuel: Prof. V. B. Lewes.

ARISTOTELIAN SOCIETY, at 8.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Behaviour of Paint under the Conditions of Practice with special reference to the Aspersion cast upon Lead Paints: H. E. Armstrong and C. A. Klein.—The Technical Production of Ethane: C. Sprent.—The Feeding Value of the Horse Chestnut: S. J. M. Auld.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Canals and Canalised Rivers: J. A. Saner.

VICTORIA INSTITUTE, at 4.30.—Vision, in Sacred and other History: Rev J. H. Skrine.

TUESDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 3.—The Heredity of Sex and some Cognate Problems: Prof. W. Bateson.

RÖNTGEN SOCIETY, at 8.15.—The Construction of Induction Coils: R. S. Wright.—A Simple Method for Inserting Radium into Lengths of Sterile Rubber Tubes: C. E. S. Phillips.

ZOOLOGICAL SOCIETY, at 8.30—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. VIII. Some Species of Ichthyotænia and Ophidotænia from Ophidia: Dr. F. E. Beddard.—Report on the Deaths which occurred in the Zoological Gardens during 1912: H. G. Plimmer.—The Anterior Ambulacrum of *Echinocardium cordatum*, Penn., and the Origin of Compound Plates in Echinoids: H. L. Hawkins.—Plankton from Christmas Island, Indian Ocean. II. Copepoda of the Genera Oithona and Paroithona: G. P. Farran.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Cave Exploration in Gibralter in September, 1912: Dr. W. L. H. Duckworth.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* The Canton-Kowloon Railway (Chinese Section): F. Grove and B. T. B. Boothby.—The Canton-Kowloon Railway (British Section): G. W. Eves. *Probable Paper:* The Erection of the Boucanne River Viaduct, Canada: P. L. Pratley.

WEDNESDAY, FEBRUARY 5.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Antipyrine in Toxicological Analysis: G. D. Lander and H. W. Winter.—The Accurate Determination of Carbon Dioxide in Carbonates: F. S. Sinnatt.—A New Method for the Volumetric Estimation of Chromium, Vanadium and Iron in Admixture: F. W. Atack.—Note on Hardened Oils: A. W. Knapp.

ROYAL SOCIETY OF ARTS, at 8.—The Economic and Hygienic Value of Good Illumination: Leon Gaster.

GEOLOGICAL SOCIETY, at 8.—Two Deep Borings at Calvert Station (North Buckinghamshire), and on the Palæozoic Floor North of the Thames: Dr. A. M. Davies and J. Pringle.—The Skeleton of *Ornithodesmus latidens* from the Wealden Shales of Brightstone Bay (Isle of Wight): R. W. Hooley.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Influence of the Resilience of the Arterial Wall on Blood Pressure and on the Pulse Curve: S. R. Wells and L. Hill.—The Occurrence of a Ganglion in the Human Temporal Bone not hitherto described: A. A. Gray.—The Action of Adrenin on Veins: J. A. Gunn and F. B. Chavasse.—A Preliminary Report on the Treatment of Human Trypanosomiasis and Yaws, with Metallic Antimony: Capt. H. S. Ranken.—Further Researches on the Extrusion of Granules by Trypanosomes and on their Further Development. (With a Note on Methods by H. G. Plimmer): Major W. B. Fry and Capt. H. S. Ranken.

ROYAL INSTITUTION, at 3.—Recent Research on the Gas Engine: Prof. B. Hopkinson.

LINNEAN SOCIETY, at 8.—Crosses of a Wild Pea with Cultivated Types: A. W. Sutton.—*Rheoxylon africanum*, a New Medullosean Stem: N. Bancroft.—Revision of the Linnean Types of Palæarctic Rhopalocera: Dr. R. Verity.

FRIDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 9.—Life in the Great Oceans: Sir John Murray, K.C.B.

SATURDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

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