THURSDAY, NOVEMBER 14, 1901.

## A CANADIAN NATURALIST.

*Wild Animals I have Known.* By Ernest Seton-Thompson. (New York City: Scribner and Sons.)

*The Trail of the Sandhill Stag.* (New York City: Scribner and Sons.)

*The Biography of a Grizzly.* (New York: *The Century* Company.)

MR. ERNEST SETON-THOMPSON, Naturalist to the Government of Manitoba, is an American author and artist whose works enjoy a wide popularity in his own country, but are less known than they deserve to be on this side of the Atlantic. He has written books on the birds and mammals of his State and done other more or less scientific work, but owes his fame, perhaps, rather to three lighter volumes, beautifully got up and illustrated by himself, with the assistance of his wife, the companion in his later wanderings. These are "Wild Animals I have Known," first published in 1898 and already, early last year, in an eighth edition; "The Trail of the Sandhill Stag," and latest, and perhaps most powerful of the three, "The Biography of a Grizzly."

The full-page drawings in all three books are finished works of art, and many of the little marginal sketches—scraps of boughs and berries, and suggestions in a few strokes of footprints in the snow and woodland and mountain scenes—would have delighted Ruskin.

At one time in his life a wolf-trapper, Mr. Seton-Thompson is, in the highest sense of the word, a field naturalist; and, gifted with a poet's imagination, has identified himself, with a completeness which few writers have reached, with the wild creatures whose lives and surroundings he paints. The key-note of his writings is struck in the preface to the first of the three books:—

"A moral as old as Scripture, We and the beasts are kin. Man has nothing that the animals have not at least a vestige of, the animals have nothing that man does not in some degree share. . . . They surely have their rights."

When caught hand and foot in wolf traps which he had been carelessly setting, and from which in the end he was freed only by the intelligence of a faithful dog, who, after one or two fruitless attempts to help him, brought him the trap wrench which had lain just beyond his reach, he remembered as the prairie wolves howled round him, drawing closer and closer, "how old Giron, the trapper, had been lost, and in the following spring his comrades found his skeleton held by the leg in a bear trap," and a "new thought came to him"—"This is how a wolf feels when he is trapped." "Yan," in "The Sandhill Stag," alone and far from help of any kind, on the trail of the muckle hart, in the mid-winter moonlight hears across the frozen snow the gathering hunting cry of the wolves, nearer and nearer, until it suddenly flashes upon him, "It is my trail you are on! You are hunting me." When at last within fifteen feet of "the great ears and mournful eyes" of his tired-out quarry, he remembers how he felt then, and cannot shoot. He had "found the Grail," and "learned what Buddha learned" more than 2000 years ago.

Where all alike are excellent, none can well be best; and of the wild animals which Mr. Thompson "has known" and writes of it is not easy to make a choice.

There is the "Springfield fox," who shook the dogs off when she thought proper by "the simple device of springing on a sheep's back," and who, when, in spite of gunshots, she had tried for three nights to bite through the chain which held her cub, and found all her attempts to free him useless and danger faced for nothing, brought him poison and was never again herself seen or heard of in the neighbourhood.

There are "Wully," the four-legged Jekyll-Hyde, a faithful sheep-dog by day; and at night a treacherous, bloodthirsty monster, who, when found out, flew straight at the throat of the girl to whom he had always professed especial devotion; and "Silverspot," the canny old leader of the band of crows which had their headquarters on a pine-clad hill near Toronto; and others, not less interesting, sketched by a master-hand.

The most striking figure in the first book, second only, if second, to the grizzly who has the honour of a volume to himself, is "The King of Currumpaw," a great wolf who, with his pure white mate and a chosen band of five, all wolves of renown, terrorised one of the vast cattle ranges of New Mexico, and with a price of 1000 dollars on his head—an unparalleled wolf-bounty—scorned all hunters, "derided all poisons, and continued for at least five years to exact tribute from Currumpaw ranches to the extent, many said, of a cow each day."

The band seldom condescended to eat mutton, confining themselves almost entirely to the best cuts of year-old heifers; but for the mere fun of the thing stampeded and killed sheep by hundreds.

Mr. Thompson gives an instance of the grim bandit's diabolic cunning which came under his own observation.

"Sheep," he writes, "are such senseless creatures that they are liable to be stampeded by the veriest trifle, but they have deeply ingrained in their nature one, and perhaps only one, strong weakness, namely, to follow their leader. And this the shepherds turn to good account by putting half a dozen goats in the flock of sheep. The latter recognise the superior intelligence of their bearded cousins, and when a night alarm occurs they crowd around them, and usually are thus saved from a stampede and are easily protected. But it is not always so. One night in last November two Perico shepherds were aroused by an onset of wolves.

"Their flocks huddled around the goats, which, being neither fools nor cowards, stood their ground and were bravely defiant; but, alas for them, no common wolf was heading this attack. Old Lobo, the weir-wolf, knew as well as the shepherds that the goats were the moral force of the flocks, so hastily running over the backs of the densely packed sheep, he fell on these leaders, slew them all in a few minutes, and soon had the luckless sheep stampeding in a thousand different directions."

It was not until "the grand old outlaw" had lost his consort and become reckless, following her body to the ranch-house and tearing the watch-dog to pieces within fifty yards of the door, that he met his end at the hands of his biographer, who had come by special invitation to the Palette Ranch to match his cunning with the great wolf's.

"Wahb," the hero of the book last on the list, is, like he king wolf (whose portrait, admirably drawn—"Lobo, Rex Corrumpæ"—appears at the end of his memoir), a real character—a sullen and solitary bear of enormous size, responsible for the deaths of at least two cowboys, and believed never to have had a mate. He was known far and wide over a broad district of New Mexico as "the worst grizzly that ever rolled a log in the Big Horn Basin"; but in the Yellowstone, where for some years he regularly passed two months in summer, and where, as in our London parks—to compare small things with great—wild things at once grow tame, he managed to pass himself off as "a peaceable sort."

From facts gathered from hunters, miners and ranchmen, and from personal experiences, Mr. Thompson has imagined and written his life through "cubhood," "days of strength" and "waning," from the time when he and his two brothers and a sister—an unusually large family for a grizzly—as woolly cubs "hustled and tumbled one another in their haste to be first at the ant-heaps which a mother's strong arm unroofed, and squealed like little pigs, and growled little growls, as if each was a pig, a pup and a kitten all rolled into one," until the time when, a grey-bearded old bear, crippled with rheumatism, dethroned and driven from his haunts by a usurper whom a year or two before he would have despised, he limps "with shaky limbs and short uncertain steps to the mysterious 'Death Gulch'—that fearful little valley where everything was dead and where the very air was deadly," and "as gently went to sleep as he did in his mother's arms by the Gray-Bulls long ago."

It is a powerfully written and wonderfully graphic story, more particularly in the earlier chapters, where the poor little cub, sole survivor of the family, wanders motherless in the woods, with all the world against him, to learn by the slow lessons of experience all about traps and guns and beasts and, worst of all, men, and the meanings of the many subtle messages which reached the brain by way of his "great moist nose," storing up wrath against the day of vengeance, which came with his strength.

One of the most interesting things in the book is the account of the way in which a big bear, when he takes possession of a country, advertises his proprietary rights by rubbing himself, whenever he passes, against particular trees.

"Wherever Wahb went he put up his sign-board—
'TRESPASSERS BEWARE!'
It was written on the trees as high up as he could reach, and everyone that came by understood that the scent of it and the hair in it were those of the great grizzly Wahb."

A critic, to assert his superiority, must pick holes somewhere. Perhaps in the case of Mr. Seton-Thompson's almost altogether perfect work, the least unreasonable way of doing what is expected is by hinting a doubt whether the vein of melancholy which runs through much of his writings is not a little strained.

"The life of a wild animal," he tells us in italics, "*always has a tragic end.*" Perhaps so; if, but only IF, sudden destruction coming unawares to end a bright existence—Death appearing without "the painful family," "more hideous than their Queen"—is necessarily a tragedy. But the world, after all, is something more than a great slaughter-house. There is, for the humbler creation at least, a "blindness to the future kindly given," and, so far as we can judge, a keen power of enjoying the present. The blackbird is not always thinking of the sparrowhawk, the ant of the turkey, nor the turkey of Christmas. The necessity for keeping the protective sense constantly on the alert may be the very best means for keeping the faculties of enjoyment bright and polished.

"A certain number of fleas," according to David Harum, "is good for a dog. They keep him from brooding on being a dog." T. DIGBY PIGOTT.

## ELEMENTARY GEOMETRY.

*Elementary Geometry, Plane and Solid, for use in High Schools and Academies.* By Thomas F. Holgate, Professor of Applied Mathematics in North-Western University. Pp. xi+440. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1901.) Price 6*s*.

THIS book covers the ground of the first six books and those parts of the eleventh and twelfth books of Euclid which are usually read; and it includes besides a discussion of the elementary properties of the simpler solid figures, the sphere, the cylinder and cone. There is also a brief appendix on trigonometry.

The introduction deals with preliminary notions and definitions, and the first chapter with triangles and parallelograms. The second chapter treats of the circle in a manner which is more direct than Euclid's, and is free from the impossible figures so bewildering to a beginner. It contains an interesting Article 204, on the principle of continuity, in which instances are given of propositions which, though very different at first sight, can by the application of the principle of continuity be harmonised under one general statement. Illustrations of this kind are most helpful and stimulating.

The third chapter, on similar rectilineal figures, contains a section on measurement, ratio, proportion and the theory of limits. As no definite agreement has yet been arrived at among teachers as to the best mode of treating this part of the subject, it is to this section that the main interest of the book is due. There is much to be said for the view of those who would definitely postpone any discussion of incommensurables to a later stage, but as it may be inferred from the book that this is not the view of the author, it will not be considered here. In order to make clear the relation of his treatment to the usual English practice, it is necessary to state very briefly what that practice is. It is usual to direct beginners to learn the fifth definition (the test for equal ratios) by heart without any adequate explanation,[1] although it rests upon ideas of extreme simplicity. It is doubtful whether one pupil in ten thousand understands the definition, though a great many are able to apply it correctly to prove two important propositions in the sixth book, viz., No. 1, "The areas of triangles (and parallelograms) of the same altitude have the same ratio as the lengths of their bases have to one another," and No. 33, "In equal circles, angles, whether at the centres or circumferences, have the same ratio as the arcs on which they stand have to one

[1] The so-called algebraic explanations frequently supplied are inadequate.

another: so also have the sectors." For the proof of these two propositions *only* is the fifth definition usually employed. All the remaining properties of proportion required for use in the sixth book are either assumed or proved (it would be more correct to say they are supposed to be proved) algebraically. Some teachers, probably a small minority, use the syllabus of the Association for the Improvement of Geometrical Teaching. This syllabus, following Euclid's line of argument, *uses the properties of unequal ratios to prove properties of equal ratios*, thus making the proofs unnecessarily artificial and therefore difficult; so that, though it is quite possible for a clever pupil to follow the reasoning in each separate proposition, it is very difficult for him to grasp the argument as a whole.

In the book under notice the fundamental definitions of the fifth book of Euclid, viz., the test for equal ratios, No. 5, the test for distinguishing between unequal ratios, No. 7, and the definition of the compounding of ratios, with which may be included the definition of duplicate ratio, find no place. And it may be conceded at once that, if these definitions are not properly explained, it is much better that they should not appear in an elementary text-book, because the beginner, to whom the simple ideas on which they rest are not carefully expounded, is far more likely to make progress in geometry with the aid of Prof. Holgate's book than with an ordinary Euclid.

The author, after defining the ratio of two incommensurable magnitudes as the limit of a rational fraction, obtained by a definite process (Art. 229), proves a general theorem on limits, viz., "that if there are two variable quantities dependent on the same quantity in such a way that they remain always equal while each approaches a limit, then their limits are equal" (Art. 230).

With the aid of this, the two propositions, Euc. VI., 1 and 33, already referred to, are proved, and also the proposition "that a straight line parallel to one side of a triangle divides the other two sides in the same ratio," Euc. VI., 2 (first part).

Taking the proof furnished of this last theorem as a type, and leaving out of it the use made of the general theorem on limits quoted above, it may be pointed out that the proof is in effect a demonstration (though some expansion would be necessary to make this clear) of the proposition that if a certain definite process be applied to the segments of each of the sides of the triangle the result will be to determine the same irrational number[1] in each case, so that this irrational number may be taken as the measure of the ratio of the two segments of each side, and that consequently these ratios are equal. With such a change the treatment would accord with modern ideas regarding irrational numbers as set forth by Dedekind in his tract on continuity and irrational numbers[2] and now generally accepted.

But when such propositions as "that if two ratios are equal, their reciprocal ratios are equal" are required (see Arts. 234, 237–240), then the proofs supplied are valid for commensurable ratios only. This change in the mode of treatment should have been clearly indicated in the text or preface. To have proved these propositions on the lines on which the treatment of the subject of ratio had been begun would soon have carried the author beyond the comprehension of those for whom his book was intended. To have proved them upon Euclid's lines would have made it necessary to add a large number of additional explanations. This, however, was the only practicable logical alternative.

The fourth chapter deals with the areas of plane polygons and with the measurement of the circle. Archimedes proved that $\pi$ lies between $3\frac{1}{7}$ and $3\frac{10}{71}$ by a consideration of the regular inscribed and circumscribed polygons of ninety-six sides. The author obtains a much closer approximation, but finds only a series of values increasing up to $\pi$ by using the inscribed regular polygons. The result would have been more impressive if a series of values decreasing down to $\pi$ had been found as well.

The sixth chapter deals with lines and planes in space. It is a matter of opinion whether the modes of constructing the perpendicular to a plane in §§ 403 and 408 are or are not more difficult than Euclid's; but these last are so useful in Spherical Trigonometry that it seems a pity they have not had more prominence given to them than is furnished by § 406. For a similar purpose it would have been useful to give some further account of the angles between a line which meets a plane and the lines in the plane than Prop. xx. in § 449, viz., "The acute angle which a straight line makes with its own projection upon a plane is the least angle it makes with any line of that plane." It is advantageous to know, not only the least and the greatest angles between a fixed line meeting a plane and lines in the plane, but also the way in which the angle varies as the line in the plane revolves.

The statement of Prop. xxii., § 458, "that the sum of any two face angles of a trihedral angle is greater than the third angle," should be limited by inserting the word "convex" before the word "trihedral."

The seventh, eighth and ninth chapters deal with prisms, pyramids, cylinders, cones and spheres.

There are several features of interest in the book, such as the use of the principle of continuity in §§ 204, 264, 323, and the directions given in § 540 for constructing the regular polyhedra. The proofs of many of the propositions seem to be new. The work is evidently that of an experienced teacher, and is written on the lines of good class teaching, in which the teacher suggests steps in the argument to the pupil, and the demonstrations are worked out by both together. The book is calculated to arouse and stimulate those who have at heart the teaching of their subject.

[1] An irrational number is defined as one which separates all rational fractions into two classes, an upper and a lower, such that
(1) Every fraction in the lower class is less than every fraction in the upper class.
(2) The lower class contains no greatest fraction.
(3) The upper class contains no least fraction.

[2] Translated into English by Prof. Beman. (Chicago: The Open Court Publishing Co., 1901.)

## MOSQUITOES AND MALARIA IN MAURITIUS.

*Les Moustiques: Anatomie et Biologie.* By A. Daruty de Grandpré and D. d'Emmerez de Charmoy. (Port Louis, Mauritius: *Planters' and Commercial Gazette*, 1900.)

THIS work is a contribution to the study of the Culicidæ, and principally of the genera Culex and Anopheles, of their *rôle* in the propagation of malaria and filariasis, and of the means of guarding against them. The authors recognise in Mauritius only the types of fever quartan, tertian and æstivo-autumnal, and have proved *Anopheles costalis* to be the definitive host of their parasites in that island. Three species of Culex —*C. anxifer*, *C. albopictus*, *C. taeniatus*—were shown to be incapable of infection by parasites of human malarial fever. *Anopheles mauritianas* also appears to have no relation to human malaria. The chapters on classification, morphology, anatomy and biology add but little to the literature of these subjects. In the present state of our knowledge of the ætiology of malaria and filariasis a more careful description of the minute anatomy of the organs of the adult insect would have been extremely useful; probably difficulties in the preparation of complete and perfect sections have prevented the authors giving minute histological details. Descriptions of such important structures as the membranous portion of the pharynx, of the salivary receptacle, and of the muscles attached to them, and, in view of the importance of the recent discoveries of the presence of filarial larvæ in the labium of the proboscis, the relations and histology of this organ especially, should have claimed the attention of these naturalists. The spermatheca of the female insect is not referred to.

The authors are evidently not acquainted with the structure of the parts of the proboscis. The salivary duct is described as uniting the pharynx to the œsophagus. Careful histological preparations show that this is far from correct; the salivary duct traverses the neck and head below the œsophagus and pharynx, and, in the region of the common origin of the mouth-parts from the head, the duct opens into the salivary receptacle—a chitinous trumpet-shaped organ with a wide membranous proximal end into the middle of which the salivary duct opens itself; while the narrow distal end is applied to the upper end of a groove—the salivary canal—which runs along the whole length of the hypopharynx.

The cells of the epithelium of the stomach are described as:—(1) Large spherical cells, with protoplasm not stained by carbol-thionin, while the nuclei stain pale rose-colour and the nucleoli violet. These are said to be of lymphocytic nature. (2) Small spherical cells, with a deep violet-staining nucleus, and protoplasm which centrally stains with difficulty while the periphery is deeply stained. These the authors consider to be digestive in their functions.

The epigastric glands of the larval stage, eight in number, surrounding the anterior part of the stomach, and the dialysing tube or membrane in the stomach wall, are considered as playing an important part in the digestive functions of the carnivorous larva.

With regard to filariasis, the authors apparently found only *F. nocturna* in the blood of the people of Mauritius where elephantiasis also occurs, and they have been able to trace the complete life-history of the larval stage of this nematode in the thoracic muscles of *Culex anxifer*.

The authors do not appear to have recognised the presence of malarial parasites in the blood of native children, and hence do not refer to segregation of Europeans as a preventive measure. "Eviter les Anopheles" is their advice, and they uphold the opinions of Ross and others that, although, perhaps, absolute extermination of the insects will prove impossible, even in small areas, yet their numbers may, by the application of inexpensive and practicable means, be easily reduced to an almost harmless minimum. They rely chiefly on the use of culicicides, particularly of petroleum, and of culicifuges, such as terebinthene and naphthalene.

H. E. A.

## OUR BOOK SHELF.

*Disease in Plants.* By H. Marshall Ward, Sc.D., F.R.S., Professor of Botany in the University of Cambridge. Pp. xiv + 309. (London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.*

THIS is a very suggestive work, and the clearness with which Prof. Ward has treated a difficult and complex subject will ensure for his book a welcome on the part of the specialist, not less than that of the wider public to whom the volume is more immediately addressed.

Most treatises on plant pathology deal with the more extrinsic aspects of the matter, such as the host and the parasite, and some of them give accounts of the evil results of an unfavourable environment. But in the book before us the questions raised are discussed from a more philosophical standpoint. The effort is made to discern wherein disease itself really consists, and to ascertain the actual relations and changes involved in the transition from the healthy or normal to the abnormal and pathological condition. "Disease (not diseases) in Plants" is the title of the book, and it fully indicates the general purport of the contents.

In order to place the reader in a position to appreciate the nature of the connection between a healthy and a diseased state, the opening chapters are devoted to a consideration of the normal physiology of the plant-organs and their relations with their surroundings. Then the various disturbing influences which make for, or actually induce, disease are passed under review, and their operations as far as possible explained. The imperceptible gradations by which an organism passes from the healthy to an unhealthy condition are pointed out, and the oftentimes indirect operation of an unfavourable influence is insisted on. One is brought into closer quarters with the heart of the matter on recognising that the most injurious factors are those which operate through the metabolic processes of the plant; just as, it may be remarked, is malnutrition in the widest sense at the bottom of so many of the ills which the animal flesh assumes itself to have inherited. The interference may come through unfavourable conditions of life, or it may be more immediately traced to influences exerted by other organisms such as parasites and the like. And these considerations open the way for discussing the question of "predisposition" and examining the various avenues in this direction leading to possible remedial measures.

Of course in a work of this kind there are some views put forward which may not command universal acceptance, but they are chiefly those concerned with side-issues, and can hardly be profitably discussed within the limits of a brief notice. Enough, it is hoped, has been said to emphasise the fact that the book forms a valuable contribution to a subject of vast importance. For on the right understanding of the nature and causes of disease in plants hang many great commercial and even national interests. The annual loss incurred through the agency of disease is enormous, but the results of current work clearly demonstrate that much of this loss can be curtailed or prevented when its causes are understood and empirical remedies have given place to intelligent counteraction.

J. B. F.

*Shell Life: an Introduction to the British Mollusca.* By E. Step, F.L.S., &c. "Library of Natural History Romance." Pp. 414, 32 Plates, Figs. in text. (London: F. Warne and Co., 1901.) Price 6*s.*

COULD paper, print and pictures make a meritorious book, this would be one. The paper is of superior quality, and the print is exceptionally clear and clean; whilst the illustrations, although drawn from many sources, good, bad and indifferent, are well printed.

The thirty-two photo-process plates are excellent of their kind, their only fault consisting in the want of good arrangement in their component items and the inclusion of some objects far too minute for this method of illustration. Unfortunately there is no reference to them in the text, and the names cited on the plates do not always coincide with those given in the text.

The figures in the text are some of them very old friends, and saw service in the Rev. J. G. Wood's "Common Shells of the Sea-shore"; others are of later date and foreign extraction. Nor must we omit a word of praise for the binding and the tasteful and quaint, if not entirely appropriate, design on the cover.

It is a matter for regret, however, that the author did not make himself more familiar with his subject so that his work might have been something better than the mere outcome of industrious compilation from authorities more or less ancient. Thus he instances the patelliform as the primitive type of the molluscan shell; he is unaware of the existence of a rudimentary heart in Dentalium, and gives renewed currency to the blunder (founded originally on a mistranslation) that its embryo shell is bivalve; and so on, and so on.

In the matter of classification our author follows that of the Cambridge Natural History, which, having already been dealt with in these pages (vol. lii. p. 150), need not be further commented on here; nor shall words be wasted on the nomenclature employed, which is hopelessly out of date.

In the endeavour to confine scientific names entirely within brackets and furnish "popular" names where none such exist, the author is driven to translations, some of which recall those that once figured on the fossil fish tablets in the British Museum. As a rule derivations of names are, perhaps wisely, avoided; but we do meet with "Aplysia (from *a* and *plus*, unwashable)."

On the whole we incline to the opinion that the publishers did well to include this book in their "Library of Natural History Romance." (BV)$^2$.

*Arithmetic.* By R. Hargreaves, M.A. Pp. viii+416. (Oxford: Clarendon Press, 1901.) Price 4*s.* 6*d.*

IT is very difficult for an author to produce anything strikingly new in such a well-worn subject as arithmetic, and consequently this treatise greatly resembles two or three others of the most meritorious character. A good feature of the work is the attention which it devotes to the *theory* of arithmetic. Labour-saving processes, when long multiplications have to be performed and one of the factors possesses some particular simplicity of form, are frequently given—to the interest as well as to the advantage of the pupil.

If only our terrible system of weights and measures were replaced by the metric system, what a load of revolting and time-wasting work would be removed from the path of the English pupil! A short account of this system will be found in the present work.

Perhaps the explanation of the properties of recurring decimals is scarcely so complete and systematic as it might be. Here the use of a little algebra would do a great deal towards promoting in the mind of the pupil an understanding of the various rules for treating these decimals; and there seems to be no valid reason against the employment of algebra for such a purpose. Purely arithmetical proofs necessarily fail in generality.

There is a good section on approximative work which will be a great help to the learner. There are also sections on the square and cube root; but, with a logarithm book in our hands, the utility of arithmetical or algebraical processes for finding a cube root is more than doubtful.

The work abounds with examples, and with good hints to the pupil for shortening calculation and for choosing one mode of procedure in preference to another when two or more ways of doing a thing present themselves.

*Intermediate Practical Physics.* By J. B. Wilkinson Pp. x + 154. (London: Chapman and Hall, Ltd., 1902.) Price 2*s.* 6*d.*

THIS book is for the intermediate and preliminary scientific examinations of the London University, and deals with experiments of a very simple kind. The exercises illustrate the various branches of physics, and they seem to be very suitable for beginners; but we regret that in many cases the descriptions are not accurate. Thus, in describing the measurement of the diameter of a sphere by placing it between two squared blocks, we are told to test the right-angles of the blocks by seeing whether they fit when placed on the table and then turning both blocks over. Surely this is no test. A little further on, in the account of the siphon barometer, the correction for change in density of the mercury and the expansion of the glass scale is attempted, but sadly needs revision and rearrangement. We should also like to know why the corrections for temperature are given with the siphon barometer and not with Fortin's pattern, where they must be equally important. Although many other points in the book require some correction, we think it is written on the right lines, as it aims at simplicity.

S. S.

*Flowers of the Field.* By the late Rev. C. A. Johns. 29th edition. Entirely rewritten and revised by G. S. Boulger, B.A, F.L.S., F.G.S., Professor of Botany in the City of London College. Pp. xlii + 926. (London: Society for Promoting Christian Knowledge, 1899.)

THE fact that this work should have passed through so many editions sufficiently proves its popularity. The present volume is an improvement on its predecessors, both by reason of the inclusion of new and valuable matter and by the excision of some that could be very well spared. The more definite and full descriptions of the species should aid in the identification of our British plants, but the illustrations still are capable of improvement. The book is, however, sure of a wide circulation amongst the large number of people who take an interest in, and desire a closer acquaintance with, the wild flowers of the country.

*Correlation Tables of British Strata.* By Bernard Hobson, M.Sc., F.G.S. (London: Dulau and Co., 1901.) Price 5*s.*

A SHORT time ago (NATURE, April 11) attention was called to the publication of Woodward's "Table of British Strata," also issued by Messrs. Dulau and Co. The present work is in some respects far more elaborate, as it comprises nineteen detailed tables ranging from Archæan to Pleistocene. The plan of the compiler is to give the subdivisions of each formation as determined in different regions in Great Britain and Ireland. Thus, to take the Cambrian, there are columns for North Wales, South Wales, Malvern Hills, Wrekin area, Nuneaton, North-west Scotland, and Ireland; and in these columns the various local divisions and their estimated thicknesses are given, together with references to original sources of information. No attempt is made to enumerate the characteristic fossils, the leading zonal forms—*Olenellus*, *Paradoxides*, *Olenus* and *Dictyonema*—being the only fossils noted from the Cambrian system. In dealing with Ordovician and Silurian strata the graptolite zones receive particular attention, and other zonal fossils are mentioned. The full stratigraphical details relating to these systems make one feel that scant justice is done to the Devonian; but as a matter of fact our knowledge of that system is far less precise. Here, as occasionally elsewhere, a column for Continental divisions is given. In the Lower Carboniferous, Mr. Hobson starts with the Devon succession and places the Lower Culm Measures with the Coddon Hill Beds on the horizon of the Lower Limestone Shales, whereas their characteristic *Posidonomya* and *Goniatites* indicate an horizon equivalent to the Upper Carboniferous Limestone or Yoredale Series. He has not, however, ventured to indicate zones in the Carboniferous, although materials have been gathered in the neighbourhood of Bristol as well as in northern counties, to which reference is made in the preface. Here and there we would suggest a greater uniformity in method: for instance, the Ammonite zones of the Lias are noted under the names *Ægoceras*, &c.; those of the Inferior Oolite are noted as *Parkinsoni* zone, &c.; and those of the Cretaceous rocks as *Ammonites lautus*, &c. The most difficult correlation is, doubtless, that of the Pleistocene, and here the student may well pause, for the "Upper Boulder Clay" of different areas is not to be regarded as contemporaneous. Indeed, the compiler in his preface remarks that "strata named on corresponding horizontal lines cannot, in some cases, be considered to be of corresponding age"; and the student will do well to bear this in mind.

The work is issued as one of the museum handbooks of the Manchester Museum, Owens College. It cannot fail to be of great service for reference to geologists in general. It bears evidence of the most painstaking care and of wide research up to the date of publication; and we feel confident that the labour will be appreciated.

*Die Partiellen Differential-gleichungen der mathematischen Physik.* By Heinrich Weber, based on Riemann's lectures. Vol. ii. Pp. 527. (Brunswick: Fried. Vieweg and Son, 1901.)

IN reviewing the first volume of this book (NATURE, vol. lxiii. p. 390) it was pointed out that owing to the great advances in mathematical physics which have taken place in the forty years since Riemann's time, Prof. Weber had found it necessary, instead of merely issuing a revised edition of the well-known "Partielle Differentialgleichungen," to write practically an entirely new book. The present volume, which is written much on the same general lines as the first, is divided into five parts. The first contains the more important properties of hypergeometric series and their application to the theory of linear differential equations. The second part, dealing with conduction of heat, is much after the lines of Riemann's original treatment, and treats mainly of conduction in one dimension and conduction in a sphere. The third part is devoted to theory of elasticity and vibrations, the torsion problem being included in the former subject, and vibrations of strings and membranes in the latter. Electrical oscillations come next in order, and the last part consists of hydrodynamics and propagation of plane and spherical sound-waves, including Riemann's own theory of sound-waves of finite amplitude.

Seeing that a whole volume might be written on any one of these branches of mathematical physics and still leave many interesting points untouched, the treatment in the present book is necessarily but fragmentary in character, but Prof. Weber is to be congratulated on the number of points which he has been able to touch in the limited space of about 500 pages. At the end is an index to both volumes. G. H. B.

## LETTERS TO THE EDITOR.

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

### The Total Solar Eclipse of September 9, 1904.

As inquiries have already been addressed to me as to the practicability of observing this eclipse, which passes across the Pacific Ocean (see "Nautical Almanac," 1904, pp. 487-490), perhaps I may be allowed, thus early, to communicate, through your instrumentality, the information I have collected on the subject.

The Walker Islands, which appear on some maps of the locality in the position 149° W., 4° N., would have been, if they existed, very favourably situated for the observation of the eclipse. But recent surveys have shown conclusively that they do not exist.

Kingman, or Caldew, Reef, 162° W., 6° N., is also favourably situated, but is stated in the Admiralty Sailing Directions to be partially dry at low water only.

Palmyra Island is placed by the most recent survey in the position 162° 6′ W., 5° 52′ N., and is thus a little too far south to be available. Proceeding westwards, the next group of islands encountered is the Marshall Islands. But even the most easterly of the group on the track of the eclipse—Aur—is too far west for our purpose, as the middle of the eclipse occurs there shortly after sunrise.

It appears that there is no island conveniently placed for the observation of this eclipse, and astronomers must wait for the total eclipse of the following August, which will afford ample opportunity for observation in Canada, Spain and North Africa.

A. M. W. DOWNING.

### The Dilution of Acetylene for Heating Purposes.

YOU have been good enough on one or two previous occasions to give me a few lines in your columns on questions connected with acetylene for heating, and as this use of the gas is extending and will undoubtedly have a much wider extension in the near future, perhaps you will renew your courtesy in this matter.

In country places for domestic and laboratory purposes, more especially with the advance of electricity and decline of coal gas for lighting, the field for acetylene for heating is very large and has so far met with strangely little consideration. The combustion of a gas containing 92 per cent. of carbon successfully in a Bunsen burner is not more easy than its combustion to produce a trustworthy luminous flame. The chief difficulty from which we suffer in the former matter is the relatively high pressure under which the gas must be burnt. No one has yet devised a Bunsen burner which will give a flame large enough for ordinary working purposes under a pressure of less than six inches of water, and even then luminosity is not entirely banished, practically no margin being left for incorrect adjustment of the burner. The pressure is objectionable, it puts the gas fittings to a severe test in the matter of leakage, it is much more than is required for lighting and has to be specially arranged for in many generators, and in those of the automatic class it involves more "after gas," necessitating larger storage capacity. The fine orifice of the jet and the necessarily narrow tube with its accompanying increased internal friction and the large injecting power essential, all make high pressure a necessity. That this luminosity trouble is partly a matter of temperature can be easily shown by heating the tube of a non-luminous Bunsen, or pouring water on to the tube of one showing luminosity, the effect being very striking, and some improvements on these lines have suggested themselves and are efficient as far as they go. We want, however, to attack the root of the matter and dilute our acetylene to begin with, and this dilution would not be altogether objectionable from a lighting point of view. Lighting burners at present generally inject some air and can only themselves be regarded as on the verge of respectability; quite an absurdly small amount of benzene vapour is sufficient to put out of temper the lighting burners now on the market. Such dilution would give them the margin for bad usage which makes so much for success in practice, even though wasteful in theory.

In seeking a diluent, one turns naturally first to metallic carbides other than calcium, with the idea of finding a commercially possible carbide which will give methane or hydrogen on decomposition with water and could be blended with calcium carbide by the manufacturer to suit, if necessary, various requirements, when we should once more see the early attempts to use for lighting the ordinary household Bray burner repeated with success. Manganese carbide is stated to be easily formed, and by Moissan to be decomposed by water yielding equal volumes of methane and hydrogen, hausmanite (presumably prepared by heating pyrolusite) being recommended. An attempt on my part to make a few grams, though it is true that the amperes at disposal only just reached double figures, failed as regards any gas produced, although reduction undoubtedly took place. I should not presume to quote so insignificant an experiment had not the manager of the Acetylene Illuminating Co., who courteously gave me an interview some months ago, told me that the Company's experiments on this carbide (and science is indebted to the Company for a great many researches, which I hope it may see fit to publish) had not led to the production of a carbide at all easily decomposed by water. I suggested the use of manganese mud as being easily obtainable, very free from silica as compared with pyrolusite, not so highly oxidised, and in a very fine state of division, and I hope that the Company may see fit to try it. Among other carbides, that of aluminium seems to offer attractions for commercial investigation, and although magnesium carbide cannot be prepared in the electric furnace alone, I do not think that dolomite as a substitute for pure carbonate of lime has been experimented upon.

Failing a suitable carbide for dilution, will not some organic chemist come forward with a bye- or waste product which will decompose in the presence of hot caustic lime produced in the generator, with, if not the production of methane, hydrogen or carbon monoxide, at least some indifferent gas, such as nitrogen or carbon dioxide?

Investigations are wanted as to the amount of diluent required to banish luminosity under some standard conditions. I can only speak at present of carbon dioxide; a Bunsen burner consuming one cubic foot of acetylene per hour under six inches water pressure, showing a fully developed luminous zone rather greater in diameter than the sum of the widths of the non-luminous zone on either side, requires a supply of carbon dioxide at the rate of 0·15 cubic feet per hour to destroy completely this luminosity. A. E. MUNBY.

Felsted, November 1.

### Magnetic Iron Ore as a Material for Concrete Blocks.

THE account of harbour works in NATURE of October 24 (p. 639) causes me once more to draw attention to the great advantage which would be gained by the use of magnetic iron ore as a material for concrete blocks. If magnetite is used instead of ordinary rock in the shape of fragments, and magnetic sand or ilmenite sand instead of common sea sand, concrete blocks can be obtained which have all the strength of the ordinary concrete blocks and which weigh, when immersed in water, exactly twice as much as the ordinary blocks. Such an increase in weight makes the magnetic blocks far superior as regards resistance to the waves. Work constructed with magnetic blocks will stand when other work will be destroyed. This superior effect of magnetic blocks is quite independent of the size of the blocks. The artificial increase of the size of ordinary concrete blocks is mentioned as a means of increasing the power of resistance, but there are certain to be some objections to this method, and if the great masses are ruptured after the rusting away of the cases, portions may give way. It is therefore better and more convenient to use the superior composition. As regards the expense, it may be mentioned that to obtain a good effect it is only necessary to use magnetic blocks for the most exposed spots of a dam, and more in the nature of a surface coating. There are immense natural deposits of magnetite, also of titanium ore, which latter is not of value for steel making, and it would surely be possible to obtain the necessary quantities in Scandinavia, or if for harbours in the East, then there would be inexhaustible supplies in southern India not too far from the coast. It has been argued that the iron ore would decay on exposure to sea water and that it would injure the cement. This may be true for inferior iron ores, but not for rich, pure magnetite and ilmenite, as I have proved by direct experiments. I have exposed fragments of magnetite to the action of filtered sea water in clean glass jars where every trace of decomposition would have been detected, but though I continued the test for a year the specimens stood the test very well. Moreover, I made sample blocks with Portland cement and subjected them to crushing tests, which showed them to be perfectly satisfactory as regards strength.

H. WARTH.

### The San Clemente Island Goat.

LAST summer, at San Pedro, California, I was shown a goat which had just been brought over from San Clemente Island. Mr. Müller, the owner of the animal, told me that the goats of that island, running practically wild since the unknown date of their introduction, were all alike, constituting an easily recognisable race. The animal was quite reddish, about the colour of a red deer; front of face black; a pale (reddish) stripe down each side of nose, and enclosing the eye; cheeks black; chin light; ears blackish above; neck and anterior part of body strongly suffused with black. The light facial stripes were particularly distinct.

The Santa Catalina Island goats, I was informed, are variously coloured. This is doubtless due to the fact that Catalina is a popular resort, and fresh animals are frequently introduced.

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., October 27.

### Food of Grass Snakes.

MAY I say, in defence of Dr. Gerald Leighton (see p. 625), that on two occasions I have found mice inside grass snakes. The first case was on a moor near Parkstone, Dorset, where on opening a smallish snake we found a mouse only partly digested. The other case occurred here last year, when I found a small shrew in a large grass snake. Also with regard to them swallowing birds, I have three times found birds inside them. In each case they were young ones; two were probably young larks (they were both in one snake), and the other was a young robin. C. M. ROGERS.

Wellington College, Berks, October 28.

## THE OBSERVATORY OF MONT BLANC.[1]

IN observing the physical features of the Alpine regions, M. Vallot and the several members of his family show a devotion that no discouraging circumstances can damp, and an energy that rises superior to the inclemencies of the weather and the loneliness of the situation. His original observatory, constructed after much labour and in spite of many difficulties, was found to be in an unfortunate position, owing to the accumulation of snow with which neither labour nor expense could efficiently deal. Without hesitation this construction is abandoned, and in the light of greater experience a fresh site is selected and a new observatory built, where, from the peculiarity of configuration, snow cannot collect and interfere with the progress of the work. This building, constructed in 1898, admirably fulfils its purpose, and here, at an altitude of 4358 m., among the eternal snows, M. Vallot and his band of energetic labourers pursue their scientific avocations. These are sufficiently various, and in the present volumes we have the result of three distinct investigations, one dealing with the influence of barometric pressure on the chemical action of solar light, another on the velocity of water in streams and under glaciers, while the last gives an account of experiments undertaken with the view of detecting the rate and character of glacier motion.

Of the first of these discussions it is sufficient to say that the author aims at a re-examination of the adequacy of the formula found by Bunsen and Roscoe in similar researches, wherein occurs a numerical coefficient

[1] "Annales de l'Observatoire météorologique physique et glaciaire du Mont Blanc." Publiées sous la direction de J. Vallot, Fondateur et Directeur de l'Observatoire. Tome iv. Pp. ix + 189. Tome v. Planches du Tome iv. (Paris: G. Steinheil, Editeur, 1900.)

depending on the height of the barometer. M. Vallot adopts the same form of expression, but unfortunately does not give the means of comparing his numbers with those found in the earlier investigation. Moreover, the methods employed are not quite the same, and a slight difficulty arises from the selection of a silver salt whose maximum effect is not exhibited at the same part of the spectrum as in the case of Bunsen and Roscoe's inquiry. Making allowance for a slight discrepancy in this respect, we gather that while Bunsen and Roscoe claimed that 59 per cent. of the solar light was lost by transmission through the atmosphere, M. Vallot finds that only 40 per cent. is so lost. Treating the sensitised paper in such a way as to make the maximum sensibility coincide with the optical maximum, M. Vallot finds the coefficient of atmospheric transmission to be 0·826, corresponding with the mean of the values found by Bouguer, Leiden and Trépied. While the agreement quoted is quite satisfactory, we miss any reference to the work of Captain Abney on the Faulhorn (2683 m.), of Dr. Muller at the Etna Observatory (2944 m.), or of Prof. Langley on Mount Whitney (3513 m.). These latter authorities have all found a rather larger transmission coefficient than others who have worked nearer the sea level, and the greater altitude of the Mont Blanc Observatory might have afforded some explanation. Doubtless if the object be to inquire into the effect of the variation of a particular factor, there is an apparent advantage in conducting the observations in such a way that that factor is most materially affected, but the advantages can be considerably discounted by the extra difficulties introduced by the remoteness of the situation and other causes, and though M. Vallot and his assistants have striven manfully with the difficulties, greater weight would attach to his results if the observations had been more frequently repeated, though at a lesser height and with a smaller diminution of the barometric pressure.

The means employed for discussing the relative velocity of water in streams and torrents is discolouration of the water by means of a powder (fluorescin), which on dissolving rapidly gives rise to a green tint, and then observing the time at which the discoloured water arrives at a distant station. M. Vallot very properly insists upon the necessity of a sufficient expenditure of the powder, which can be determined experimentally according to conditions varying with the quantity of outflow that passes a given point, the colour of the water, &c. Observations made in this way do not permit of very great accuracy owing to the tendency of the coloured water to spread itself according to the character of the channel over which it passes, but when it is a question of determining the velocity in a subterranean channel, under glaciers, it is difficult to see what better means could be devised. M. Vallot has confined his attention mainly to the effect of the slope of the river bed on the rate of flow, and concludes that this is most rapid when the incline is about three in a hundred. As the slope increased, contrary to his expectation, the rate as measured horizontally, diminished. From this he concludes that the onward rush of water along steep ravines is more apparent than real. When the incline is very steep the effect is to hollow out the bottom, giving rise to great irregularities in depth which produce eddies and tend to stop the hurrying progress. It is therefore the mean velocity with which M. Vallot is concerned, and the distances measured vary from 1000 to 4000 m. The maximum velocity observed in the unconfined stream is 2·25 m. per second, and for a subterranean current of the same slope the progress is about one half of this quantity. The same ratio obtains between open streams and sub-glacier currents, whether the horizontal or vertical velocity be measured.

But the particular investigation to which M. Vallot has devoted the greatest attention is the movement of the glacier, Mer de Glace, in its various parts. Here the author enters into a very difficult inquiry, and it would be surprising if some of his results did not differ from generally received opinions. As a contribution to a more complete investigation the study made by M. Vallot is no doubt valuable, and much of his work, such as the difficult triangulation of the Mer de Glace, will be appreciated by later observers. But a complete theory of glacier movement is not to be derived by a study, however minute, of a single glacier in the space of a few years. An international commission under M. Forel has been at work for a considerable period and is probably still collecting data which show that the problem possesses many perplexing variations, not the least difficult being the evidence of periodicity in glacier movement connected with some obscure law that appears to affect the general climate of the earth. During the eight years that M. Vallot has been at work on this subject, he claims to have established the following prominent facts, which undoubtedly have reference to the particular phase of the motion which obtained in the period to which his observations have reference. We regret that it is impossible to enter with minuteness into the character of the evidence by which his conclusions are supported, but they may be briefly summarised thus: (1) That the progress of the glacier throughout the year is constant, the summer does not hasten nor does the winter witness any abatement of the uniform progress. Changes of incline of the bed on which the glacier moves will always explain any observed variation of velocity. (2) That the uniformity of the velocity in all seasons is opposed to any theory of regelation, or, indeed, to any explanation in which changes of temperature play a part. (3) That the movement of the glacier does not partake of the character of a viscous fluid, the whole moving as one piece. M. Vallot thus sums up the result of his long and arduous labours, which have been pursued under great difficulties with considerable skill and over a large area. We can only hope that the experience he has gained will be still longer employed in this species of investigation. "La conclusion de ce travail est que *la progression des glaciers est causée par le glissement de la masse, sous l'action de la pente du lit, aidée par la poussée des parties postérieures*. La pesanteur seule parait être en jeu, à l'exclusion de toute action calorifique."

## GEOLOGY AND METEOROLOGY.

THE subject of climatic changes has always been of absorbing interest to geologists, and they have been perhaps more puzzled to account for the occurrence of plants of temperate or even subtropical character in Arctic regions than for the occurrence of wide-spread Arctic conditions in temperate regions. To explain these changes in the northern hemisphere, the alterations in the distribution of land and water and consequent influence on the Gulf Stream, the modification of the internal heat of the earth, changes in the position of the earth's axis, variations in the amount of heat given off by the sun, the eccentricity of the earth's orbit, and even fluctuations in the amount of carbon dioxide in the atmosphere, have individually or collectively been invoked. The influence of ocean currents, as modified either by the elevation of a tract of islands to form a continental area or by the total or partial submergence of a continent, has naturally been regarded as of very great importance. Moreover, the effect which such changes would have on winds has not been neglected, although their local influence has not been fully realized.

The apparently wide extent of tropical and subtropical climates during past epochs, with evidence of progressive diminution in temperature in later Tertiary times, has been held to be due to astronomical rather than geographical causes. According to M. Eug. Dubois[1] one obscure enigma is that relating to the glacial episode which has been recognised in parts of India, Australia and South Africa in Permo-Carboniferous times. In those subtropical regions the débris from snow-clad mountains had been able to reach sea-level and be commingled with organic remains of almost tropical character. Other evidence, however, tends to show that there was no general lowering of temperature in this ancient epoch, but that there must locally have been mountains of considerable altitude, and that meteorological conditions were favourable to the development of huge glaciers. So also in the case of the far earlier pre-Cambrian period, during which it is believed that glaciation occurred. In connection with the phenomena M. Dubois discusses the evolution of the sun and the various influences affecting radiation of heat, maintaining that the general evidence of higher and more uniform temperature over the earth's surface prior to middle Tertiary times is well established, and is not interfered with by evidences of extensive though restricted glaciation.

In drawing attention to the influence of winds upon climate during the Pleistocene epoch (*Quart. Journ. Geol. Soc.*, August 1901), Mr. F. W. Harmer has opened up inquiries of considerable and far-reaching interest. Remarking that seasons abnormally warm or cold, rainy or dry, may be caused by the prevalence of particular winds, though the course of the oceanic circulation remain the same, he justly remarks that permanent alterations would equally result were the direction of the prevalent winds permanently changed.

Having attentively studied the causes and influence of areas of high and low pressure, he concludes that the climate of the northern hemisphere could not have been wholly cold during any part of the Pleistocene epoch, and that consequently the period of maximum glaciation in North America could not have coincided with that which affected the British Isles.

Regions covered by ice would have been to a greater or less extent anticyclonic at all seasons, low pressure systems prevailing elsewhere. The northerly winds on one side, either of a cyclonic or an anticyclonic centre, are the necessary equivalent of the southerly winds on the other, the direction in the northern hemisphere in the case of the anticyclone being like that of the hands of a watch, and in the case of a cyclone in the opposite direction.

Thus the effect of the anticyclone of an ice-sheet extending eastward from Greenland, over Great Britain, Scandinavia, and Northern Europe, would have been to change the prevalent alignment of the low-pressure system of the North Atlantic, producing warm southeasterly winds in Labrador and New England during the winter, instead of the northerly winds now prevalent there. The alteration in the direction of the winds would have tended, moreover, to divert the warm surface-currents of the North Atlantic from the European to the American coast.

It is admitted by Mr. Harmer that the maximum glaciation of Great Britain could only have taken place at a time when the Icelando-British channel was closed, either by an elevation of the submarine ridge connecting those countries or by its being blocked with ice. Thus, although the winds have naturally a most powerful influence, which he has done good service in pointing out, he is led to consider that to differential earth-movements of elevation and subsidence in different parts of the northern hemisphere may have been due the suggested shifting of glacial conditions from one side of the Atlantic to the other, and the alternation of glacial and interglacial periods in the eastern and western continents. In this way the milder periods which locally prevailed at intervals during the Pleistocene epoch would be attributed to meteorological and geographical rather than to astronomical causes.

[1] "Les Causes probables du Phénomène paléoglaciaire permo-carboniférien dans les basses latitudes." *Archives Teyler*, vii., Partie 4. (Haarlem, 1901.)

## *ANIMAL PHOTOGRAPHY.*[1]

THE advantages of photography as compared with wood-engraving for the illustration of works on natural history are in many ways so great that any attempt to perfect and popularise the methods in use should be heartily welcomed. Quite apart from artistic effect, the great superiority of photography is that it ensures absolute accuracy, and, when living animals are the subjects, shows them in natural attitudes. In wood-engraving there are several sources of error which only too frequently make themselves apparent. In the first place, the draughtsman may make a blunder. But too often it is the engraver who is in fault, very frequently from mistaking the nature of some feature in the drawing he has to reproduce. For example, the author of the volume before us calls attention to a curious engraver's error in a well-known popular work, where, from some misconception, the mouth of a stickleback appears in a totally wrong position.

Such errors are, of course, impossible in photographs and photogravures. Nevertheless, photography has

FIG. 1.—Hedgehog.

certain disabilities of its own in regard to animal portraiture. A trained zoological draughtsman, whose object should be to produce a *characteristic* rather than an *artistic* picture, always takes care to draw his subject in a position which will show to the best advantage its distinctive features, whether of form or colour, and for this purpose he generally consults the specialist for whom the sketch is undertaken. The photographer, on the other hand, is usually content to "snap" the animal he has in hand in any effective pose, with the too frequent result that his picture, from a zoological point of view, has comparatively little value. That is to say, the features by which alone the affinities of the animal can be decided are either not shown at all, or are but imperfectly displayed.

One of the main objects of the present work appears to be to instruct photographers how to avoid these effects

[1] "Photography for Naturalists." By D. English. Pp. 132. Illustrated (London: Iliffe, 1901.) Price 5s. net.

As a case in point, the author takes the natterjack toad. "There are three particular features about the natterjack toad," he writes, "which distinguish it from the commoner variety. It has a yellow stripe down its back, its hind feet are not webbed, and it has a peculiar running method of progression. A really good illustration of this toad would show these three distinctive features. A photograph might easily be produced which would show none of them—a side view, for instance, of the toad sitting still—and such a photograph would probably be the one taken by a photographer who had not troubled to make himself acquainted with his subject."

The author then proceeds to show the methods necessary in order to procure the desired results. Elsewhere he states that for photography of this description the only satisfactory way is to keep the animals whose portraits are desired in confinement for some little time, when they soon become sufficiently tame not to mind the approach of the artist with his camera. It will, of course, be obvious in this connection that the photographer must either be a good practical naturalist himself, or that he must consult someone duly qualified to point out the characteristic features of the animals about to be taken.

Not less important than the display of an animal's distinctive structural peculiarities is the reproduction of its characteristic attitudes. In this respect nature fortunately comes to the artist's assistance. "Living creatures," as the author truly observes, "adopt their characteristic attitudes more frequently than any others. The photographer has, therefore, to learn which attitudes his subjects most frequently adopt, and should endeavour to perpetuate them in his store of negatives."

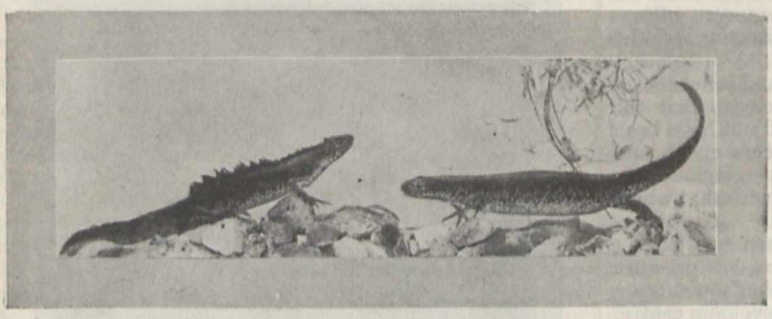


FIG. 2.—Male and Female Great Newts.

A third essential is to pay the greatest attention to the natural "accessories" of the animals photographed. In many cases this is a matter of extreme difficulty; and the artist is frequently sorely tempted to take his subject when in a favourable pose amid incongruous surroundings. Should this course have to be taken—and in some cases it is almost unavoidable—the author advises blocking out the animal and making a fresh negative with a suitable background.

Mr. English is careful to distinguish animal photography of the above nature from what he terms "stalking" photography, when the animal is approached stealthily in its native haunts with the camera, or the camera is concealed in a suitable position to await its arrival. And he renders full justice to the excellent results which have been obtained by the Messrs. Kearton in this branch of the subject.

In the main the author deals with British animals, of which he gives some exquisite pictures. Two of these, by the courtesy of the publishers, we are enabled to reproduce, so that our readers can judge for themselves as to their merits. While it is no doubt of the highest importance to have a large stock of life-like portraits of our native animals, the number of photographers who labour in this field will probably ere long produce a sufficiency. For scientific zoology the portraits of rare foreign animals are still more essential; and in a future edition it may be hoped that the author will see his way to urging his fellow-workers to take up this part of the subject in real earnest.

A large portion of the work is, of course, devoted to the *technique* of the subject; but this we may well leave to the consideration of practical photographers.

The author has done good service in endeavouring to impress on his fellow-workers the importance of producing animal portraits which shall satisfy the requirements of zoologists, and we sincerely trust that his efforts to promote improvement in these matters will not be in vain. The book should be in the hands of every photographer as well as of every naturalist. R. L.

## NOTES.

THE Royal Society's medals have this year been adjudicated by the president and council as follows:—The Copley Medal to Prof. J. Willard Gibbs, For. Mem. R.S., for his contributions to mathematical physics; a Royal Medal to Prof. William Edward Ayrton, F.R.S., for his contributions to electrical science; a Royal Medal to Dr. William Thomas Blanford, F.R.S., for his work in connection with the geographical distribution of animals; the Davy Medal to Prof. George Downing Liveing, F.R.S., for his contributions to spectroscopy; and the Sylvester Medal to Prof. Henri Poincaré, For. Mem. R.S., for his many and important contributions to mathematical science. His Majesty the King has been graciously pleased to approve of the award of the Royal medals. The medals will, as usual, be presented at the anniversary meeting on St. Andrew's Day (November 30). The Society will dine together at the Whitehall Rooms on the evening of the same day.

THE following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1902 at the anniversary meeting on November 30. The names of new members are printed in italics:—President, Sir William Huggins, K.C.B.; treasurer, Mr. A. B. Kempe; secretaries, Sir Michael Foster, K.C.B., and *Dr. Joseph Larmor*; foreign secretary, Dr. T. E. Thorpe, C.B.; other members of the council, Prof. H. E. Armstrong, *Mr. W. Bateson*, *Dr. W. T. Blanford*, *Prof. F. O. Bower*, Mr. C. V. Boys, *Prof. W. Burnside*, *Prof. W. W. Cheyne, C.B.*, *Prof. G. C. Foster*, Prof. W. M. Hicks, *Mr. Frank McClean*, *Prof. H. A. Miers*, *Sir John Murray, K.C.B.*, Prof. J. Emerson Reynolds, Dr. R. H. Scott, Prof. C. S. Sherrington, and Mr. J. W. Swan.

ON November 24 a medal will be presented to M. Berthelot, in the large amphitheatre of the Sorbonne, to commemorate his services to science. M. Berthelot's activity during more than fifty years has been extraordinary, and there are no branches of chemistry on which he has not made his mark. His last publication is "Les Carbures d'hydrogène," a work in three stately volumes, comprising an account of his labours on these compounds during the last half-century. To mention only some of M. Berthelot's achievements, his researches on the synthesis of the natural fats, his discovery of polyhydric alcohols, his work on explosives, on the fixation of nitrogen by plants, his long investigations in the domain of thermal chemistry, and the contributions which he has made to the history of chemistry, constitute a record of work which, it is not too much to say, has not been equalled since the time of Berzelius. The presidents of the Royal and the Chemical Societies have been asked to be present to represent English science, and the President of the Republic will do honour to this eminent man of science by presiding at the celebration.

THE list of birthday honours includes the name of Prof. A. Pedler, F.R.S., Director of Public Instruction, Bengal, who has been made a Companion of the Order of the Indian Empire.

PROF. A. FISCHER DE WALDHEIM, the director of the Botanic Garden at St. Petersburg, has just commenced the publication of a periodical *Bulletin* of the Gardens.

THE Imperial Academy of Sciences of Vienna has received intelligence of the botanical expedition in Brazil, from its chief, Prof. R. von Waldheim, down to September 10, from São Paulo. The rivers Rio Branco, Rio Mambu, and Rio Aguapihy, flowing through an almost unexplored country, had been navigated in canoes; and large consignments have already been sent to Vienna in the form of living plants and roots, herbarium specimens, preparations in spirit, woods, fruits, and economic products.

WE have received from Major Ross the "First progress report of the campaign against mosquitoes in Sierra Leone" (Liverpool School of Tropical Medicine, *Memoir* v. part i.), in which is detailed the methods of procedure and the results up to date of this interesting attempt to reduce the numbers of mosquitoes in a district. The works carried out include the removal of rubbish, especially empty tins and broken bottles, which form breeding places for Culex and Stegomyia (the supposed yellow-fever host), and the filling up and drainage, or brushing out and treating with crude petroleum, of the puddles which harbour Anopheles. Dr. Taylor, who is in charge of the expedition, writes that it is now (September 28) difficult to find Anopheles, Stegomyia is getting very scarce, and Culex is only seen now and again. Dr. Daniels, of the London School of Tropical Medicine, gives testimony to the same effect in a report at the end. The expedition is intended to be an object-lesson in the manner of ridding tropical towns of mosquitoes by drainage and cleaning, and has been financed by private munificence.

ROPE railways have for some time been in use for the conveyance of iron ore and stone in districts where, owing to the nature of the country, ordinary railways would be impracticable. One of the latest examples of these has recently been constructed in Ireland between Ballinphellic and Ballinhassig by the Cork, Bandon and South Coast Railway Company. It is intended for the conveyance of bricks from the works of the Cork Brick Manufacturing Company, situated about eight miles from Cork. The line is four miles in length and has a transporting capacity of twelve tons per hour. There are 126 buckets, which travel at the rate of four miles an hour, each holding 3½ cwt. The rope is of steel, and there are forty-three supports consisting of steel trestles, the height of which is sufficient to allow the buckets to travel overhead clear of all obstructions. The loads automatically take on and leave the cables at the stations without any separate coupling operations. The line is worked by a stationary engine, and it requires 12 h.p. to drive the rope. The cost of transport of bricks to Cork has been reduced from an average of 18*s*. per thousand to 5*s*.

IN the Swedish journal *Jernkontorst*, a description is given by Mr. G. F. Heindenstam of the conversion of the wood waste and sawdust from the saw-mills in that country into charcoal. The waste pieces of wood cut off in the conversion of the logs are passed through rolling-mills designed for drying out the greater part of the moisture and reducing the wood to the form of sawdust. This is then passed on to heated presses and the carbonising apparatus. In these the liquid bye-product is distilled and the solid matter converted into briquettes. A plant consisting of light carbonising apparatus can deal with 9000 tons of waste wood and sawdust, from which 6000 tons of charcoal briquettes are made, the remainder being used as fuel for driving the machinery. These yield 2006 tons of charcoal, having a market value of from 2*l*. 5*s*. to 3*l*. 6*s*. per ton, besides 530½ tons of tar, 300 tons acetate of lime, and 45 tons of methylic alcohol and acetone. The total yield from these is 11,487*l*., the cost of conversion being 7661*l*., leaving a profit of 3826*l*. after allowing 2550*l*. for the value of the waste wood and sawdust, and 10 per cent. on a capital of 16,666*l*.

A PAPER has been contributed to the Vienna Academy of Sciences by Prof. J. M. Pernter on polarisation of light in turbid media, considered in reference to the colour of the sky. The author has observed the polariscopic effects and the relation of the polarisation to the colour in various emulsions of mastic in water, and a comparison has been made between these effects and those observed in the light of the sky. He finds that the two phenomena are in close agreement, and an experimental test is thus afforded of Lord Rayleigh's theory of the colour of the sky.

IN connection with the Austrian deep-sea expedition a paper has been published by the director, Herr Th. Fuchs, dealing with the character of the deep-sea fauna of the Red Sea. In spite of the prevailing high temperatures even at the greatest depths, the fauna is entirely of the character of a deep-sea fauna and resembles that of the open ocean. The deep-sea fauna, considered both as a whole and in regard to its individual species, shows considerable resemblance with the fauna of the so-called "Badner Tegel." Lastly, the peculiar fauna begins at a depth of about 200 metres, although the temperature at this depth is about 23° C., and is sufficiently high to allow of the growth of coral reefs.

VAN DER WAALS's equation was undoubtedly an important step in obtaining a more approximate representation by a mathematical formula of the isothermal lines of fluids than was given by Boyle's law or similar formulæ. The further modifications proposed by Clausius, Tait and others, including, recently, Amagat, all tend to show that such formulæ are at best to be treated as mere approximations. The next step in advance, consisting in the expression of the equation of state of gases by means of series, forms the subject of a paper, by Dr. H. Kamerlingh Onnes, in the *Communications* from the Leyden Physical Laboratory, No. 61. Various forms of series were tried, and the most convenient was found to be an expansion of $pv$ in descending powers of $v$. For the coefficients of these powers, which are, of course, functions of the temperature, series involving the temperature and its reciprocal as well as exponential functions of the reciprocal of the temperature were chosen. A closely allied subject, namely the precise isothermal of hydrogen at 20° C. up to 60 atmospheres, is dealt with by Mr. J. C. Schalkwijk in the preceding number of the *Communications*.

THE eleventh volume of the *Deutsches Meteorologisches Jahrbuch*, by Prof. Paul Bergholz, contains the meteorological observations of the town of Bremen for the past year. The volume is divided into six sections, the first two of which deal with the hourly and daily readings of the various meteorological instruments throughout the year, and the third with the results from the different rainfall stations for the same period. Part iv. contains the mean values of the readings of the self-recording instruments for the years 1896-1900 and 1891-1900, while part v. includes similar information from observations made three times a day. Of perhaps the greatest interest is the sixth and last section, in which are brought together the results of the meteorological observations since they were commenced. Thus we find that the series for temperature commenced in the year 1803, that for rainfall in 1830, and pressure and humidity in 1876. The mean values are given in a very convenient form, being arranged according to intervals of a month, year, five years and ten years. There are also numerous other tables in which maxima values, minima values, temperature for each season of the year, number of frost days, &c., are separately dealt with. The volume closes with a table showing the mean values for the whole period of observation of all the meteorological elements for each month of the year, the mean temperature for every day of the year, and a set of curves illustrating many of the variations mentioned above and showing many of the mean daily variations.

THE International Aëronautical Committee have published their complete account of the results of the manned and unmanned balloon ascents which took place on November 8, 1900. The work contains the original observations, together with those taken at mountain stations, and special cloud observations on the day of the ascents. Dr. Hergesell has discussed the observations of each ascent with reference to barometric pressure, temperature and wind, and has shown on two charts the distribution of pressure and temperature at the sea level and surface of the earth respectively and at a height of 5000 metres. Great variations of temperature were exhibited in different localities, even up to the highest strata of air; the coldest districts lay in the north-west and the warmest in the south-east of the continent. At an altitude of 5000 metres, the temperature over Paris was about $-20°$ C. and over Vienna, $-11°$. The isotherms at 5000 metres run from S.W. to N.E.; that of $-10°$ extends from the north of the Adriatic to Moscow; that of $-15°$, from the south-west of France, across Germany and the Baltic to St. Petersburg, and those of $-20°$ and $-25°$ take a more northerly course, while over Ireland the air is cooled to $-30°$. The isobars at the above-mentioned altitude, like the isotherms, run generally from S.W. to N.E.; the pressure is lowest over the British Islands and highest over the S.E. of Europe. The wind velocity is best shown by the manned ascents; from the observations taken by Dr. Berson, the velocity rose from 8·3 metres per second at 1600 metres to 11·2 metres per second at 2300 metres, and he estimates that at altitudes above 6000 metres the velocity would be about 16 metres per second. The ascents were mostly made during anti-cyclonic conditions, and an inversion of temperature was generally observed, especially after reaching the limits to which the ground fog extended.

WE have received from Messrs. Isenthal and Co. a well-illustrated catalogue of electric heating and cooking appliances, which shows that this branch of electrical industry has been very fully worked out. It cannot be claimed for electrical heating that it is very economical, but its superior cleanliness and convenience are recommendations that are sure to lead in the course of time to its widespread use. A point strongly in its favour is that heat need only be generated at the time and the exact place at which it is required; an electrical cooking range can be shut down when not needed much more easily and completely than a coal fire. It is impossible to estimate the gain in cleanliness and healthiness which would result from a general adoption of electrical in place of coal or gas heating for domestic purposes, but the advantage is sure to be realised sooner or later, just as it is being realised in electric lighting, and we may hope in time to have a fogless London as a result. At present electric lighting companies have a business which is so rapidly expanding that it is, perhaps, not worth their while to take special pains to induce consumers to adopt electrical heating. The gain would all the same be very great to the supply companies, as it would give them a heavy day load. That there is already a considerable demand for electric heating apparatus is evidenced by the catalogue before us, which describes appliances for meeting almost every conceivable want, both for domestic and scientific or laboratory purposes. Some of the latter apparatus would be very convenient in laboratories where electric current is available, as it affords easier means of regulation and is safer than gas, and also allows any desired temperature to be obtained a second time with much less trouble.

WE have received from the publishers, Messrs. Iliffe and Sons, Ltd., the Christmas number of *Photography*, a number which will be welcomed by all interested in the art of picture making. No pains seem to have been spared to make the magazine all that could be desired in the way of quality of paper and printing, while the text is of very general interest and the reproductions of numerous well-known photographs excellent. In the opening article a brief account is given, with illustrations, of three of the foremost photographic artists in France, and we may suggest to those who are not familiar with their style of work that much may be learnt from the article. The second contribution is on a subject which interests every photographer, but the importance of which is not often thought of until too late. One recollects with regret how many good negatives would have been greatly improved if only a figure had been inserted or placed in another position or even omitted altogether. Valuable hints on this score will be found in the chapter entitled "the introduction of figures into landscape pictures," and much can be gathered from the excellent and appropriate illustrations. The main part of this publication is devoted to criticisms and reproductions of many pictures by well-known photographers, which, as is stated, is a reprint in a revised form from *Photography*. The number concludes with a set of sixteen borders with different designs for Christmas cards, all of which are copyrighted, but are placed at the disposal of amateurs and professionals desiring to use them for their own cards.

THE Imperial Department of Agriculture for the West Indies has issued a full report on sugar-cane experiments conducted at Antigua and St. Kitt's in the season 1900–1901. The report is in two parts, the first, of 32 foolscap pages, dealing with experiments with varieties of sugar cane, with an appendix on the chemical selection of sugar cane; and the second, of 78 pages, with manurial experiments. Mr. Francis Watts, chemist-in-charge, states that the variety and manurial experiments involved the analysis of the juice from upwards of 900 plots, while those on chemical selection necessitated the determination of the sucrose in 600 canes. Taking the mean results of the experiments in Antigua, cane D 95 occupies the best place with 8158 lb. of sucrose per acre in juice, Mont Blanc variety following with 7256 lb., while B 147, the best Barbados seedling, stands twelfth on the list with 6050 lb. The means for ratoon canes, however, place B 147 first with 7164 lb. In St. Kitt's, one of the most promising of the Barbados canes, B 208, stands first with 9817 lb., Naga B second with 8956 lb. and B 147 third with 8874, Mont Blanc and D 95 being respectively eleventh and twelfth on the list. On the question of chemical selection the results obtained were not conclusive. Polarising the juice of 200 "high" canes and 200 "low" canes, the difference proved so small that it may lie entirely within the limits of experimental error. The manurial experiments are fully described, with forty-three tables of particulars. They indicate the possibility of growing good crops of plant canes with the use of pen manure only (including such organic manures as green dressing), and when it is obtainable in sufficient quantity artificial manure is unnecessary. If there is no pen manure, fields in good condition will produce good crops with the aid of artificial manures. What should be done with phosphate is not clear. Artificial manures are unremunerative on land in poor mechanical condition. It is recommended that energy should be devoted to raising pen manure rather than spend money on artificial manures. Experiments are being undertaken to determine whether it will be remunerative to use artificial manures in growing green dressings.

GEOLOGICAL surveys in the United States take a more comprehensive view of geology than is prevalent elsewhere, as they deal generally with natural history. The State Geologist of Alabama has issued a bulky volume on the plant life of the State, by Dr. Charles Mohr. In it are enumerated all the known species of native plants, with their synonymy, localities and mode of occurrence. The author makes some remarks on the spontaneous flora in its relation to agriculture, and observes that the fitness of the land for the production of a special crop can often be ascertained by the farmer from the character of the vegetation alone, without having to resort to costly and time-consuming experimentation.

THE Geological Survey of India has published an account of the Son Valley in the Rewah State and of parts of the adjoining districts of Jabalpur and Mirzapur, by Messrs. R. D. Oldham, P. N. Datta and E. Vredenburg (*Mem. Geol. Surv. India*, vol. xxxi. part i., 1901). The report is accompanied by a colour-printed map on the scale of an inch to four miles, and this shows the exposed areas of unfossiliferous and more or less metamorphosed rocks, a red shale series, and overlying divisions of the Vindhyan and Gondwana groups, which have been regarded as representing Silurian and Jura-Trias respectively. The present work relates almost wholly to the stratigraphical, petrographical and physical questions. There is an almost complete absence of minerals of economic value and apparently also of fossils. Special attention is drawn to the porcellanites of the Lower Vindhyan series, which are regarded as volcanic tuffs.

DR. FRITZ NOETLING describes the fauna of the Miocene beds of Burma ("Palæontologia Indica," new series, vol. i. 1901). Two groups of Tertiary strata are recognised; the lower, characterised by a marine fauna, is considered to be of Miocene age, and the upper, characterised by fluviatile and terrestrial forms of life, is regarded as Pliocene. The Miocene deposits yield remains of Anoplotherium, Crocodilus, Python and Myliobates, which suggest comparison with higher Eocene and Oligocene strata. The author, however, maintains that the beds are newer than the Bartonian (Eocene), and he has "purposely refrained from mentioning the Oligocene," as, in his opinion, "no evidence warrants the adoption of this name for any part of the Indian Tertiary system." The fauna is composed mainly of Lamellibranchs and Gasteropods, and these exhibit relationships with the Eocene of France and with the recent fauna of the western Pacific. Thirty per cent. of the species are direct ancestors of forms living in the Indian Ocean, but this recent fauna contains also a foreign, probably European, element of Miocene origin. One of the author's conclusions is that there was no direct communication between the Miocene Ocean of Europe and India during the Miocene period, as there is not a single species common to the two areas. The vertical range of the species is very restricted.

THE Report of Mr. Edgar Thurston, superintendent of the Goverment Museum, Madras, for the year 1900–1901 has reached us, and contains much interesting information concerning the work done in the various departments of the institution, particularly in the case of those devoted to anthropology, natural history and industrial economics. During the year under review four parts of the *Bulletin* of the Museum were issued, the contents of which have already been referred to in these columns.

THE Baschkirs are an interesting group of peop who live on the eastern slopes of the Urals; formerly they were all nomads, but they have been constrained by the Russian Government to become more or less settled, and they now constitute three groups—the forest- mountain- and steppe-Baschkirs. Hofrat Peter von Stenin gives in *Globus* (Bd. lxxx., Nr. 10, p. 150) an ethnographical illustrated sketch of these people, with references to the literature of the subject, but he omits the brilliant essay on their sociology by M. Edmond Demolins in *La Science Sociale* (tome ii., 1886, p. 405), which is based upon the observations of Le Play in the second volume of his "Ouvriers Européens." The difficulty with which a pastoral people take to agriculture is indicated by both the German and French authors in a manner characteristic of their several nationalities.

THE anthropological investigations in connection with the Madras Government Museum are being conducted with energy and ability, the last research being by Superintendent F. Fawcett on the ethnography of the Nâyars of Malabar. The account is published in the *Bulletin* of the Museum (vol. iii. No. 3) and is illustrated with eleven plates. The Nâyars, the Nareæ of Pliny, were the swordsmen, the military caste of the west coast of India. They are said to be the most complete existing example of inheritance through females. Their average stature is 1·656 m., the cephalic index 73·1, and nasal index 76·8; that is, they belong to the somewhat short, long-headed, distinctly dolichocephalic mesorhine group of the non-Aryans of southern India. The customs relative to marriage, birth, death are carefully narrated. The religion is described, special mention being made of serpent worship and certain festivals, and astrology and magic.

MR. C. J. HERRICK, the well-known author of the "Mammals of Minnesota," contributes to the October number of the *Journal of Comparative Neurology* an important paper on the cranial nerves and cutaneous sense-organs of the North American cat-fishes, or siluroids. Starting with Merkel's discovery of the divisibility of the cutaneous sense-organs into two chief types—the "terminal buds" and "neuromasts," or organs of the lateral-line system—the author has endeavoured to ascertain whether these two types are supplied by different nerves, as has been thought probable by other investigators. The investigation has involved the complete working-out of the nervous system of the common American cat-fish, *Ameiurus catus*.

THE latest issue (vol. xxix. part iii.) of Gegenbaur's *Morphologisches Jahrbuch* contains five papers, all dealing with the morphology and development of the lower vertebrates. Prof. B. Haller discusses the primitive kidneys of the spiny dog-fish, Mr. H. L. Bruner the respiratory mechanism of amphibians, as exemplified by the myology of two genera, and Mr. J. F. Holm the finer anatomy of the nervous system of the lampreys of the genus Myxine. The first appearance of the olfactory organ in the larva of the true lampreys forms the subject of an article by Dr. W. Lubosch, while F. Hochstetter describes certain variations in the aortic arch and the bases of the arteries springing from the same in reptiles.

THE August issue (vol. iv. part i.) of *Annotationes Zoologicae Japonenses* contains five papers, for the most part on somewhat abstruse biological subjects, and thus bears witness to the thoroughness with which natural science is studied in Japan. In the first communication Prof. Mitsukuri discusses "negative phototaxis" in the Japanese periwinkles and its influence on their habitat. Knowing that these molluscs like shallow water, it is argued that when the depth becomes too great for their comfort they endeavour to escape by crawling in the direction which appears to them the darkest—that is towards the land. In a second paper Mr. S. Hatta reviews the lampreys of Japan;

while in a third Dr. Bashford Dean adduces evidence to prove the existence of vestiges of an original holoblastic cleavage in the egg of the Japanese representative of the Port Jackson shark. This discovery is of the highest morphological importance, sharks' eggs having been hitherto regarded as typically meroblastic. "No one, I fancy," writes the author, "would have been bold enough to have prophesied that the wide difference between the typically meroblastic egg of the shark and the holoblastic egg of such a teleostome as a sturgeon might come to be bridged over within the limits, not of fossil sharks, but of recent sharks themselves."

THE singular bulbiform seeds of certain Amaryllideæ—especially species of Amaryllis and Crinum—are the subject of an interesting paper by Dr. A. B. Rendle in the November number of the *Journal of Botany*. These seeds are of three kinds:—(1) True seeds developed from a normal ovule, the outer integument of which becomes thick and fleshy after fertilisation, and forms the substance of the bulbiform mass; (2) true seeds developed from a naked ovule, the fleshy substance being derived entirely from the endosperm, which develops chlorophyll in its outer layers and continues to grow for some time; (3) a vegetative growth replacing the seed; a normal ovule is produced, but a viviparous growth of an adventitious shoot and root takes place at the base, and a bulbil is formed, the ovule integuments forming the outer coats.

DR. FRIEDRICH BERWERTH has communicated to the Vienna Academy of Sciences a paper on soundings from the eastern Mediterranean. In regard to the distribution of calcareous mud, it is found that two principal zones exist, one to the north of the Nile delta, which extends along the Syrian coast and contains but little carbonate of lime (5 to 15 per cent.), while the other, consisting of the remainder of the eastern Mediterranean, is largely calcareous, the proportion of chalky matter being on an average 60 per cent., with variations of 20 per cent. above and below this average. The relation between the proportion of calcareous matter and the depth appears to be at variance with what would be expected from Murray's theory. The sedimentary matter consists, in general, of (1) calcareous organic remains (mollusca and foraminifera), (2) fragments of siliceous matter of organic origin, including sponges and radiolaria, (3) fragments of minerals and rocks, (4) a precipitate, partly calcareous, partly argillaceous, showing little microscopic structure, which constitutes the main part of the mud.

A SOUND and practical knowledge of "The Cyanide Process of Gold Extraction" can be obtained from the volume on that subject by Prof. James Park, published by Messrs. Charles Griffin and Co. The first English edition was favourably noticed in these columns last year (vol. lxii. p. 148), and the second has now appeared. The whole volume has undergone revision, and the new matter includes a detailed description of well-designed slime and sulphide plants now in use in the great mining centres of the world.—Another of Messrs. Griffin's technical handbooks which has reached a second edition is "Practical Coal Mining," by Mr. George L. Kerr, the first edition of which was reviewed in NATURE of February 28 (vol. lxiii. p. 417).

LOW-TEMPERATURE research at the Royal Institution during the past seven years has been assisted by the Hodgkins Trust Fund—a sum of 100,000 dollars left by the late Mr. T. G. Hodgkins as a source of income to be employed in the "investigation of the relations and co-relations existing between man and his Creator." To show what has been done towards this end, Miss Agnes M. Clerke has prepared for the Hodgkins Fund a popular essay on Prof. Dewar's work at the Institution from 1893 to 1900. The essay traces the course of his researches in the physics and chemistry of low temperature, and contains, in addition, three illustrations showing the lecture table of the Royal Institution upon the occasion of the centenary commemoration lecture on liquid hydrogen, and the elaborate refrigerating machinery and liquid hydrogen apparatus used by Prof. Dewar.

THE current number of the *Berichte* contains a paper, by A. Hantzsch and A. Holl, on sulphimide. This substance was first obtained by W. Traube from the products of the action of ammonia upon sulphuryl chloride, and the formula $SO_2NH$ was attributed to it, from the analyses of its salts. In the present paper the authors have been successful in obtaining sulphimide in the solid form, and have found by molecular weight determinations that it resembles cyanuric acid in being trimolecular $(SO_2NH)_3$. They have also succeeded in isolating the methyl ester of this substance, and have found that this is also trimolecular. It is pointed out that the analogy between the nitrogen derivatives of carbonic acid and sulphuric acid is much closer than has hitherto been supposed.

*Bulletin* No. 186 of the U.S. Geological Survey contains an interesting study of pyrites and marcasite, by Dr. H. N. Stokes, and describes a method for the quantitative determination of these minerals when in mixture. The method depends upon the fact that when either mineral is boiled with an excess of a solution of ferric salt to complete reduction of the latter the ratio of sulphur oxidised to mineral decomposed is perfectly definite and characteristic of each mineral, provided certain standard and easily controllable conditions are observed. Under these conditions the percentage of sulphur oxidised on pyrites is about 60·4 per cent. and on marcasite about 18 per cent. of the total sulphur. The application of this method has thrown considerable light on several doubtful questions relating to the dimorphous $FeS_2$. It is shown, for example, that density is not a trustworthy means of determining one mineral in presence of the other, that the hypothesis that most natural specimens are mixtures of the two is without foundation, and that there is no evidence of a difference of valency of iron in the two minerals. Specimens crystallising in the regular system are true pyrites, whilst those forming rhombic crystals are true marcasite.

THE additions to the Zoological Society's Gardens during the past week include a White-crowned Mangabey (*Cercocebus aethiops*) from West Africa, presented by Mr. Fred Gordon; a Cape Zorilla (*Ictonyx zorilla*), a Derbian Zonure (*Zonurus giganteus*) from South Africa, presented by Mr. W. L. Sclater; a Gazelle (*Gazella dorcas*) from Egypt, presented by Mrs. Bensusan; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. John Booth; a Bauer's Parrakeet (*Platycercus zonarius*) from South Australia, presented by Miss Gillam; a Lobed Chameleon (*Chamaeleon parvilobus*) from South Africa, presented by the Rev. Duncan Travers; a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, an Alligator Terrapin (*Chelydra serpentina*), a Pennsylvanian Mud Terrapin (*Cinosternum pennsylvanicum*), a Muhlenberg's Terrapin (*Clemmys muhlenbergi*), six Long-eared Sun Fish (*Leptomis auritus*) from North America, deposited; three Australian Wild Ducks (*Anas superciliosa*), bred in the Gardens.

## OUR ASTRONOMICAL COLUMN.

THE LEONID METEORS.—Arrangements are being made at several observatories to record, by eye observations and photography, any Leonid meteors which appear during the epoch of the Leonid meteoric shower, November 14-15.

NEBULOSITY SURROUNDING NOVA PERSEI.—A telegram from the Centralstelle at Kiel announces that from the examination of photographs taken with the Crossley reflector of the Lick

Observatory, Prof. Perrine has found four principal condensations of the faint nebula surrounding Nova Persei, and that these have been displaced *one minute of arc* to the south-east in a period of six weeks.

MEAN PARALLAX OF STARS.—No. 8 of the *Publications* of the Astronomical Laboratory at Groningen contains an investigation, by Prof. J. C. Kapteyn, of the mean parallax of stars considered with reference to their determined proper motions, magnitude and spectral type.

PLANETARY INFLUENCE ON SUN-SPOT PERIOD.—In the Paris *Comptes rendus* (vol. cxxxiii. pp. 726–729), Prof. Birkeland gives the discussion of a further attempt to trace any possible connection between the 11-yearly sun-spot period and the gravitational disturbance of the planets Mercury, Venus and Jupiter, using observations made from 1892–1896. He comes to the same conclusion as formerly, that the variations cannot be traced to planetary influence.

DISTRIBUTION OF COSMIC VELOCITIES.—Profs. J. C. Kapteyn and W. Kapteyn have recently completed the elaborate treatment of two preliminary communications made by the former to the Academy of Sciences at Amsterdam, and the first part of the treatise is published as No. 5 of the *Publications of the Astronomical Laboratory of Groningen*.

In this an attempt is made to deduce, from the available observations of proper motion, the law defining the relation between the number of stars having linear velocities of determined values, or shorter, the law by which the frequency of a linear velocity is given as a function of its magnitude. The main assumption on which the derivation is based is "the real motions of the stars are equally frequent in all directions."

In the papers mentioned above it had been stated that certain inequalities existed in the distribution of velocities with respect to the apex of the solar motion, and that these had been traced to the influence of a systematic error of the proper motions in declination. It is now thought that many of the former difficulties will be removed by the introduction of a correction for this anomaly.

The formulæ given are developed to such terms as are likely to provide for any great future extension of the accuracy attainable in proper motion determinations, and although the time may come when spectroscopic investigations of velocity (the accuracy of which does not depend on the distances) will supersede the present observations, at present the possibility of having two independent determinations from different components of the real motion is a valuable and important consideration.

The second part of the work, dealing with the application of these formulæ to the observations, will be presented in a later publication.

## *THE INFLUENCE OF THE MEDITERRANEAN PEOPLES IN PREHISTORIC BRITAIN.*[1]

THE progress of archæological discovery during the last twenty years has thrown a flood of light on the relation of the prehistoric period in Europe north of the Alps to the civilisation of the Mediterranean in the period embraced by history. We are now in a position to recognise the source from which the inhabitants of middle and northern Europe, and of the British Isles, obtained the art manifested in their articles of daily use, and we are able to trace them back to that wonderful Mediterranean civilisation, proved by the labours of Schliemann to be older than the Greeks and shown recently by Mr. Arthur Evans to have occupied a commanding position in the island of Crete. Schliemann discovered its range over the eastern Mediterranean from Troy to the Peloponnese, Evans extends it to almost within sight of Italy, where the Etruscan civilisation is the dominant factor at the dawn of history.

The picture presented to us of the Mediterranean region during the period extending from the establishment of the Greeks in the east and the Romans in the west, backwards to at least 2300 years B.C., as proved by the discoveries at Knôssos, may be outlined as follows. A civilisation of the very highest order existed in the region extending from Italy eastwards through the Ægean Sea to Asia Minor, equal in splendour to that of Egypt and Assyria. Although it borrowed many things from both, it was a development independent of both, and, so far as the evidence goes, it appears to have been indigenous in the Mediterranean region and Asia Minor. Whether or no it is as ancient as that of Egypt and Assyria is an open question.[1] It was common to the ancient Trojans and Mycenæans overthrown by the Greeks, to the Cretans, and to the Etruscans overthrown by the Romans. It is worthy of remark that in the eastern Mediterranean it formed the foundation of Greek art, while it survived in the west under the name of Roman, its possessors in each case being absorbed into the Greek and Roman peoples.

The establishment of the Phœnicians in the Eastern Mediterranean, at least as far back as the seventeenth century B.C., as proved in the records of Egypt, has also to be considered. They were the great merchants and carriers, distributing the wares of Egypt, and later of Assyria, to the various Mediterranean peoples, founding colonies here and there, among the greatest of which was Gades (Cadiz), about 1100 B.C., and Carthage, 814 B.C. Their fleets in penetrating westward had to contend with the Etruscan maritime power, dominant in the western Mediterranean. They and the Etruscans were the great distributors of metal, more particularly bronze, and their ships penetrated in later times far northwards along the Atlantic shore. It is not at all improbable that Phœnician ships coasted along the Atlantic as far north as the British Isles, bringing with them the wares of the Mediterranean and returning with tin from Cornwall and gold from Ireland. There is, however, no absolute proof of their presence in Britain, because, like the English of to-day, they had no art of their own and merely imitated the art of other peoples.

During the period under consideration, the various peoples inhabiting the Mediterranean were sufficiently organised to allow of a confederacy for the attack of Egypt. The first mention of a European people in the Egyptian annals is the attack of the Sardones and the Tyrrhenes (Etruscans) and their defeat by Ramses II. in the seventeenth century B.C. This was followed about seventy years afterwards by a more formidable combination, in which the two above-mentioned peoples were joined by the Sicels, Lycians, Achæans and Lybians. The allies advanced by sea and land, conquered part of the Delta, and were defeated after a desperate struggle by Meneptah I.

It remains now to trace the influence of the Mediterranean civilisation through middle and northern Europe. The two oldest routes of traffic are those starting from the head of the Adriatic, from the ancient Etruscan city of Hatria. The first runs by Trieste, Laibach, Gratz and Bruck, to Presburg, and thence past Breslau and along the Lower Vistula to the amber coast of Samland. The second, or western route, takes the line of the Adige, past Verona and Trient, over the Brenner Pass into the valley of the Inn, crossing the Danube either at Linz or Passau. Thence it ran through the Bohemian passes into the valley of the Elbe, and made for the amber coast of Schleswig and Holstein. These were the two principal routes taken by the caravans, which brought to the inhabitants of middle and northern Europe in the Bronze Age bronze swords, axes, daggers, bracelets, brooches and other articles from the south, carrying back, among other things, the amber so highly valued by the Mediterranean peoples. There were probably similar routes to these northwards and westwards over the plains of France, starting from the Alpine passes, and along the river valleys, along the lines afterwards followed by the Greeks of Marseilles (Massilia). It was probably by one or other of these routes that brooches, swords and other implements of southern derivation, arrived at the sea-board of the North Sea and Atlantic, and were brought by ship into Britain and Ireland. Ireland, it must be noted, at this time was the *El Dorado* of the west, attracting adventurers from the south both by sea and land.

These routes were also used in the prehistoric Iron Age north of the Alps, and along them metal work of most beautiful design, brooches and bracelets, mirrors and other articles, belonging to the so-called "late Celtic" art, were introduced into Britain—such, for example, as the mirror, brooch, and bronze bowl found at Glastonbury. In Ireland this art is amply represented in the numerous golden and bronze ornaments.

The Greeks, too, after their establishment at Massilia in the sixth century B.C., took up this trade, making clearly defined routes through France, to the Atlantic shore and to the Rhine valley, along which the tin of Cornwall was carried overland to

[1] Presidential Address by Prof. Boyd Dawkins, D.Sc., F.R.S., to the Vesey Club, on October 15, illustrated with slides.

[1] I feel unable to accept Prof. Flinders Petrie's conclusion, that some of the pottery found in the tombs of the first dynasty in Egypt belongs to the Mycenæan or Ægean pottery, and therefore goes back as far as 4750 B.C.

the south. They also probably carried on a trade by sea. In 325 B.C., Pythias, the first explorer of Britain known to fame, was sent at the head of an expedition from Massilia, working his way along the Atlantic coast and wintering somewhere near Dover. From this point he sailed to the Orkneys and Scandinavia, returning by way of the amber coast at the mouth of the Elbe. The Greek influence was also felt from the northern borders of Greece through Germany. In Britain a coinage which was copied from the Stater of Philip of Macedon marks the close of the prehistoric Iron Age, when the Greek influence was dominant. In Ireland, it is worthy of note, none of these coins have been met with, and it is likely, therefore, that the Greek influence was never felt in that island.

From this outline it is clear that the principal artistic development in Britain, in the Bronze and prehistoric Iron Ages, was due to the art of the south, and that it was derived mainly from the Mediterranean civilisation, including under that term Mycenæan, Ægean, Etruscan and Dalmatian art, and that in later times it was aided by intercourse with the Greeks.

W. BOYD DAWKINS.

## *THE MOVEMENTS OF PLANTS.*[1]

IT is sometimes asserted that the power of movement is a character distinguishing animals from plants. This statement arises to some extent from an obvious confusion of thought. Trees are stationary, they are rooted to one spot; but they are not, therefore, motionless. We think them so because our eyes are dull—a fault curable with the help of a microscope. And when we get into the land of magnification, where the little looks big and the slow looks quick, we see such evidence of movement that we wonder we do not hear as well as see the stream of life that flows before our eyes.

In speaking of the cells of which plants are built, Mr. Huxley said that a plant is "an animal enclosed in a wooden box, and Nature, like Sycorax, holds thousands of delicate Ariels imprisoned in every oak." It is this delicate prisoner, the living protoplasm, that we may watch pacing round its prison walls. And we may see it stop as though frightened at our rough usage, and then, after a hesitating twitch or two, we see it recover and once more flow round the cell. Or we can see under the microscope minute free-swimming plants rushing across the field of view, all one way, like a flock of little green sheep that we can drive to and fro with a ray of light for a sheep dog.

But I am not going to speak to-night of microscopic matters, but rather of things on a bigger scale which can be seen with the naked eye. I will begin by trying to show that very obvious movements are to be seen in every kitchen garden or in every garret window where a scarlet runner is grown for its red flowers' sake.

If you will examine a scarlet runner, you see that the shoot is not completely vertical, but bends over to one side. To record the movements of the plant a series of photographs may be taken vertically from above the plant, so that the end of the shoot shows like the hand of a watch against a sort of clock-face on which the points of the compass are marked. These photographs will show how the shoot swings round in its instinctive search for another stick to climb up.

This well-known movement is performed by a co-ordinated series of curvatures the exact nature of which need not trouble us now. Let us rather consider the less obvious power of coordination which enables a plant to grow upwards in a straight line. Think of a forest of pine trees, hundreds of thousands of them, all growing vertically up towards the sky. Here is a clear case of movement, for the leading shoots were once but a few inches from the ground, and now they are crawling along vertical lines 100 feet up in the air. It may be said that this is mere increase in size, not movement in the ordinary sense. But I can show you that the trees could not grow in this way had they not a power of curvature to which the name of movement cannot be refused.

As it is not easy to experiment on pine trees, we will use a pot of mustard seedlings, which represents in miniature a forest of vertical stems. Now suppose the flower-pot upset and left lying on its side for a few hours: the seedlings will be found to have all recovered the vertical position, and they have done so by a bend which is just as much a case of movement as the flexure of a man's arm, though it is effected by a very different mechanism. Not everyone realises how rapid this movement is. Fig. 1 is from a diagram made in the ordinary course of class-work at Cambridge, and illustrates this point. A shoot of *Valerian* was placed horizontally at 2.17 and a black line painted like a silhouette on a vertical sheet of glass to record its position at 2.30; similar lines were painted at intervals, forming a record of fairly rapid movement. If greater delicacy of observation had been practised, it would have been easy to show that the plant begins to curve up within a few minutes of being placed horizontally.

It is a remarkable fact that the plant should be stimulated, or stirred up, to a definite curvature by merely placing it horizontally. The curvature tends to bring the plant into the upright position, and when the whole stem has reached the vertical, the stimulus ceases to exist. It is as though the plant were in a condition of content when vertical and of discontent in any other position, and as though the discontent expressed itself in curvature.

But the plant does not gain the vertical by a single continuous curvature; at first it overdoes the thing (see Fig. 1) and the end of the shoot may pass beyond the vertical by 20°–30°. But this new position, inasmuch as it is not vertical, originates a new stimulus, and the new curvature which follows brings the shoot back towards the upright position. It may again overshoot the mark, but by repeated corrections it finally attains the normal upright posture.

It is this power of correcting the line of growth whenever it deviates from the upright that enables the pine tree to grow straight upwards. And this is what I meant when I said that its habit of growth depends on regulated curvature to which no one can refuse the name of movement.

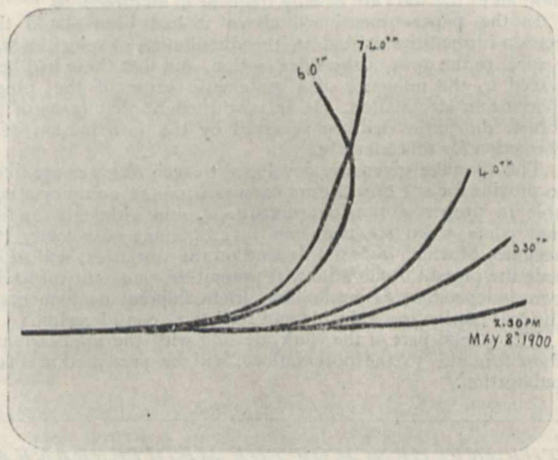



FIG. 1.—A *Valerian* stem curving geotropically.

The pine and the seedling have, in fact, a wonderful kind of sensitiveness—a sensitiveness to the force of gravity. To those accustomed to think of Mimosa as the sensitive plant *par excellence* my words may sound strange. But the sensitiveness of Mimosa is crude by comparison with that of the seedling. A plant with a perception of the position of the centre of the earth and a power of growing along the line so perceived is a much greater miracle than a leaf that closes its leaflets when burnt or cut or shaken.

I hope I shall be able to prove to you that we can point to certain parts of the plant which have the special quality of the perception of gravitation, but we are at present ignorant of how the act of perception is effected. We know something of the machinery of hearing or vision in animals, but in plants we can only guess that when a cell is placed horizontally a resulting change of pressure on the protoplasm produces that loss of equilibrium which is translated into curvature.[1]

The use of this gravitational sensitiveness is clear enough. It is to the pine tree what a plumb-line is to the builder, for

[1] Evening lecture delivered at the Glasgow meeting of the British Association, September 16, by Francis Darwin, F.R.S.

[1] It is, however, probable that Nemec and Haberlandt are right, and that the stimulus depends on the pressure of solid particles, *e.g.* starch-grains, on the protoplasm. See their papers in the *Deutsch Bot. Ges.*, 1900.

neither plant nor man can build high unless he builds straight. A man has a general perception of the verticalness of his body and of surrounding objects, but he does not trust to this sense in placing brick on brick to make a house. He uses a plumb-line which tells him through his eye the precise line along which he must pile his bricks. The tree has also to pile one over another the cells or chambers in which its protoplasmic body lives, and this too must be done along a vertical line; but the plant does it by the sensitiveness to gravity of which I have spoken.

It must be clearly understood that gravity does not act directly on the growth of plants. It does not act as a magnet acts on iron, or to take a better example, it does not simply act as gravity acts on the plumb-line in which the string is kept in a vertical straight line by the weight. It might be supposed that in some occult way the stem was mechanically kept straight like the string, and this indeed was the view formerly held about such roots as grow straight down into the earth. But it is not so; the thing is not explicable mechanically. Gravitation is nothing more than a sign-post or signal to the plant—a signal which the plant interprets in the way best suited to its success in the struggle for life, just as what we see or hear gives us signals of the changes in the exterior world by which we regulate our conduct.

You will say that this is hard to prove, and indeed, like other biological hypotheses, it can only be shown to be true by explaining a number of facts. It is interesting to try to explain the facts without the assumption in question. If gravity does *not* act indirectly as a signal it must act directly, and we must find a reason why, in the case of the mustard seedling above referred to, the stem has grown up and the root down. There is absolutely nothing in their structure or manner of growth to help us to see why this difference of behaviour under identical conditions should exist. And if, instead of placing the mustard seedling in the dark we had grown it near the window, we should have come across another remarkable phenomenon, namely, that the stem grows towards, the root away from, the light—and this is equally inexplicable on a mechanical basis.

But it may be said that it is not fair to compare a root and a stem which are structurally unlike. Let us, therefore, stick to roots. When the root of a bean has grown vertically down into the soil for some distance it begins to bud forth into side roots. These are exactly like the primary root from which they spring; there is no difference in structure or in machinery of growth. Yet the secondary roots do not grow vertically down, but obliquely, or in some cases horizontally. There is one more striking fact about the roots of the bean. The secondary, like the primary roots, give off branches, and these—the tertiaries—behave differently from both primary and secondary roots. For instead of directing themselves vertically or horizontally, they simply treat the force of gravity with contempt and grow just where fancy leads them. The point on which I wish to insist is that it is impossible to explain on any theory of the direct action of gravity why the three orders of roots have three distinct modes of growth. They may remind us of three generations, grandfather, father, and son, all of one blood and yet behaving towards the universe in three distinct ways—a fact not unknown in human society.

On the other hand, it would not be difficult to show that the behaviour of the three orders of roots is well suited to the plant's needs, and therefore we can understand how the power of behaving in three different ways to the same signal has been evolved. The main root takes the shortest course to the deeper layers of earth; the four or five ranks of secondary roots divide the world between them and push forth all round, keeping slightly below the horizontal; the tertiaries take it for granted that their predecessors have done the usual thing and that they can satisfactorily occupy the spaces left among their elders by random growth. The fact that the tertiary roots have no specialised sensitiveness of gravitation shows that their unregulated growth is good enough for the necessities of the case. For among organised beings necessity is the mother of development, and what their brethren of second rank have developed they too could assuredly have gained. To this point of view I shall return, but first I should like to give a few more instances of actions carried out in response to the signal of gravity; and these examples shall be from stem-structures.

The flower-heads of a clover (*T. subterraneum*) bury themselves in the ground, thus effectually sowing their own seeds, and they are guided to the ground by their unusual capacity of curving down and directing themselves like a primary root towards the centre of the earth.

Other flower-stalks are guided by gravitation for quite different purposes. Take, for instance, a common narcissus. In the young condition there is a straight shaft piercing the ground

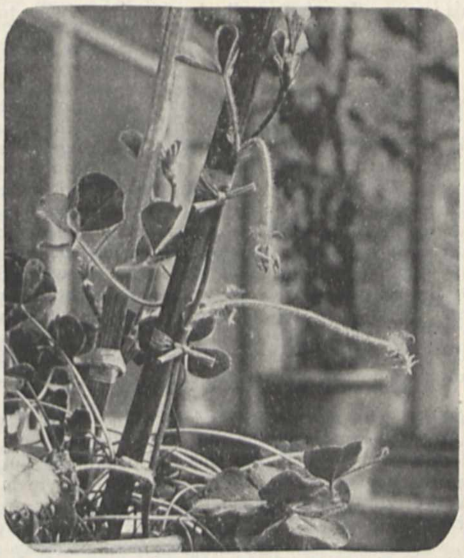


FIG. 2.—*Trifolium subterraneum.* Two flower-heads in the fruiting condition: the upper one has bent sharply and is growing vertically downwards.

with its compact pointed flower bud; but as the flower opens the stalk bends close to the top and brings the flower-tube into a roughly horizontal position, where it shows off its brightly coloured crown to the insects that visit it. The flowers are guided to the right position by the gravitation sense, and they increase or diminish the angular bend in their stalk till the right position is attained, as shown in Fig. 3. The same thing

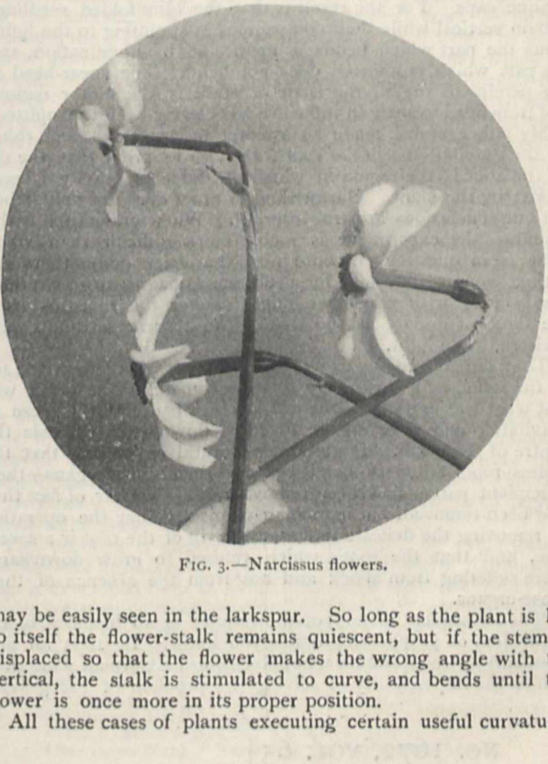


FIG. 3.—Narcissus flowers.

may be easily seen in the larkspur. So long as the plant is left to itself the flower-stalk remains quiescent, but if the stem is displaced so that the flower makes the wrong angle with the vertical, the stalk is stimulated to curve, and bends until the flower is once more in its proper position.

All these cases of plants executing certain useful curvatures which occur when the plant is displaced as regards the vertical and cease when the habitual relation is reached, all these, I say, seem to me only explicable on the theory that gravitation does not act as a mechanical influence, but as a signal which the plant may neglect entirely, or, if it notices, may interpret in any way; that is, it may grow along the indicated line in either direction or across it at any angle. You may say that this is no explanation at all, that it only amounts to saying that the plant can do as it chooses. I have no objection to this, if you will first define the meaning of the word "choice."

I AM now going to deal with the subject of movement from a somewhat different point of view, namely, to show that it is possible to discover the part of the plant which reads the signal, and this is not necessarily the part that executes the correlated movement. In the reflex movement of an animal (for instance, a cough produced by a crumb going the wrong way), we distinguish the irritation of the throat and the violent action of the muscles of the chest and abdomen, and further, the nervous machinery by which the stimulus is reflected or switched on, by way of the central nervous system, from throat to coughing muscles. In the plant, too, if we are to compare its movements to the reflexes of animals (as has been done by Czapek), we must distinguish a region of percipience, another of motility, and the transmission of an influence from the percipient to the motor region.

Transmission of a stimulus has long been known in Mimosa, but in the far more important curvatures which we are now considering it was not known to exist before the publication of the "Power of Movement in Plants." There is an experiment of Rothert's[1] which we do in class work at Cambridge, and which only differs from my father's classical experiment in the fact that a much more perfectly adapted plant is employed. The plant in question is a grass, *Setaria*, which has a remarkable form of seedling. When the grain germinates it does not send up a simple cylindrical sprout like an oat, but a delicate stem terminating in a pointed swollen part which looks like a little spear-head. When a group of *Setarias* is illuminated from one side, they bend strongly over, with their little spear-heads all pointing straight at the light. The spear-heads do not bend; the whole movement is carried out by the stalk on which the head is supported. But the remarkable thing is that it is the spear-head and not the stalk which perceives the light. This is easily proved by covering the heads of a few *Setarias* with opaque caps. For the result is that the blindfolded seedlings remain vertical while their companions are pointing to the light. Thus the part which bends is unaffected by illumination, and the part which is affected does not bend. The spear-head is the percipient organ, the shaft or stalk is the motor region, and from head to shaft an influence has clearly been transmitted.

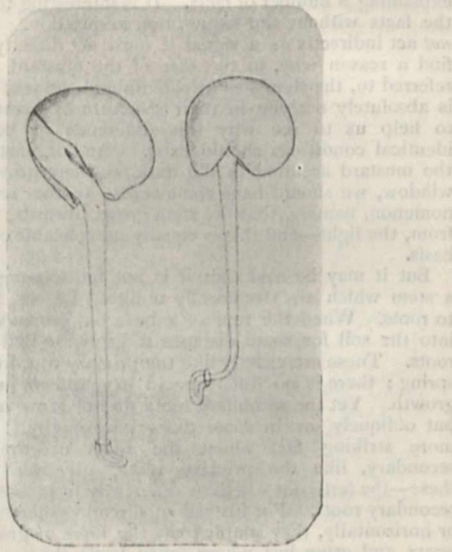
My father and I made an attempt to prove the same thing for the gravitation-sense of roots, that is, to prove that the tip of the root is the region in which the force of gravity is perceived by the plant. Our method of proof does not hold good, but our conclusions are true after all. When gravitation is the stimulus, the experiment is much more difficult than when light is in question, because now that fairy godmothers are extinct we must not hope for a substance opaque to gravitation, a substance with which we might shelter the root-tips from the force of gravity as the tips of the *Setaria* seedlings were sheltered from light.

The plan adopted by us was simply to cut off the extreme tip of the roots, and fortunately (or unfortunately) the result was just what was expected—the tipless roots had lost the sense of gravitation and were unable to curve downwards towards the centre of the earth. It was surely natural to believe that the tipless roots failed to bend because their sense-organs—their percipient parts—had been removed. As a matter of fact they had been removed, but it was fairly objected that the operation of removing the delicate tissues at the tip of the root is a severe one, and that the roots which refused to grow downwards were suffering from shock and not from the absence of their sense-organs.

The subsequent history of the inquiry is an instance of the unwisdom of prophesying unless you know. In 1894 an able summary of the question was published in a German journal, in which the impossibility of solving the problem of the gravitational sensitiveness of the root-tip was dwelt on, and immediately afterwards Section K of this Association had the satisfaction of hearing Pfeffer read a brilliant paper giving the long-hoped-for proof that the tip of the root is a sense-organ for gravitation.[1]

Like many other experiments, it depends on a deception or trick played on the plant. The root is forced to grow into a glass tube closed at one end and sharply bent in the middle, resembling, in fact, a little glass boot. The extreme tip is thus kept at right angles to the main body of the root; if the theory we are testing is the right one, a root with its motor region horizontal and its tip vertical ought to continue to grow horizontally, because the tip being vertical is not stimulated by gravity; it is in a quiescent, or, as it were, a satisfied condition, and no bending influence is being sent to the motor region. And this is what Pfeffer and Czapek found. Fig. 4 A, if turned through a right angle, will represent such a root. On the other hand, if the main body of the root points vertically down while the sensitive tip is horizontal, a curvature results, because as long as the tip is horizontal it is stimulated, and the stimulus is transmitted to the motor region. Fig. 4 A shows the tip horizontal; B shows the curvature which brings the tip into the vertical once more.

This experiment proves not only that the tip of the root is the sense-organ for gravity, but also that the motile part is not



A B

FIG. 4.—Roots in glass boots (from *Pringsheim's Jahrbücher*).

directly sensitive; in other words, that gravitation is perceived exclusively in the tip of the root. Since the publication of Pfeffer's and Czapek's papers I have been lucky enough to hit on another way of testing the theory that the tip is the percipient organ for gravitation,[2] and I am not without hopes that botanists may become in this question as fertile as Cyrano with his seven ways of flying to the moon.

There is a certain kind of inverted action familiarly known as the tail wagging the dog, and it is on this principle of inversion that my experiment is designed. Inversion may in some cases be practised without altering the final result. For instance, it does not much matter whether the thread goes to the needle (the rational masculine plan) or *vice versâ*, as in the orthodox feminine way of threading a needle. In other cases you create what is practically a new machine by inversion, as in a certain apparatus in which the hand of a clock stops still while the clock itself rotates. The effect is still more striking with my plants, for the inversion practised on them entirely changes the character of their movement.

The result may be shown with the seedling *Setarias* of

1 Cohn's *Beiträge*, 1894.

1 Pfeffer, in the *Annals of Botany*, September 1894. Further details in Czapek's paper in *Pringsheim's Jahrb.*, 1895.

2 F. Darwin, *Annals of Botany*, December, 1899.

which I have spoken, or with *Sorghum*, as in Fig. 5. If one of these is supported by its seed with its stem projecting freely in the horizontal plane, the gravitation stimulus makes it bend upwards until the tip is vertical, when the stimulus ceases to act and the curvature comes to an end. If the conditions are reversed, if the seedling is supported in a horizontal position *by its tip*, while the seed projects freely, the result is at first the same, though finally it comes to be strikingly

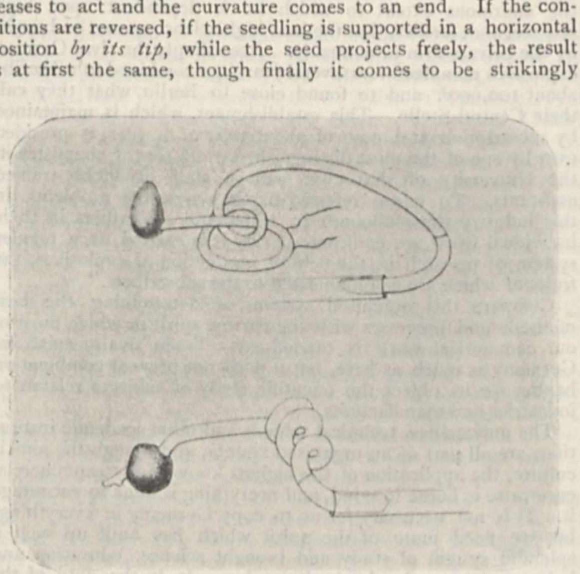
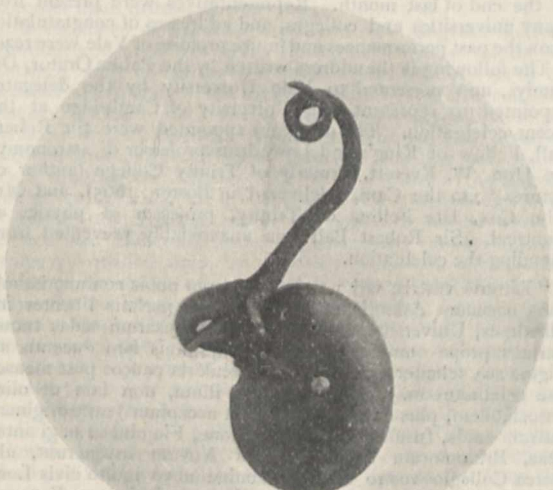


FIG. 5.—Seedling *Sorghums* supported by their tips in horizontal glass tubes. (From the *Annals of Botany*.)

different. The basal end of the seedling is carried upwards by the curvature of the stem; but according to the theory we are testing, the tip of the seedling is the only part of the plant which feels the gravitational stimulus, and the tip of the seedling remains horizontal in spite of the curvature of the stem. Therefore the tip of the seedling is not freed from stimulation as it was in the first case, where the curvature brought the tip into



IG. 6.—A bean-root which had been supported by the tip; the curvature thus corresponds to that in Fig. 5.

the vertical position. The horizontal tip therefore continues to send commands to the stem to go on curving, in a way I can best explain if I am allowed to make the plant express its sensations in words. The tip says to the stem, "I am horizontal, therefore you must bend upwards"; and when this order has been obeyed the tip says, "It is of no use, I am still horizontal—go on bending." The result is that the stem curls up into a spiral like a corkscrew or a French horn, as shown in Fig. 5. I have also been able to get the same result with the roots of beans and peas, as shown in Fig 6.[1]

These unfortunate plants are in the position of a convict on the treadmill; their movements are, from their own point of view, absolutely ineffectual and meaningless. The results are, however, of some importance from our point of view, since they give clear support to the theory which I have now attempted to place before you, namely, that the percipient region is at the tip of the *Setaria* seedling or of the bean root (as the case may be), and that by what corresponds to a reflex action the stimulus perceived by the tip is transmitted to the motor region. I think I may quote my father's words and say that it is hardly an exaggeration to say that the tip acts like the brain of one of the lower animals.

I should like to add a few words on the question how far the movement of plants can be placed under the general laws deducible for the movements of animals. Unfortunately, as soon as we attack this question we are liable to enter regions where for the ignorant there are many pitfalls. We are, in fact, face to face with the question whether in plants there is anything in which we may recognise the faint beginnings of consciousness, whether plants have the rudiments of desire or of memory, or other qualities generally described as mental.

If we take the wide view of memory which has been set forth by Mr. S. Butler[2] and by Prof. Hering, we shall be forced to believe that plants, like all other living things, have a kind of memory. For these writers make memory cover the whole phenomena of life. Inheritance with them is a form of memory, or memory a kind of inheritance. A plant or an animal grows into the form inherited from its ancestors by passing through a series of changes, each change being linked to the preceding stage as the notes of a tune are linked together in the nervous system of one who plays the piano. Or we may compare the development of an animal or plant to the firing of a train of gunpowder, which completes itself by a series of explosions each leading to a new one. To use the language I have been employing, each stage in development acts as a signal to the next.

In the same way the characteristic element in what is done by memory or by that "unconscious memory"[3] known as habit is the association of a chain of thoughts or actions each calling forth the next.

What I wish to insist on is that the process I have called action by signal is of the same type as action by association, and therefore allied to habit and memory. The plants alive to-day are the successful ones who have inherited from successful ancestors the power of curving in certain ways when, by accidental deviations from their normal attitude, some change of pressure is produced in their protoplasm. With the pianist the playing of A has become tied to, entangled or associated with the playing of B, so that the playing of A has grown to be a signal to the muscles to play B: similarly in the plant the act of bending has become tied to, entangled or associated with, that change in the protoplasm due to the altered position. There is no mechanical necessity that B should follow A in the tune; the sequence is owing to the path built by habit in the man's brain. And this is equally true of the plant, in which a hereditary habit has been built up in a brain-like root-tip.

The capacities of plants of which I have spoken have been compared to instincts, and if I prefer to call them reflexes it is because instinct is generally applied to actions with something of an undoubted mental basis. I do not necessarily wish it to be inferred that there can be nothing in plants which may possibly be construed as the germ of consciousness—nothing psychic, to use a convenient term; but it is clearly our duty to explain the facts, if possible, without assuming a psychological resemblance between plants and human beings, lest we go astray into anthropomorphism or sentimentality, and sin against the law of parsimony, which forbids us to assume the action of higher causes when lower will suffice.

The problem is clearly one for treatment by evolutionary method—for instance, by applying the principle of continuity.[4] Man is developed from an ovum, and since man has consciousness it is allowable to suppose that the speck of protoplasm from which he develops has a quality which can grow into consciousness, and by analogy that other protoplasmic bodies, for instance those found in plants, have at least the ghosts of similar

[1] F. Darwin, in *Proc.* Cambridge Phil. Soc., xi.
[2] "Life and Habit," 1878.
[3] Mr. S. Butler's term.
[4] See James Ward, "Naturalism and Agnosticism," i. 283.

qualities. But the principle of continuity may be used the other way up—it may be argued that if a lump of protoplasm can perform the essential functions of a living thing to all appearances without consciousness, the supposed value of consciousness in Man is an illusion. This is the doctrine of animal automatism so brilliantly treated by Mr. Huxley.[1] He is chiefly concerned with the value of consciousness to an organism—a question into which I cannot enter. What concerns us now is that, however we use the doctrine of continuity, it gives support to belief in a psychic element in plants. All I contend for at this moment is that there is nothing unscientific in classing animals and plants together from a psychological standpoint. For this contention I may quote a well-known psychologist, Dr. James Ward,[2] who concludes that mind "is always implicated in life." He remarks, too (*ibid.* p. 287), "it would be hardly going too far to say that Aristotle's conception of a plant-soul . . . . is tenable even to-day, at least as tenable as any such notion can be at a time when souls are out of fashion."

This is a path of inquiry I am quite incapable of pursuing. It would be safer for me to rest contented with asserting that plants are vegetable automata, as some philosophers are content to make an automaton of Man. But I am not satisfied with this resting-place. And I hope that other biologists will not be satisfied with a point of view in which consciousness is no more than a bye-product of automatic action, and that they will in time gain a definite conception of the value of consciousness in the economy of living organisms. Nor can I doubt that the facts we have to-night discussed must contribute to the foundation of this wider psychological outlook.

[1] "Science and Culture," Collected Essays, i.
[2] *Loc. cit.* p. 288.

## LESSONS FROM GERMANY.

WE are glad to see that many public men are directing attention to the relationship between scientific investigation and industrial progress, and urging reforms which were advocated in these columns, and by men of science generally, long before the present position was reached. There is no question now that resolute efforts must be made if Great Britain is to hold her own during the twentieth century. Already we have lost supremacy in several branches of industry, and we shall probably be surpassed in others by America and Germany unless our commercial men learn to realise that science is the source of energy of all sustained industrial movements.

It is the business of scientific research to extend natural knowledge, and the investigator is not usually concerned with the commercial aspects of his work. The application of scientific results to industrial developments is for the manufacturer and merchant to consider, but they are unable to appreciate the possibilities of such results unless they have themselves had a scientific education. A discovery which to one man appears trivial may be made by another the nucleus of a great industrial development. Commercial history can afford numerous instances of the connection between science and prescience and the influence which the two combined exert upon progress. Mr. R. B. Haldane, M.P., mentions a few cases of this kind in an article in the November number of the *Monthly Review*. He selects the brewing industry as one instance of a change which should cause national concern. Thirty years ago Germany exported no beer, to-day she exports almost as much as Britain. The advance is due to the discovery and application of scientific method. When the "Brauerbund" was formed, it was definitely decided to make science with practice and practice with science the principle to work upon. Scientific stations were established in which technical problems confronting the practical brewer could be studied, brewing schools were founded, each with laboratories, experimental maltings and a brewery attached to them, and every effort was made to provide for the education of brewers with scientific as well as technical knowledge. The result of this thorough provision for educating scientific brewers is that German beer is a very active rival of English beers in our own country, and in France it almost monopolises the market.

This is one example given by Mr. Haldane to show how the ndustrial life in Germany is in close contact with the academic life. The case of the aniline dyes is too well known to need to be described here again, but our loss may be understood by the fact that 80 per cent. of the coal-tar colours used by the Bradford Dyers' Association now comes from Germany.

It is, however, not only through the school that the man of science in Germany comes to the aid of industry, but also through the experiment stations or central bureaus of scientific opinion. The German, remarks Mr. Haldane, "is aware of the enormous extent to which he is dependent upon high science, and, further, that the best high science cannot be bought by the private firm or company. Accordingly the rival German explosives manufacturers several years ago combined to subscribe about 100,000*l*. and to found close to Berlin what they call their Central-Stelle. This establishment, which is maintained by subscription at a cost of about 12,000*l*. a year, is presided over by one of the most distinguished professors of chemistry in the University of that city, with a staff of highly-trained assistants. To it are referred as they arise the problems (in this industry these abound) by which the subscribers in their individual work are confronted. By it is carried on a regular system of research in the field of production of explosives, the fruits of which are communicated to the subscribers."

Compare this organised system of determining the best methods and processes with the narrow spirit in which most of our commercial work is carried on. Trade rivalry exists in Germany as much as here, but it does not prevent combination having for its object the scientific study of subjects related to industries and manufactures.

The universities, technical schools and other academic institutions are all part of an organised system, and though the aim is culture, the application of the highest knowledge to commercial enterprise is borne in mind, and everything is done to encourage it. It is not necessary for us to copy Germany in everything, but we need more of the spirit which has built up such a splendid system of study and brought science, education and industry into such close relationship. It is the duty of the State to do far more than it has hitherto done to promote this connection by assisting research, organising and extending scientific education, and encouraging men to devote their lives to the extension of natural knowledge.

## THE BICENTENNIAL OF YALE UNIVERSITY.

THE two hundredth anniversary of the foundation of the University was celebrated by a series of imposing ceremonies at the end of last month. Representatives were present from many universities and colleges, and addresses of congratulation upon the past performances and future promise of Yale were read.

The following is the address written by the Public Orator, Dr. Sandys, and presented to Yale University by the delegates appointed to represent the University of Cambridge at the recent celebration. The delegates appointed were Sir Robert Ball, Fellow of King's and Lowndean professor of astronomy, the Hon. W. Everett, formerly of Trinity College (author of lectures "On the Cam," delivered in Boston, 1865), and Mr. John Cox, late Fellow of Trinity, professor of physics at Montreal. Sir Robert Ball was unavoidably prevented from attending the celebration.

"Litteris vestris, viri nomine non uno nobis coniunctissimi, trans oceanum Atlanticum ad nos nuper perlatis libenter intelleximus, Universitatem vestram, inter Musarum sedes transmarinas prope omnium vetustissimam, annis iam ducentis ab origine sua feliciter exactis, sacra saecularia paucos post menses esse celebraturam. Trans oceanum illum, non iam ut olim dissociabilem, plus quam sexaginta (ut accepimus) ante originem vestram annis, Insulae Longae e regione, Fluminis Longi inter ripas, Britannorum coloni Portum Novum invenerunt, ubi postea Collegio vestro antiquo nomine novo indito civis Londiniensis liberalitatem etiam illustriorem effecistis. Ergo et animi nostri fraterni in testimonium, et diei tam fausti in honorem, tres viros amicitiae foederi novo vobiscum feriundo libenter delegimus, primum Astronomiae professorem nostrum facundum, quem quasi nuntium nostrum sidereum, velut alterum Mercurium Pleiadis filium Atlantis nepotem, trans maria ad vos mittimus; deinde, e vestra orbis terrarum parte, non modo Universitatis Cantabrigiensis utriusque alumnum, cuius eloquentia olim Cami nostri nomen Angliae Novae inter cives magis notum reddidit, sed etiam Universitatis nostrae alumnum alterum, qui provinciae Canadensis Universitatum inter professores numeratur. Has igitur litteras a legatione nostra ad vos perferendas Mercurio nostro tradimus, in quibus Universitati vestrae florentissimae propterea praesertim gratulamur, quod nuper tam insigne vivacitatis documentum dedistis, ut ex alumnis vestris, quos quindecim milium ad numerum per annos ducentos laurea vestra coronastis, partem plus quam dimidiam adhuc inter vivos numerare potueritis. Valete atque etiam in posterum plurimos per annos felices vivite."

The doctorate of laws was conferred on President Roosevelt and forty-six others, including the following men of science and college presidents:—Prof. J. H. Biles (Glasgow), Dr. J. S. Billings (New York), President C. W. Dabney (Tennessee), Prof. D. W. Finlay (Aberdeen), Prof. Jacques Hadamard (Paris), Dr. S. P. Langley (Smithsonian Institution), Prof. A. A. Michelson (Chicago), Prof. W. Osler (Baltimore), President H. S. Pritchett (Massachusetts), President Ira Remsen (Baltimore), Prof. O. N. Rood (Columbia University), Prof. Wilhelm Waldeyer (Berlin), President J. B. Angell (Michigan), Principal William Peterson (McGill University), Mr. Seth Low (ex-president of Columbia University), President J. G. Schurman (Cornell), Mr. Franklin Carter (ex-president of Williams College), President W. R. Harper (Chicago), Mr. W. C. Harrison (Pennsylvania), President F. L. Patton (Princeton), President B. I. Wheeler (University of California).

On October 22, Dr. D. C. Gilman, a graduate of Yale, and for twenty-five years president of the Johns Hopkins University, delivered an address on the relations of Yale University to letters and science. The address is published in full in *Science* of November 1, from which we select a few notes on men of science who have been connected with Yale.

The Collegiate School of Connecticut was the beginning of Yale University; it became Yale College in 1718, and about the beginning of the nineteenth century developed into the University. During the last fifty years two new schools have sprung into existence—the Sheffield Scientific School and the School of Fine Arts—and the former has increased in importance in a most remarkable manner.

Prior to the Revolution the two men of more than provincial fame whose names are associated with Yale are Edwards, the naturalist, and Eliot. Before Yale College was fifty years old, Benjamin Franklin became its valued friend and was enrolled among its laureati in 1753. Four years previously he had presented the College with an electrical machine which enabled the young tutor, Ezra Stiles, to perform the first electrical experiments tried in New England. A Fahrenheit thermometer was a subsequent gift, and his influence led the University of Edinburgh to confer upon Stiles a doctor's degree.

At the dawn of scientific activity in New England the commanding and attractive figure of Manasseh Cutler stands out. Cutler, a man of the true scientific spirit, an observer of the heavens above and of the earth beneath, is the father of New England botany. He made a noteworthy contribution to the memoirs of the American Academy, collected and described between three and four hundred plants of New England, and left seven volumes of manuscript notes, which are now in the Harvard herbarium, awaiting the editorial care of a botanical antiquary.

Among others whose names are renowned in the world of science are Silliman, leader in chemistry, mineralogy and geology, equalled only by Agassiz; Olmsted, the patient, inventive instructor, whose impulses toward original investigation were not supported by his opportunities; Loomis, interpreter of the law of storms and master of the whirlwind; Dana, the oceanographer; Newton, devoted to abstract thought, who revealed the mysteries of meteoric showers and their relation to comets, not before suggested; and Marsh, the inland explorer, whose discoveries had an important bearing on the doctrine of evolution—these all, with the brilliant corps of the Sheffield Scientific School, were men of rare ability who expounded and illustrated the laws of nature with such clearness and force that the graduates of Yale are everywhere to be counted as for certain the promoters of science.

Two agencies are conspicuous in the second era of Yale, the *American Journal of Science* and the Sheffield Scientific School. Benjamin Silliman showed great sagacity when he perceived, in 1818, the importance of publication, and established of his own motion, on a plan that is still maintained, a repository of scientific papers, which through its long history has been recognised both in Europe and in the United States as comprehensive and accurate; a just and sympathetic recorder of original work; a fair critic of domestic and foreign researches; and a constant promoter of experiment and observation. In the profit and loss account, it appears that the College has never contributed to the financial support of the journal, but it has itself gained reputation from the fact that throughout the world of science Silliman and Dana, successive editors from the first volume, have been known as members of the faculty of Yale.

Agricultural science in the United States owes much to the influences which have gone out from the Sheffield School. J. P. Norton, J. A. Porter, S. W. Johnson, and W. H. Brewer are the followers in our generation of Jared Eliot, the colonial advocate of agricultural science.

In the thirties of last century there was an informal association which may be called a voluntary syndicate for the study of astronomy; and the example and success of these Yale brethren initiated that zeal for astronomical research which distinguishes America. The Clark telescope, acquired in 1830, was then unsurpassed in the United States. One of its earliest and noteworthy revelations was the appearance of Halley's comet, which was observed, from the tower in the Athenæum, weeks before the news arrived of its having been seen in Europe. This gave an impulse to observatory projects in Cambridge and Philadelphia, and college after college soon emulated the example of Yale by establishing observatories in embryo, for the study of the heavens. The most brilliant luminary in the constellation was E. P. Mason, a genius, who died at twenty-two, having made a profound impression on his contemporaries by discoveries, observations, computations and delineations. Under the leadership of Olmsted, Herrick, Bradley, Loomis and Hamilton L. Smith were associate observers, and they were afterwards reinforced by Twining, Lyman and Newton. Chauvenet became a writer and teacher of renown, and Stoddard carried to the Nestorians the telescope that he had made at Yale under the syndicate's influence.

In the science of mineralogy Yale has long maintined the American leadership. No one is likely to overestimate the influence of the collection in the Peabody Museum upon the mind of James D. Dana, nor to overestimate the value of his treatise on mineralogy which, revised and enlarged by able cooperators, continues to be a standard text-book in every country where mineralogy is studied. In view of its recent acquisition, the Museum may almost be described as the "House of the Dinosaur." Its choice collections give an epitome of the sciences of mineralogy, crystallography, meteoroids, geology, palæontology and natural history, from the days of Silliman to those of the Danas, Brush, Marsh and Verrill.

In controversial periods the attitude of Yale has been very serviceable to the advancement of truth. The Copernican cosmography was probably accepted from the beginning, although elsewhere the Ptolemaic conceptions of the universe maintained their supremacy, and the notes which Rector Pierson made on physics when he was a student in Harvard come "between the Ptolemaic theory and the Newtonian" (Dexter). When geology became a science, its discoveries were thought to be in conflict with the teachings of the Scripture. Silliman stood firm in the defence of geology, and although some of the bastions on which he relied became untenable, the keep never surrendered, the flag was never lowered. When the modern conceptions of evolution were brought forward by Darwin, Wallace and their allies, when conservatists dreaded and denounced the new interpretation of the natural world, the wise and cautious utterances of Dana at first dissipated all apprehensions of danger and then accepted in the main the conclusions of the new biological school. Marsh's expeditions to the Rocky Mountains and his marvellous discoveries of ancient life made the Peabody Museum an important repository of geological testimony to the truth of evolution.

But there are many others whose work has promoted science at Yale, and the next centennial discourse will do justice to them. Among the departed whose careers were made outside the walls of Yale, Percival, the geologist of Connecticut and Wisconsin; J. D. Whitney, the geologist of California; Chauvenet, the mathematician; Hubbard, the astronomer; Sullivant, the chief authority in mosses as Eaton is in ferns; F. A. P. Barnard, the accomplished president of Columbia; Eli Whitney, the inventor of the cotton-gin; and S. F. B. Morse, whose name is familiar from its relation to the electric telegraph—are especially entitled to honourable mention in this jubilee. So is a much older graduate, David Bushnell, the inventor of submarine explosives—the precursor of the modern torpedists.

This is a record of which Yale may well be proud; and the series of volumes which has been issued in commemoration of the work of the University is really a stupendous monument to activity in all departments of knowledge. We are only concerned with the volumes containing papers from the scientific laboratories, but even these are of far too elaborate a character to be described adequately in this short article. Five volumes have been received, which can only be briefly noticed. Two of these, edited by Prof. F. A. Gooch, contain records of researches carried on in the Kent Chemical Laboratory of Yale University from the opening of the laboratory in 1888 to the present time. In one volume there are fifty-nine papers, and in the other forty-nine, together with a systematic index, index of authors and index of subjects. A consideration of the more familiar phenomena of optics is given by Prof. C. S. Hastings in a volume on "Light," which ought to receive the attention of students of the subject. The laboratory of invertebrate palæontology contributes a volume, edited by Prof. C. E. Beecher, on "Studies in Evolution," containing papers bearing on the investigation and study of the development of a number of invertebrate animals. The papers deal with the origin and significance of spines, structure and development of trilobites, development of the brachiopoda and miscellaneous studies in development. The fifth volume which has reached us is edited by Profs. S. L. Penfield and L. V. Pirsson, and it contains papers on the results of researches in mineralogy and petrography made in the Sheffield Scientific School of the University. The man of science needs no better evidence of the life and progress of a university than is afforded by volumes like these, which are published in New York by Messrs. Charles Scribner's Sons, and in London by Mr. Edward Arnold.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

OXFORD.—The president of Magdalen (Mr. T. H. Warren), who has always taken an active part in furthering the interests of science, has been elected a member of the Hebdomadal Council. Prof. Elliott has been elected a delegate of the University Museum.

CAMBRIDGE.—Dr. L. E. Shore, St. John's, has been re-appointed University lecturer in advanced physiology, and Mr. F. F. Blackman, St. John's, University lecturer in botany. Mr. H. O. Jones, Clare, has been appointed demonstrator in organic chemistry to the Jacksonian professor, in place of the late Mr. Spivey. Mr. C. Shearer, advanced student, Trinity, has been appointed to occupy the University table in the Naples zoological station.

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MR. W. MAITLAND (Aberdeen) has been appointed junior demonstrator of chemistry at University College, Sheffield, in succession to Dr. T. S. Price.

THE Report of the work of the Examinations Department of the City and Guilds of London Institute again directs attention to the fact that the general education of a large number of students who enter the technological classes is still defective, and they are consequently unable to profit, as they should do, by the special instruction they receive. Insufficient knowledge of the elementary principles of science, and particularly of such subjects as mensuration, geometry and drawing, is a frequent cause of failure of students to pass the examinations in technology. The preliminary course of instruction, and corresponding examinations, arranged by the Institute, provides a partial remedy for this defect; and the recent announcement that the Board of Education is prepared to consider suggestions from schools for grouped courses of instruction in branches of science cognate to certain trade subjects should do something to decrease the number of candidates without a knowledge of scientific principles. The Institute's Examination Committee strongly recommend students to attend courses in geometry, mathematics and elementary science, prior to, or concurrently with, the study of technology and workshop practice. "Technical instruction," it is wisely remarked, "fails altogether of its purpose if the student does not understand the 'why' and the 'wherefore' of the operations he performs. The aim of such teaching as is given in technological classes is not to make expert workmen, but to show how difficulties may be overcome, and how skill in drawing and a knowledge of the principles of science may, with sufficient practice, help to produce expert workmen. It is not the object of the Institute's examinations to test mere skill in workmanship. The craftsman's own work is the best certificate he can produce. But as evidence of training in the principles underlying the practice of his trade, the class certificate in technology has a distinct and recognised value."

THE current number of the *Record*, the organ of the National Association for the Promotion of Technical and Secondary Education, contains several interesting articles. Specimen lessons are given to show how interest in nature-knowledge may be encouraged, and how it may be assisted by Museums. It may be doubted, however, whether any useful purpose is served by creating an animistic attitude in the minds of children studying nature. The following statement, for instance, is, to say the least, misleading: "When the horse-chestnut feels winter coming on, it says to itself—you can hear the branches whispering during any autumn evening—'Dear me, my leaves will begin falling off in a minute, and there are those new leaves and things to see about in the spring; I must begin making buds this very instant.'" The child who is taught on these lines will believe that a hawthorn tree is really able to look ahead to a severe winter, and takes pains to provide plenty of haws for the birds during the forthcoming hard times.

THE funds available for purposes of technical education are the residue received under the Local Taxation (Customs and Excise) Act, direct aid from the rates, and grants from the Public Libraries rate. A Return has been issued showing the extent to which, and the manner in which, local authorities are applying these funds in (A) England, (B) Wales, and (C) Ireland. The results are summarised below, the amount shown for Wales and Monmouth, in line B, being exclusive of the amount—estimated at 43,203*l*.—to be devoted annually to intermediate and technical education under the Welsh Intermediate Education Act, 1889:—

| | Total amount expended on technical education during the year 1898–99. | Total amount expended on technical education during the year 1899–1900. | Total amount raised by loan on the security of the local rate under the Technical Instruction Acts (or otherwise) during the years 1898–99 and 1899–1900 respectively. | |
|---|---|---|---|---|
| | | | Year 1898–99. | Year 1899–1900. |
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| (A) | 830,404 17 2 | 876,436 6 11 | 104,301 2 4 | 80,347 10 7 |
| (B) | 35,658 11 4 | 33,526 1 11 | 1,000 0 0 | — |
| (C) | 4,549 3 1 | 5,172 6 3 | — | 10,000 0 0 |
| | 870,612 11 7 | 915,134 15 1 | 105,301 2 4 | 90,347 10 7 |

## *SOCIETIES AND ACADEMIES.*

### LONDON.

**Physical Society**, November 8.—Mr. T. H. Blakesley, vice-president, in the chair.—A paper on a voltameter for small currents was read by Dr. R. A. Lehfeldt. The instrument consists of a capillary tube about 25 cms. long completely filled with mercury with the exception of a bubble of mercurous nitrate solution about 1 cm. long placed near the middle of the tube. Connection with the two mercury columns is made by means of platinum wires passing through the side of the tube. To use the instrument it is placed in a vertical position, the anode being at the top, and the quantity of electricity which passes through is measured by the change in volume of either electrode. In a test experiment the change in volume was measured by means of a micrometer, and agreed within 0·6 per cent. with the amount deduced from the known value of the current. It is necessary that the currents should be small, so as to avoid complications due to polarisation. The chairman pointed out that the presence of air in the tube would render the readings inaccurate, and asked if it was necessary to apply any temperature correction. Dr. Lehfeldt said that it was quite easy to seal the tube without admitting air, and the temperature correction was negligible.—A note on a paper by Prof. Fleming and Mr. Ashton entitled "On a Model which Imitates the Behaviour of Dielectrics," by Dr. J. Buchanan, was read by the secretary. The action of this model depends on the viscosity of a liquid, and the diagrams derived from it show by their form that the motion of the pencil which traced them approximated closely to what may be expressed by the term "motion of a viscous fluid by diffusion." In other words, the displacement curves obtained from the model and their derived velocity curves are of the same form as the graphs of certain solutions of Fourier's well-known equation $\frac{dv}{dt} = K\frac{d^2v}{dx^2}$. Lord Kelvin has shown that the potential and the current at any point in the wire of a cable can be expressed by appropriate solutions of this equation, and in the same manner by the use of solutions of this equation the diffusion of electricity into or out of the dielectric of a condenser can be treated. It appears, therefore, that the motion of the model and the diffusion of electricity in a dielectric are subject to one and the same mathematical law. The author suggests that the inventors should obtain hysteresis diagrams by cyclical loading of the springs. Prof. J. A. Fleming said he was glad that Dr. Buchanan had drawn attention again to the model because there were points about it which might be amplified with advantage. After giving a short description of the apparatus he said that Dr. Buchanan had shown that mathematically the theory of the model was the same as that of diffusion in a cable, and he suggested that there might be something more than mathematical analogy. Prof. Fleming referred to the discussion on the original paper in which Prof. Ayrton asked in what respect the model served its purpose better than a twisted wire. A twisted wire cannot represent the properties of a dielectric, because if twisted beyond the elastic limits there is a permanent set. There is no permanent set in the present model. He would like to know if a dielectric has a true conductivity, and suggested that experiments should be made by subjecting a dielectric to constant electric pressure at constant temperature, for years if necessary, and observing whether the curve of current becomes asymptotic to the zero line or to a line parallel to it. The model could be made to represent a conduction as well as a displacement current by so arranging the bottom piston that it could descend but not return. The fact that the movements of the model were similar to the diffusion of current in a cable suggested that the process of conduction in a metal was *similar* to that of displacement in a dielectric.—Mr. J. Macfarlane Gray read a note on the numerical value of the "characteristic" of water. The author referred to a paper on thermodynamics which he wrote twenty years ago and in which he supported the theory of a granular ether under enormous pressure. This theory easily explains the properties of bodies. There is a numerical characteristic for every substance in the state of vapour. This characteristic can be deduced from an analytical expression involving certain physical data which must be experimentally determined. His original number for water was 25·30693, but later experiments by Lord Rayleigh on the weight of hydrogen have altered this number to 25·33776. The author's original value for the absolute specific heat of water was 124960 "mms. lift at Paris," but recent experiments of Callendar give 126230. According to the author's theory, water commences to freeze at 95° F. and the variation of the specific heat of water at low temperatures is due to the latent heat of ice. The formation of ice particles also explains the peculiar changes in volume of water as it cools to the freezing point. The chairman asked if this theory could explain the fact that water can remain liquid below 32° F. Mr. Macfarlane Gray said it could.

### PARIS.

**Academy of Sciences**, November 4.—M. Bouquet de la Grye in the chair.—On *Analysis situs*, by M. H. Poincaré.—On some chemical effects produced by the radium radiation, by M. Henri Becquerel. It is pointed out that the radium radiations consist of a part capable of deviation in the magnetic field, identical with the kathode rays, and a part non-deviable, a fraction of which is absorbable and the remainder extremely penetrating. Some kind of spectrum analysis is, therefore, necessary before studying the chemical action of these rays. Fresh observations are brought forward showing the action of the rays upon glass, the transformation of yellow into red phosphorus, the reduction of mercury perchloride in the presence of oxalic acid and the effect upon seeds. In the latter case it was found that prolonged exposure to the radium radiations had the effect of destroying the power of germinating in the seed.—The electrolysis of ammonium chloride in solution in liquefied ammonia, by M. Henri Moissan. Liquid ammonia at −80° C. is readily electrolysed with a potential difference of 115 volts, and it is remarkable that no nitrogen is produced. At the positive pole chlorine is evolved, and at the negative pole hydrogen, the purity of the latter being proved by analysis. Dry iodine is not attacked or dissolved by liquid ammonia at −70°, or at temperatures below this, but at higher temperatures the iodine goes into solution.—The decomposition of calcium-ammonium and of lithium-ammonium by ammonium chloride, by M. Henri Moissan. Both calcium-ammonium and lithium-ammonium react upon ammonium chloride in solution in liquid ammonia at a temperature of −80° C. Under these conditions the group ammonium could not be isolated, ammonia and hydrogen being set free.—On a new method of detecting very small electric charges, by M. R. Blondlot. Attempts were made, without success, to determine some very small electric charges by means of the usual electroscopes and electrometers. A new instrument was, therefore, constructed, details of which are given, possessing the required sensibility.—The sugars in the blood and their glycolysis, by MM. Lepine and Boulud. It is shown that the difference between diabetic blood and normal blood consists not only in the fact that the former preserves its reducing power better than the latter, but also in the decisive fact that after keeping for an hour in glass vessels at 39°, the fermentable sugar of the blood is not modified, whilst it is destroyed in normal blood.—Remarks by M. Marey on two reports on chronophotography and of a commission on physiology and hygiene.—Report by a committee appointed to examine the papers left by the late M. Halphen. The memoirs left in a state fit for publication are too few in number to publish in volume form, but it is desirable that some periodical would insert certain fragments.—Observations of the 1901 comet made at the Observatory of Santiago, Chili, and the elements of the same comet, by M. Obrecht.—Sunspots and planets, by M. Birkeland. The results given in a former paper have been recalculated, taking into account the action of the planet Saturn, but the conclusions previously arrived at are not thereby altered.—On persistent conjugated network, by M. J. Raffy.—On the adiabatic curve, by M. George Moreau. The usual equation to the adiabatic curve, $PV^r = \text{const.}$ is obtained under the suppositions that the ratio of the specific heats, the specific heat at constant volume and the coefficient of expansion are constant. It has been shown, however, by MM. Mallard and Le Chatelier that the specific heat at constant volume is not constant, but is a linear function of the temperature, and the coefficient of expansion is also a function of the temperature. On these assumptions a more general form of the equation to the adiabatic curve is worked out.—On the chlorobromides of thallium of the type $Tl_4X_6$, by M. V. Thomas. The current theories of the constitution of double salts would allow of the prediction of two sesquichlorobromides of thallium. The mode of preparation of two isomers of $Tl_4Cl_3Br_3$ is described in detail.—Some reactions of trichloracetic acid, by M. A. Clermont. The ethyl ester and amide of this acid are so readily prepared that their formation may be used as tests for the acid.—Researches on some isomerides of pinacone and its derivatives, by M. Maurice Delacre. The reactions of pinacoline agree in part with the formula suggested by Butlerow $(CH_3)_3.C.CO.CH_3$, and in other respects corresponds to Friedel's formula $(CH_3)_2C\overset{O}{\text{——}}C{-}(CH_3)_2$. As a result of the experiments here given the author inclines to the view that pinacoline contains the two substances represented by the above formulæ in a state of equilibrium.—The constitution of piceol, by MM. Ernest Charon and Démétrius Zamanos. The glucoside piceine, extracted by M. Tanret from *Pinus picea*, was shown by him to be hydrolysed by acids into glucose and a substance piceol. It is now shown that this latter substance is paraoxyacetophenone, the properties of the natural and synthetical piceols agreeing completely.—On the calculation of the amounts of water added to and cream abstracted from milk, by M. V. Génin.—On the formation of the perfume of vanilla, by M. Henri Lecomte. The following hypothesis would best appear to explain the formation of vanillin in the fruits during their preparation. The coniferine is converted into coniferyl alcohol and glucose by means of a hydrolytic ferment, crude vanilla, in fact, always containing glucose. This alcohol is then transformed into vanillin by the action of an oxydase, the existence of which has been proved in the plant extracts in several ways. It is a curious fact that the varieties which are the most esteemed commercially are those which contain the greatest amount of this oxydase.—On the *Iboga*, on its exciting properties, its composition, and on the new alkaloid, ibogaine, which it contains, by MM. J. Dybowski and Ed. Landrin. A plant much used by the natives in the French Congo, and called by them *iboga*, has been found to owe its sustaining and fatigue-resisting properties to the presence of a new alkaloid, ibogaine, to which the constitution $C_{52}H_{66}N_6O_2$ is assigned. In small doses this substance produces a peculiar excitement, in large doses the effects resemble those due to the absorption of alcohol in excess.—The influence of methylal upon the growth of some algæ in soft water, by M. Raoul Bouilhac. Certain algæ, nostoc and *Anaboena*, were placed in nutritive solutions and exposed to light of feeble intensity, too feeble to enable the algæ to decompose carbonic acid; it was found that under these conditions growth could take place if a small quantity of methylal were present.—Researches on the formation of the ovule and the embryonic sac in the Araliaceæ and of the modifications undergone by the tegument, by M. L. Ducamp.—The germination of the spores of *Penicillium* in water, by M. Pierre Lesage.—The effects of freezing upon milk, by MM. F. Bordas and de Raczkowski.—On the secular variations of terrestrial magnetism, by M. V. Raulin.—Experiments in maritime aëronautics, by M. H. Hervé.

NEW SOUTH WALES.

**Linnean Society**, September 25.—Mr. J. H. Maiden, president, in the chair.—Arachnida from the South Seas, by W. J. Rainbow. Thirty-four species are enumerated, of which four are described as new, namely, *Leptodrassus insulanus*, *Argyrodes walkeri*, *Diaea bipunctata* and *D. regale*. The most interesting of them is *L. insulanus*, as it records a new locality for the genus.—On the systematic position of *Purpura tritoniformis*, Blainv., by H. L. Kesteven. Reasons are given for removing *P. tritoniformis* from *Urosalpinx* and *Cominella* and transferring it to *Purpura*. In selecting the subgenus of the latter for its reception, the resemblance of the larval shell and anatomical characters to *P. succincta* cause the writer to place it in *Trochia*. The names *Adamsia* and *Agnewia* consequently lapse into the synonymy of *Trochia*.

## DIARY OF SOCIETIES.

*THURSDAY*, NOVEMBER 14.

MATHEMATICAL SOCIETY, at 5.30.—Linear Groups in an Infinite Field: Dr. L. E. Dickson.—Note on the Algebraic Properties of Pfaffians: J. Brill.—On Burmann's Theorem: Prof. A. C. Dixon.—The Puiseux Diagram and Differential Equations: R. W. H. T. Hudson.—Determination of all the Groups of Order 168: Dr. G. A. Miller.—An Outline of a Theory of Divergent Integrals: G. H. Hardy.—On the Representation of a Group of Finite Order as a Permutation Group; and on the Composition of Permutation Groups: Prof. W. Burnside, F.R.S.—(1) On the Inversion of Plane Stress; (2) On the Theory of Hele-Shaw's Experiments on Fluid Motion: J. H. Michell.—On the Steady Motion of a Sphere through Viscous Liquid: T. Stuart.—Addition Theorems for Hyperelliptic Integrals: A. L. Dixon.—Limits of Logical Statements: H. MacColl.

*FRIDAY*, NOVEMBER 15.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The President, Dr. Patrick Manson, C.M.G., F.R.S., will deliver his Inaugural Address on the Ætiology of Beriberi.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.

*TUESDAY*, NOVEMBER 19.

ZOOLOGICAL SOCIETY, at 8.30.—Okapia, a New Genus of Giraffidæ from Central Africa: Prof. E. Ray Lankester, F.R.S.—On the Giraffe discovered by Sir Harry Johnston, K.C.B., near Mount Elgon, Central Africa: Oldfield Thomas, F.R.S.—On the Genital Organs of the Male Lepidosiren and Protopterus: J. Graham Kerr.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: The Discharge of Sewage into a Tidal Estuary: W. Kaye Parry and Dr. W. E. Adeney.—*And, time permitting*: The Treatment of Trades Waste Bacterially: William Naylor.

ROYAL STATISTICAL SOCIETY, at 5.30.—Local and Imperial Burdens: Lord Avebury, F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Japan as illustrated by Herself: J. W. Groves.

*WEDNESDAY*, NOVEMBER 20.

GEOLOGICAL SOCIETY, at 8.—On the Origin of Certain Concretions in the Lower Coal Measures: H. B. Stocks.—Some Remarks on the Meteorological Conditions of the Pleistocene Epoch: Nils Ekholm.—Notes on the Genus Lichas: F.R. C. Reed.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Exploration of the Atmosphere at sea by means of Kites: A. Lawrence Rotch.—Meteorological Phenomena in relation to the Changes in the Vertical: Prof. John Milne, F.R.S.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Stereomicrography: Prof. G. P. Girdwood, preceded at 7.30 by an Exhibition of some Antipoints seen under the Microscope: Conrad Beck.

SOCIETY OF ARTS, at 8.—Opening Address: Sir William Henry Preece, K.C.B., F.R.S.

ENTOMOLOGICAL SOCIETY, at 8.

*THURSDAY*, NOVEMBER 21.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On Skin-currents. Part II. Observations on Cats: Dr. Waller, F.R.S.—The New Biological Test for Blood in relation to Zoological Classification: Dr. G. H. F. Nuttall.—Observations on the Cerebral Cortex of the Ape (Preliminary Communication): A. S. F. Grünbaum and Prof. Sherrington, F.R.S.—On the Inheritance of the Mental Characteristics in Man: Prof. K. Pearson, F.R.S.

LINNEAN SOCIETY, at 8.—Report on the Botanical Publications of the United Kingdom as a Part of the International Catalogue of Scientific Literature: B. Daydon Jackson.

CHEMICAL SOCIETY, at 8.—On the Oxidation of Sulphurous Acid to Dithionic Acid by Metallic Oxides: H. C. H. Carpenter.—Optically Active β-hydroxybutyric Acids: A. McKenzie.—On the Hydrochloride of Thiocarbamide: H. P. Stevens.—The Constituents of the Essential Oil of Asarum Canadense: F. B. Power and F. H. Lees.—Note on the Reduction of Trinitrobenzene and Trinitrotoluene with Hydrogen Sulphide: J. B. Cohen and H. D. Dakin.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

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SUPPLEMENT.

# SUPPLEMENT TO "NATURE."

## *A MODERN TEXT-BOOK OF CHEMISTRY.*

*Roscoe-Schorlemmer's ausführliches Lehrbuch der Chemie.* By Jul. Wilh. Brühl, Professor in the University of Heidelberg. Vol. vii. Part v., and Vol. viii. Part vi., Organic Chemistry, in cooperation with Eduard Hjelt and Ossian Aschan of the University of Helsingfors. Pp. xxvii + 1320 and xxxix + 1045. (Brunswick: Friedrich Vieweg und Sohn, 1899-1901.)

THE well-known treatise on chemistry by Roscoe and Schorlemmer, which has for so many years been a standard work in this country, is now being published in a totally revised form in Germany, and two parts of the German edition have been received for review. The preceding (sixth) volume, containing an account of the heterocyclic five-membered rings, was published in the spring of 1898, the seventh in July 1899, and the eighth in May of the present year. The ninth and concluding volume, dealing with albuminoid compounds, ptomaines, toxines and enzymes, is promised in a few months' time, so that the work has been pushed on with remarkable rapidity. Certain sections, moreover, such as the portions dealing respectively with the vegetable alkaloids and albuminoid compounds, have been published as separate monographs, the former having already been noticed in these columns by the present writer.

Taking the two volumes before us in due order, the seventh, which consists of 1320 closely printed pages, is devoted to the six-membered heterocyclic ring compounds. These comprise the pyrone, pyridine, quinoline and isoquinoline groups and their hydro-derivatives, the alkaloids related to this class, the azines, the uracil and purine compounds, the pyrazines, piperazines, quinoxalines, azine colouring-matters, kyanidines, cyanuric acid derivatives, &c. Dr. Brühl, in his prefatory notice, calls attention to the fact that the whole of this enormous mass of material has been worked up within the short period of one year, the editorial work having been concluded towards the beginning of 1899. The section on the metallic compounds of pyridine, which occupies twenty-two pages, has been contributed by Prof. Alfred Werner, of Zürich, while Prof. Emil Fischer has revised the portion relating to the purine group. We are further told in the preface that the aim of the authors has been, not only to present a complete, but also a *readable* account of modern organic chemistry, and each chapter accordingly commences with a concise but thorough historical introduction, which will be found most interesting by all who desire to follow the steps by which our knowledge of the different groups has been built up.

Comparing the present work with its English predecessor, it will be seen that the rapid development of organic chemistry has necessitated much more than mere revision. Whole sections have been re-written, and but little of the original "Roscoe and Schorlemmer" beyond the general plan is left. That this work of compilation and coordination has been carried out most thoroughly and efficiently is sufficiently guaranteed by the names of Dr. Brühl and his coadjutors. In view of the great advance of the science of chemistry in every direction, it is practically impossible to produce a text-book, however complete, which can be expected to survive for more than a limited period. Such a work as that under consideration must be considered as presenting a complete epitome of the science down to the date of its publication; and as a standard of reference for students and workers it may be confidently asserted that it is destined to have a long and useful career. How many years will elapse before a new edition is called for—whether it will be possible to keep pace with the progress of discovery by the issue of supplementary volumes, whether it may not be necessary to revise particular volumes from time to time—these are questions of procedure to which time and the exigencies of the German publishing trade can alone give a reply. But if the reader who, without being a specialist in this department of chemistry, is interested in a general way in the development of our knowledge of the carbon compounds will make such a comparison as is here suggested, he cannot fail to be struck by the manifest indications of ceaseless activity on the part of investigators in this practically inexhaustible domain. Take, for example, the purine group, which has been attacked with such brilliant success by Emil Fischer and his pupils. It is about seventeen years ago since Fischer's first communication on this subject, and at the present time it may be said that our knowledge of the constitution of all the physiologically important members of the group is fairly complete, and what makes this chapter of research so particularly interesting is that not only have the majority of these products of animal and vegetable life been synthesised, but a large number of new purine derivatives which have never been elaborated by "vital" processes have been called into existence by virtue of that mastery over the chemical molecule which invariably follows when the constitution of the type has been established. From the same point of view the pyrone group is likewise of special interest. Colouring-matters, such as chrysin, from the buds of various species of *Populus*; apigenin, which occurs as a glucoside in parsley; fisetin, from *Rhus cotinus*, *R. rhodanthema* and *Quebracho colorado*; luteolin, from *Reseda luteola*; kampheride, from the Chinese galanga root (*Alpinia officinarum*); quercetin, which occurs as a glucoside in quercitron bark (*Quercus tinctoria*) and in many other plants; rhamnetin, from buckthorn berries, &c.; isorhamnetin, from the wall-flower; morin, from fustic; euxanthone, from Indian yellow; gentisin, from the root of *Gentiana luteola*, and other well-known and definite products of vegetable origin are now known to belong to the benzo-γ-pyrone and dibenzo-γ-pyrone types. In establishing the constitution of these compounds A. G. Perkin, of the Yorkshire College, has taken an important part. Only two years ago the authors of the present volume were obliged to state, in summing up our knowledge of the benzo-γ-pyrones, that "none of these natural colouring-matters have as yet been synthesised" (p. 49). Of the dibenzo-γ-pyrone (xanthone) group, euxanthone had been synthesised by Liebermann in 1889 and gentisin by v. Kostanecki and Tambor in 1894. Since the appearance of the present volume the synthetical production of chrysin, apigenin and other natural colouring-matters of the same group has been announced from time to time by v. Kostanecki and his colleagues. It is not improbable that before many years have elapsed the above statement concerning the benzo-γ-pyrones will have to be modified so as to read in the exactly opposite sense.

In calling the attention of English chemists to the present edition we cannot too strongly emphasise the point that the eminently readable character of the original "Roscoe and Schorlemmer" has been greatly enhanced by the revision which it has undergone in Germany. It is not only the historical treatment which makes the book such interesting reading, but the logically coherent way in which the descriptive facts and theoretical deductions are marshalled so as to lead the reader step by step from the first discovery of a compound up to the latest constitutional formulæ for the whole group. The evidence which has led to the adoption of any particular formula is given in detail, with bibliographical references in the foot-notes. If educationists of the old school should at any time challenge (as they have before now) the value of modern science as a mental discipline, we may confidently ask them to place this book in the hands of a student who has mastered the elementary principles of chemistry and request him to read conscientiously through any one of the sections and follow the work which the investigators have carried out in arriving at the results given. If after this he is not inspired with a desire to become a worker himself, or if he fails to see the logical connection of the various discoveries which have culminated in the present state of knowledge, his case may be dismissed as hopeless, and some non-chemical career recommended.[1]

The general plan of the English original is, of course, well known in this country; but it may be useful in connection with the above eulogistic statements to invite attention to the details of treatment of one or two groups taken at random. On p. 80, for example, there commences the section dealing with six-atom rings containing one nitrogen atom. This section comprises seven groups, viz. pyridine and homologues and isomerides; hydropyridines; quinoline and homologues and hydro-derivatives; the acridine group; phenanthridine and chrysidine group; quino-quinoline and naphthinoline group; and the isoquinoline group. The first only of these need be taken by way of illustration. The occurrence of the pyridine bases from the historical point of view is first considered, and a summary of the early work of Runge, Hofmann, Thomas Anderson and other investigators of "Dippel's oil" and the coal-tar bases is given in chronological order. A short paragraph on the mode of formation of pyridine bases by the destructive distillation of animal matter explains the theory first promulgated by Weidel and Ciamician that the bases originate in this process from unsaponified fats, the glycerol complex being essential for the pyrogenic synthesis of the bases. Then follows a section on the separation of the bases from bone-oil and from coal-tar, the so-called "light oil" of the latter being at present the chief source of pyridine and its homologues.

[1] A distinguished mathematician known to the writer used to take great pleasure in reading original papers on organic chemistry, although he had no practical acquaintance with the science. He considered the methods of arriving at constitutional formulæ as masterpieces of scientific reasoning.

The discussion of the constitution of pyridine occupies nine pages, full consideration being given to this subject on account of the important position which this base holds as the type of a series which comprises so many members and to which many natural alkaloids are related. The first formula considered is that of Körner and Dewar, corresponding to Kekulé's benzene ring formula. Of the various formulæ proposed as alternatives, that of Riedel and of Lieben and Haitinger, in which there is cross linkage between the nitrogen and the opposite γ-carbon atom, is alone considered as having any serious claim. The formulæ corresponding to the "prismatic" and "diagonal" benzene formulæ are dismissed in very brief paragraphs, the latter being considered as disproved by the (unpublished) spectrometric researches of Brühl. The "centric" formula proposed by Bamberger, and corresponding with the centric formula of benzene, is regarded as beyond the possibility of experimental proof, and, like the corresponding benzene formula, is considered to be outside all analogy. On the whole, while admitting that a decisive proof of the constitution is yet wanting, the original formula of Körner is shown to be most in harmony with the known facts and is adopted throughout the work.

The constitutional formula of pyridine—the parent compound of the series—having been thus threshed out, the following section is devoted to the question of isomerism and orientation among the derivatives. The synthetical formation of pyridine compounds is next dealt with. Taking the various methods in the order given, we have the formation of pyridine homologues by heating aldehydes or ketones with aldehyde-ammonia, acetamide, ammonium phosphate, &c., as first observed by v. Baeyer and Ador in 1870; then follows the general method of Hantzsch (1881), which consists in condensing β-keto-compounds (such as acetoacetic ester) with aldehydes and ammonia, and the extension of this method to diketones by Beyer and Knoevenagel (1891 and 1898). Another general method, discovered by Claisen in 1893, consists in the condensation of methenyl derivatives of certain β-diketo-compounds with ammonia. Ladenburg's intramolecular formation of the α- and γ-homologues by the action of heat on pyridinium methyl iodide and the formation of oxypyridines by the action of ammonia on α- and γ-pyrone derivatives are next considered, and attention is directed finally to the remarkable formation of pyridine derivatives from pyrrole and its homologues by the action of halogen-derivatives of methane on the potassium or sodium derivatives of the pyrroles as observed by Ciamician and his colleagues (1885–1887). The mechanism of all these synthetical processes is, of course, explained as far as known and illustrated by formulæ. After a few pages devoted to the general properties of the bases of the series, the description of the individual members is given in exhaustive detail. Beginning with pyridine itself and ending with dipyridyl, this descriptive part extends over 157 pages.

The chemistry of any of the groups dealt with in the present work can be systematically followed out by those who make use of these volumes either for the purposes of reference or in order to make themselves acquainted with the actual state of knowledge down to the date of publication. The above example is typical of the treatment throughout, and the student or worker may confidently make use of any portion of the vast mass of information crowded into every page as accurate and authoritative. It is interesting to note also how among compounds of industrial importance references to patents figure occasionally in the literary notes. We have on former occasions pointed out that discoveries of first-rate scientific importance are often in the first place published through the Patent Offices, owing to their being also of commercial value.

The larger portion of the eighth volume deals with the vegetable alkaloids, and concerning this we have only to refer our readers to the opinion expressed in the former notice (NATURE, vol. lxiii. p. 486, March 21, 1900). Dr. Brühl states in the preface that this monograph was sent to press in January 1900, and the printing concluded in October of the same year. The volume contains in addition a monograph on vegetable glucosides which occupies 138 pages, sections on bitter compounds (non-glucosidic) and natural organic colouring-matters, and sections amounting to monographs on chlorophyll and the compounds obtained from lichens. The concluding section is devoted to the indifferent or neutral compounds not previously considered. It will be only necessary to indicate very briefly the contents of these sections. The glucosides are classified according to the nature of the complex associated with the carbohydrate residue such as hydrocarbon glucosides (picrocrocin), glucosides of benzophenols, of alcohols, of aldehydes, of acids, of oxy-anthraquinone, of oxyflavone, &c., and those glucosides of which the products of hydrolysis are at present imperfectly known. The neutral bitter principles comprise compounds such as aloin, picrotoxin, podophyllotoxin, cantharidin, &c. The natural colouring-matters are classified as derivatives of pyrone, of benzophenone, of hydrindene, of naphthalene and anthracene, &c. Not the least interesting of this group of compounds are the colouring-matters derived from insects, such as cochineal, lac-dye and kermes, which are classified as hydrindene derivatives. Our knowledge of these compounds has made considerable progress of late years, as will be seen on reading this connected account of the researches of Liebermann and his pupils on carminic acid. So also it may be noted that our knowledge of the constitution of the colouring-matters of logwood, Brazil wood and of other familiar vegetable dye-stuffs has been much advanced by the work of W. H. Perkin, jun., and his colleagues. Should these ever (as is not at all improbable) come within the domain of accomplished syntheses, we might see the last of the vegetable dyes replaced by the products of chemical factories.

The section on chlorophyll is quite remarkable for its completeness, and will appeal not only to chemists, but to physiological botanists and biologists generally. It occupies more than seventy pages and comprises a bibliographical list of no less than nine pages, giving full references to all the papers and memoirs of any importance that have been written on the chemistry of this subject, the arrangement being chronological from the memoirs of Senebier in 1782–1788 down to the latest papers of Marchlewski and Schunck in 1900. Under this section there are comprised not only chlorophyll and its derivatives, but the various yellow colouring-matters which accompany chlorophyll and other related compounds. Equally remarkable as a revelation of progress is the long list of lichen products, our knowledge of which has been so largely extended of late years, chiefly through the labours of Hesse and Zopf, who have won for themselves the foremost position as pioneers in this branch of plant chemistry. Nearly 100 distinct compounds of this group have now been isolated and analysed, and considerable progress has been made towards establishing the constitutional formulæ of some of them. Vulpic acid, which occurs in many lichens and which was first isolated in 1831, was synthesised by Volhard in 1894.

The prevailing impression left after looking through the contents of this eighth volume is that its interest will extend to a much wider circle of readers than those who are likely to make use of it from the purely chemical point of view. The immense number of natural products—such as alkaloids, colouring-matters, neutral compounds, chlorophyll, glucosides, lichen products, &c.—described and discussed will make this instalment of the new "Roscoe and Schorlemmer" particularly valuable to physiologists. In the words of Dr. Brühl, who in the preface calls attention to the circumstance that the present volume contains a large amount of material which has now in part undergone systematic chemical investigation for the first time:—

"Wenn dieses Material für den Chemiker mehr als alle bisher behandelten Gruppen noch Unbekanntes enthält, so ist es für den Biologen nicht minder fragenreich und von grosser Bedeutung. In dem rapiden Entwickelungsgange der Naturwissenschaften nähert sich die Chemie in neuester Zeit immer rascher den biologischen Disciplinen, und eine zusammenfassende Bearbeitung derjenigen Gegenstände, welche gegenwärtig diese Wissenszweige beschäftigen und mit der Chemie verknüpfen, wird daher zweifellos Vielen willkommen sein. Es ist in diesem Bande, mit besonderem Hinblick auf die Interessen eines weiteren naturwissenschaftlichen Kreises, zwar stets das Chemische als Hauptaufgabe behandelt, indessen auch das Biologische so weit berücksichtigt worden, als dies in einem chemischen Lehrbuch thunlich erschien."

One serious consideration arising from the publication of the present work is that a standard treatise originally planned and published in this country should now have passed out of our hands. The reading public interested in chemical literature cannot have been sufficiently numerous to warrant the publication of a revised edition in English. On the other hand, we find German chemists of the very highest repute willing to undertake the literary labour and a German firm willing to incur the risk and bear the expense of publication. The writer knows nothing of the cost of printing and publishing in Germany, but the price of the books is not less than that of the original edition in this country (vol. viii., in paper wrappers, is priced at 22 marks), so that it cannot be urged that the German student gets his text-books cheaper than the English student. The natural conclusion would appear to be that a sufficiently large number of readers in Germany can be depended upon to warrant the risk of publication of the work in that language, and this again raises the question whether the kind of scientific literature in demand in England and Germany respectively may not be taken as an indication of the relative position of science teaching in the two countries. For depth and breadth of treatment, we naturally turn to works like that under consideration—a treatise which the facts before us now declare to be in such little demand here that the English publishers do not feel warranted in undertaking the further responsibility of issuing a revised edition. On the other hand, it may be confidently asserted that there is no other country in the world which of late years has produced such a vast number of little elementary books on chemistry. It is no exaggeration to say that books of this class can be named by hundreds. Almost every newly appointed teacher, lecturer, and professor feels it a duty to contribute to the list of what may in the majority of cases be called little cram books. Thus, while the demand for a substantial work is on the decline, there is apparently an unlimited field for manuals of the kind referred to. The system of wholesale smattering which is so characteristic of the modern educational revival in our country appears to have acted prejudicially upon the chemical literary energy of our authors and publishers, which is thus being frittered away in small efforts directed mainly towards the requirements of examining boards. It has been said with justice that in the domain of fiction magazine writing has been the curse of high-class English literature. It may with equal truth be asserted that writing up to the requirements of examining bodies has been the curse of English chemical literature. The Americans have in recent times shown a great desire to possess good text-books of science, and their translations of certain German works are in use in this country. It only remains now for some enterprising American to bring out a translation of the new "Roscoe and Schorlemmer" to convert the position into one of ignominy for the country which first contributed this treatise to the literature of modern science. R. MELDOLA.

## *PRÆ-ARYAN RELIGION IN GREECE.*

*Mycenaean Tree and Pillar Cult and its Mediterranean Relations.* By Arthur J. Evans. "Journal of Hellenic Studies," vol. xxi. pp. 99*ff*. Pp. xii + 106. (London: Macmillan and Co., Ltd., 1901.) Price 6*s*. net.

FEW discoveries in the archæological field during the past few years have commanded such universal attention and have so profoundly modified our conception of the *origines* of European civilisation as the excavation of the Mycenæan palace and city of Knôssos in Crete by the able and energetic keeper of the Ashmolean Museum at Oxford, Mr. Arthur J. Evans. It is not many years ago since, in spite of the discoveries of Schliemann and his successors at Troy, at Mycenæ and at Tiryns, and of the steadily accumulating evidence from all parts of the Greek world, things "Mycenæan" were still looked at askance, especially by classical archæologists of the older school, who could never accustom themselves to the idea that the classical Greece which they and their forefathers for three centuries back had known by heart was but the *second* phase of Greek life and activity, that long before the First Olympiad Greece had been the seat of a magnificent and luxurious culture of which faint echoes are preserved to us in the Homeric poems, and of which the actual remains still exist upon Greek soil. The treasuries of Minyas and of Atreus still stood above ground, but none seemed to realise their intense interest; Mycenæ still existed off the road from Corinth to Argos, but nobody had thought of looking to see whether it had really been "golden" and "widewayed" until the firm belief of Schliemann in the historical reality of the Trojan War impelled him to go and look. We know what he found, and now, after twenty years, we can appreciate the revolution which he wrought in our conceptions of the earlier ages of Greece. Mr. Evans's Cretan discoveries have rivetted our attention once more upon the antiquities of the "Mycenæan" Age, and now we can see clearly, where before we saw but darkly, that the relics of the First Greece which we can hold between our hands are not those of any problematical "Mycenæan" period, the date of which was but doubtful and was, indeed, not to be too closely investigated lest it upset our traditional ideas too much—are, in fact, the relics of the Heroic Age of Greece. The Heroes existed: and here are their cities, their palaces and their works of art. No such actual personages as Agamemnon or Achilles or Minôs need ever have existed in life, but their magnificent figures undoubtedly represent the great kings who ruled in Mycenæ and the Isles, in Lacedæmon and in Crete, in times which to the Homeric singers were already ancient. The Trojan War is no sun-myth, it is a tradition of an actual occurrence. Theseus may never have actually rescued Ariadne from the Minotaur, but the Labyrinth has been laid bare by the spade of Mr. Evans, and the Cretan kings who are personified by the legendary Minôs undoubtedly lived therein and venerated there a deity to whom the bull was sacred and to whom human sacrifices were very possibly offered in remote days long before the story of Theseus and the Minotaur took shape. And now Mr. Evans has discovered and placed before us the actual hieroglyphed tablets which contain the records, the accounts, the inventories, the registers of the daily transactions of the Minoans of the Heroic Age. We cannot yet read them, but there is no doubt that no energy will be spared to attain this end. We are on the brink of discoveries which may extend our knowledge of the beginnings of Greek, and therefore also of European civilisation, in directions which cannot as yet be guessed at. We may yet read the actual historical records of events of which Greek tradition has preserved to us but distorted and imaginative accounts.

The purpose of Mr. Evans's present monograph is to arrive at some measure of certainty with regard to the religious conceptions of the Heroic Greeks on the basis of the representations of cult-scenes which they have left behind them on gems, rings, vases, &c. It is a difficult task, but one which Mr. Evans has essayed with much success, though it may seem to the reader that his treatment of it is somewhat too voluminous, that, indeed, while reading it is occasionally difficult to see the wood for the trees. This is no doubt due to Mr. Evans's unrivalled power of illustration from Greek legend and his minute knowledge of even the most out-of-the-way hints in the classical writers which in any way bear upon the problem which he seeks to elucidate; perhaps, therefore, it should be accounted to him as a virtue rather than as a vice. We have said that Mr. Evans has discovered the veritable Labyrinth of Minôs. Unless the reader is well read in the voluminous literature, scattered through a hundred learned periodicals, of Mycenæan archæology, it will perhaps be difficult for him to appreciate all the various items of evidence which render this clear, but it is a fact which it is difficult to dispute. On p. 110 of the work under review Mr. Evans writes:—

"In the great prehistoric Palace at present partially excavated by me at Knôssos I have ventured on many grounds to recognise the true original of the traditional Labyrinth. It is needless here to speak of its long corridors and succession of magazines with their blind endings, its tortuous passages, and maze of lesser chambers, of the harem scenes painted on its walls, and its huge fresco-paintings and reliefs of bulls, grappled perhaps by men, as on a gem impression from the same site, the Mycenæan prototype of Theseus and the Minotaur. All this might give a local colour to the mythical scenes with which the building became associated. But there is direct evidence of even a more cogent nature. It was itself the 'House of the Double Axe,' and the Palace was at the same time a sanctuary. The chief corner-stones and door-jambs, made of huge gypsum blocks, are incised with the double axe sign, implying consecration to the Cretan Zeus. More than this, in the centre of the building are two small contiguous chambers, in the middle of each of which rises a square column, formed of a series of blocks, on every side of which in one case and on three sides of the other is engraved a double axe (Fig. 5). There can, I venture to think, be little doubt that these chambers are shrines, probably belonging to the oldest part of the building, and the pillars thus marked with the sign of the god are in fact his aniconic images."

Now the double axe is known to us as the symbol of a deity, the Karian Zeus of *Labranda;* it occurs also on Carian coins and on coins of Tenedos, where it is also a god-symbol.

"With the evidence of this primitive cult of the weapon itself before our eyes," says Mr. Evans (p 108), "it seems natural to interpret names of Carian sanctuaries like Labranda in the most literal sense as the place of the sacred *labrys*, which was the Lydian (or Carian) name for the Greek πέλεκυς, or double-edged axe. On Carian coins indeed of quite late date the *labrys*, set up on its long pillar-like handle, with two dependent fillets, has much the appearance of a cult-image."

Now we have traditional evidence for the fact that the præ-Hellenic or Eteokretan population of Crete was ethnically connected with the inhabitants of Asia Minor, that it was, in fact, of "kleinasiatisch" stock. Many place-names in south-western Asia Minor end their Græcised forms in -νδα or -νδος, which is generally regarded as a typically Karian and Lycian termination. The Lycian language can be to a great extent read, and we know that a typically Lycian nominal affix was *-ñna*. This is the -νδα, -νδος of the Greek transliteration. Labra-*nda* or Labrau-*nda* is then "The Place of the Double Axe." Now in Crete, originally inhabited by a people ethnically connected with the speakers of Lycian and Karian, we have at Knôssos a legendary *Labyrinthos*, identified with the worship of a Zeus in connection with whom the bull was venerated. Also, one of the Curetes of Cretan legend was named *Labrandos*. Now, as Mr. Evans points out (p. 109), Jupiter Dolichenus, a Commagenian form of the double-axe god of Asia Minor, is represented standing, armed with his axe, *upon the back of a bull.* Further, on a Mycenæan gem from Argos a double axe is seen immediately above a bull's head. It is then evident that in Greece as in Asia the god of the double axe was also the god of whom the bull was an emblem, to whom the bull was sacred. In all cases this god is identified with Zeus. At Knôssos Mr. Evans finds a temple-palace devoted to the service of a god with whom the bull is constantly brought into connection and of whom the double axe is the symbol. It is a "Place of the Double Axe." At Knôssos we have the Labyrinth of legend; Λαβυρι-νθος is then naturally concluded to be the Cretan equivalent of Labra-nda; in the præ-Hellenic "kleinasiatisch" language of Crete the name signified "Place of the Double Axe." The palace of Knôssos is then the veritable Labyrinth of Minôs.[1]

Now the double axe of the Knôssian Zeus is often found on Mycenæan gems placed above a two-horned object, which must, since the axe was an object of worship, be a horned altar. When, therefore, he finds that pillars and trees are often represented in the same position as the axe, above a two-horned altar, Mr. Evans naturally concludes that the Pillar and the Tree were, equally with the Double Axe, objects of veneration to the Mycenæans of Greece proper as well as of Crete. Traces of such worships are, as he exhaustively shows, abundant in classical Greece, and there can be little doubt that in Mycenæan days they flourished exceedingly. When, however, Mr. Evans, rightly ascribing their origin to an "aniconic" period of religious development, proceeds to argue that the religion of the highly-civilised Mycenæans, the progenitors of Greek culture, had remained exclusively aniconic, it may be permissible to join issue with him: because no large Mycenæan idols have *yet* been found, we cannot say that none will ever be found, and we know that the barbaric ancestors of the Mycenæans, the "Præ-Mycenæans" of the "Island-Graves" of the Cyclades, actually did venerate rude marble idols, which are found in their tombs. And glyptic representations of Mycenæan deities are common enough. It seems preferable to hold that while anthropomorphic images of deities were probably made and worshipped by the Mycenæans, at the same time their symbols, the Pillar, the Tree, the Axe, &c., continued to be venerated.

Mr. Evans speaks of the Mycenæan altar-horns as the "Horns of Consecration," and naturally compares this article of religious furniture, as well as the Pillar and the Tree, with the horned altar, the *Maṣṣêbhâh* or sacred stone (*baitylos*), and the *Ăshêrâh* of the Semites. There is obviously a connection here, but, as Mr. Evans points out (p. 131), this connection is by no means necessarily

[1] The various portions of the argument will be found discussed in Mr. Evans's monograph, by Mayer ("Mykenische Beiträge," in the *Jahrbuch des kgl. deutschen Instituts*, vii. (1892) p. 191), and in Kretschmer's "Einleitung in die Geschichte der griechischen Sprache," ch. x. p. 289 *ff.*

of the kind which is likely to be assumed by those who are well acquainted with Semitic antiquities but are not aware of the present trend of opinion with regard to the ethnology of the peoples of the Eastern Mediterranean basin. The question is not "Did the Semites influence Mycenæan religion in the matter of Tree and Pillar worship?" but rather "From whom did the Semites derive their Tree and Pillar worship?" The matter is as yet by no means clear, but all the indications, in regard to which archæology, philology, and ethnology, as exemplified in the conclusions of Evans, Kretschmer, and Sergi, concur, point to Aryan Greeks and Phrygians and Semites having been in reality the successors in Greece, north-eastern Asia Minor, and Palestine respectively of a præ-Aryan and præ-Semitic race of the same stock as the inhabitants of the greater part of Asia Minor, who were certainly neither Indo-Europeans nor Semites. It is with these people that the Tree- and Pillar-cults of both Greeks and Semites may have originated. Whether the Mycenæans of Knôssos were pure-blooded members of this præ-Hellenic and præ-Semitic "Pelasgian" race or were already mixed with Aryan Hellenic elements must remain for the present a moot question.

This seems to be the pith of Mr. Evans's arguments. He explores many byways of his subject in his exhaustive essay, but into these we have not the space to enter here, and it is easy to lose one's way in them, for they are a labyrinth as difficult to explore as Minôs's own! One point may be noticed, however; when Mr. Evans enters into comparisons of Mycenæan with Egyptian religious conceptions, we do not know that he will find Egyptologists in general inclined to agree with him. When, for instance, he compares the Mycenæan Pillar-cult with the Egyptian veneration of the well-known symbol of the Mendesian Osiris, the Ṭaṭ or Dad, often erroneously called "The Emblem of Stability," speaking of it as a "Pillar with its quadruple capital indicative of the four supports of heaven" (p. 146), he does not note that this explanation of the emblem is in the highest degree doubtful, for in all probability it is not a pillar at all, but an extremely ancient and traditionally conventionalised representation of the holiest relic of the god, the Backbone of Osiris. And if comparisons with Mycenæan heraldic designs are to be sought, the heraldic conceptions of the early Babylonians might more aptly be quoted than those of the Egyptians. Further, of Mycenæan influence on Egyptian art little trace can be found beyond the temporary adoption by the Egyptians of the false-necked vase (*Bügelkanne*); and of the remarkable evidence of this influence, which, according to Mr. Evans (p. 148), the monuments of Tell el-Amarna exhibit, nothing can be said, simply because it is in no way apparent. The naturalistic vigour of the artists of Åkhenàten's court was as purely Egyptian in its origin as was the cult of the *Àten* itself.

From the above remarks, however, it will be evident that in his monograph Mr. Evans has once again made a most notable contribution to our knowledge of Mycenæan culture, and that he has proved his main point there will be little doubt in the minds of those archæologists who are not bound by preconceived notions as to the origins of Greek civilisation. H. H.

## *ANCIENT MEDICINE AND BOTANY.*

*Magistri Salernitani nondum editi. Catalogo ragionato della Esposizione di Storia della Medicina, aperta in Torino nel* 1898. By Piero Giacosa. Pp. xxxiv + 723. 8vo, with Atlas in folio. (Torino: Bocca, 1901.)

THIS fine work owes its origin to the "General Italian Exhibition," held at Turin in 1898. The author, Sig. Giacosa, suggested the formation, on that occasion, of a section for the history of medicine, in which should be collected documents illustrating that subject from the great libraries of Italy. A similar collection had been brought together at the International Medical Congress held at Rome in 1894, but, unfortunately, had been dispersed without being properly catalogued or described. It was therefore proposed also that on this occasion a complete descriptive catalogue should be prepared.

These propositions were favourably received by the Minister of Public Instruction and other authorities, with the result that, in response to invitations sent out, a large number of precious manuscripts, archives and other documents were sent in from various public libraries, forming probably the most remarkable collection of its kind ever brought together.

Most of the public libraries of Italy contributed to the exhibition, but there were certain exceptions. The absence of any contribution from the library of the Vatican is easily understood; but we regret to observe that nothing was sent from the splendid Laurentian library at Florence, which is particularly rich in works of this class.

The most remarkable part of the collection consisted of ancient medical manuscripts, dating from the ninth century onwards, many of them richly illustrated, and important in the history of art as well as in that of science. The text of many of these had never been printed, and the marvellous illustrations had remained entirely unknown except to those who were able to study them in the libraries where they are preserved. Before these treasures were again dispersed, Sig. Giacosa, assisted by eminent scholars, transcribed, and has here published, some very important inedited manuscripts, and reproduced specimens of the text by photography. In addition, some of the more remarkable pictorial illustrations which adorn the older codices have been also reproduced in the splendid atlas which accompanies the work.

The first part of the printed book consists of previously unpublished medical writings belonging to the school of Salerno, "Magistri Salernitani nondum editi." Salerno was the seat of the earliest medical school—indeed the earliest University—in Europe, which produced a medical literature of its own before the Arabian medical writers, with their versions of the Greek medical classics, occupied all the schools of Europe and formed the basis of European medicine in the Middle Ages. The study of the school of Salerno is most important in the history of medicine, and the texts published by Sig. Giacosa, which supplement in many ways the "Collectio Salernitana," edited by Henschel, Daremberg and de Renzi, nearly fifty years ago, form an important contribution to that study.

The second part of the book contains an admirable detailed description of the ancient MSS., more than one hundred in number, which were exhibited. This catalogue, containing numerous extracts with references to other MSS. and printed texts, forms, beside its immediate value, an excellent guide to the treasures of this kind preserved in Italian libraries.

It would be out of place here to enter on the interesting questions relating to the history of medicine which are raised in this volume, but we desire to call attention to the important bearings of some of these ancient works, and especially of the illustrations reproduced in the atlas, on the history of botany.

It is well known that a considerable number of works on medical botany, written in late Roman times, have come down to us and are still preserved in MS. in several European libraries. The most celebrated and probably the earliest is the MS. of Dioscorides, of the fifth century, now at Vienna, but originally brought from Naples, which is illustrated with a large number of coloured figures of plants. Another work, bearing the name of "Herbarium of Apuleius Platonicus," exists in many codices, and is always illustrated with the same series of figures, copied from one MS. to another. The ancient Anglo-Saxon version of this work, in the British Museum, with the same figures, has been printed in Mr. Cockayne's "Anglo-Saxon Leechdoms." There are others, which need not be mentioned here.

The text of these works has little botanical interest, being the work of mere servile compilers. But the illustrations have a peculiar and indeed unique value, and this *because* they are the work of copyists, who have transmitted to us, more or less accurately, a tradition of the way in which classical artists of the Roman period figured plants. The great MS. of Dioscorides is unique, or nearly so, and whether its figures were copied from still earlier figures we cannot say. But the earliest MSS. of Apuleius (ninth century) were probably copied from earlier works, and exhibit, therefore, a still earlier period in science and art.

These rich materials for a study of ancient botanical illustration have been most imperfectly explored, and have never been reproduced for the benefit of students in general. There is a printed edition of Apuleius issued by Philip de Lignamine at Rome about 1480, with rough copies of the figures in the original MS. ; but the book is almost as rare as the manuscripts. The figures of the Vienna Dioscorides were copied on copper plates in the eighteenth century ; but only two impressions are known to exist. A few were reproduced in Daubeny's "Roman Husbandry" and elsewhere, but they amount to very little. It would be a worthy, though costly, enterprise for some Government or academy to reproduce one of the old MSS., with its figures in their original colours.

We are therefore glad to see that Sig. Giacosa has copied in his atlas some of these ancient figures of plants. The chief characteristics of the school, viz. the diagrammatic representation of the plant with artificial symmetry, the disproportion of parts, the formal outline, and the decorative aim of the whole, can be well traced ; while a comparison of figures of different dates shows the growth of conventionalism. Some realistic botanical figures of later schools form an instructive contrast.

As an example, we can only refer to the figures of one plant, the celebrated *Atropa mandragora* or mandrake, of which so many fables have been told. A comparison of the representations of this plant at different periods shows the gradual development and embellishment of the legend.

The legend of the mandragora, a formidable plant which caused the death of whoever pulled it up, so that a dog was employed in this fatal task, as told by Josephus and others, is well known. We find here, however, from a MS. of the ninth century, a fuller account than we have met with elsewhere, which it may be of interest to translate :—

"Mandragora is a plant which the poets call *anthropomercas* [sic], since it has a root shaped like a man. It is given in wine to those who wish to undergo a surgical operation safely, as when stupefied by it they feel no pain. When you come to it you will recognise it because it shines at night like a lamp. When you see its head you must cut round it with a knife lest it should escape. For such is its virtue that on the approach of an impure man it quickly flees before him. Therefore you dig round it with a knife, which must not touch the plant, and carefully remove the earth with an ivory spade. And when you see the hand and foot of the herb, tie round it a new cord and fasten the cord to the neck of a dog which has been kept fasting, and a little way off place a piece of bread so that the dog (trying to seize the bread) may pull up the herb. But if you do not wish to kill the dog, since the herb has such a divine power that it kills in an instant whoever pulls it up, proceed as follows. Make a snare of a long rod, and tie the cord which is fastened to the herb to the top of the rod, and bend it down ; so that when the rod springs up by its own force it will pull up the herb mandragora."

This merciful substitute for the dog we have not found mentioned elsewhere.

All the pictures of the mandrake accordingly show the dog and the cord, sometimes a spectator, stopping his ears, lest (according to another part of the story) he should hear the shriek uttered by the herb when pulled up, which it was death to hear. In some, presumably the older figures, the herb is merely a forked tap-root with arms, the extremities ending in fibres, and surmounted by a tuft of leaves. In later figures the tuft is replaced by a well-formed human head and the fibres by distinct fingers and toes.

There are other figures of plants which, without possessing the romantic interest of the mandrake, are well worthy of study, and furnish interesting, though difficult, problems in identification. Some old botanical glossaries are also worth attention.

We have quoted enough to show the botanical interest of Signor Giacosa's beautiful work. It is an important contribution to the history of science, and should find a place in all the greater botanical as well as medical libraries. J. F. P.

## *THE ANDES OF PATAGONIA.*

*Les Andes de Patagonie.* Par L. Gallois. Pp. 28 + plates. (Paris : Librairie Armand Colin, 1901.)

THIS brochure treats almost entirely of the orography of Patagonia in its relation to the boundary-line question between the Argentine Republic and Chile, which is now *sub judice*, having been submitted to the arbitration of the English Government. The author claims that his "only object in this study is to assist in making better known one of the most curious regions of the globe";

but it is easy to see which side of the controversy he would espouse if he felt himself free to give his opinion.

His brochure is richly embellished by numerous beautiful plates of mountain chains, scenery around the lake districts and along the Andean foothills, taken from the Argentine "case," as presented to the Arbitrator, in five large folio volumes. He also reproduces several Argentine Government maps on a reduced scale.

M. Gallois sets forth the salient features of the various treaties and protocols which have, during a score of years, resulted from this question, and he justly regrets that "La formule que les diplomates adoptèrent fut donc tout simplement la formule traditionelle." "S'il y avait un pays au monde où les vieilles formules dussent être avec soin évitées, c'était la Patagonie." In this opinion he is not alone, for every student of South American politics and geography must lament the interminable blunders made by diplomatists and lawyers when they rely upon their own language to determine frontier lines instead of submitting their description to scientific experts.

M. Gallois especially criticises the ignorance of the framers of the treaties regarding rivers which eat back until they have established their determined vertical curve of equilibrium. Herein is the crux of the whole dispute between the Argentine Republic and Chile. The former claims that the boundary line should be traced along the highest crests and peaks of the main Andean chain; and the latter claims that the treaties demand the tracing of the line along the continental *divortia aquarum*. But some of the rivers which flow into the Pacific Ocean have sawed back through the Cordillera and now have their sources upon the Patagonian plateau to the east of the Andean main chain. Thus the rival claims are in direct conflict. Many cases of this tendency of rivers may be found in almost every country in South America, and Colonel Church, in his "Physical Geography of South America," has given us numerous instances of it, especially in Ecuador, Perú, and Bolivia.

The brochure has a laconic but excellent description of Patagonia in a few pages, and gives due credit for information to Chilian as well as Argentine explorers. A long line of cliffs borders the Atlantic coast, interrupted at rare intervals by great valleys which open on to the sea. The surface of the immense Patagonian plateau rises gradually towards the west up to the vicinity of the Cordillera. Here and there a depression is filled with saline waters, and, especially towards the south, the country is covered with immense sheets of basaltic lavá. Deep valleys, too immense for the existing streams of water, cut the plateau in certain parts and have a labyrinth of affluent cañons.

"The aspect rapidly changes along the approaches to the Cordillera. . . . It is a broken region, often mountainous, rich in prairies; rich, above all, in sheets of water, the smallest of which equals the area of our great European lakes. A privileged country, where the climate is free from extremes, where moisture is sufficient, where forests, easily penetrated, adorn the mountain sides. It is there that Argentine colonisation has been developed, and also *there* are the disputed territories.

"More to the west, but without the transition being suddenly established, commences what we call, without prejudging anything, the main chain.

"The Cordillera drops suddenly to the sea from 42° south latitude. Up to 47°, it dominates a long submerged depression which visibly continues the interior plain of Chile. . . . Further to the south the outline is less defined."

He notes the marked resemblance of this Pacific coast to that of Alaska and Norway—scored and penetrated by fjords and channels cutting the coast-line into islands and presenting numerous glaciers. Many rivers find their way to the Pacific Ocean through deeply carved valleys in the Cordillera, but so violent and broken in their course that none of them are navigable except for a very short distance from the sea.

Such is the outline that M. Gallois gives of Patagonia, and it enables the reader to acquire a very fair general knowledge of the orography and topography of the country without studying the voluminous works which have been prepared for the umpires in the boundary-line dispute. It is to the credit of M. Gallois that, however difficult, he has found it possible to preserve an impartial attitude in his instructive and ably-written brochure.

G. E. C.

## WIRELESS TELEGRAPHY.

*Wireless Telegraphy*. By G. W. de Tunzelmann. Pp. iv + 104. (London: Office of *Knowledge*, 1901.) Price 1*s*. 6*d*.

MR. DE TUNZELMANN, in writing a popular account of wireless telegraphy, has attempted the double task of describing its historical development and of giving an account, which shall be intelligible to the lay reader, of the fundamental principles of the subject. The descriptive parts are based mainly on the papers which have been read by Mr. Marconi, and explain in an interesting manner free from superfluous detail the system which he has worked out. It is to be regretted that the work of other experimenters is hardly adequately recognised; Prof. Slaby, for example, deserves more than the half dozen lines allotted to him. Moreover, such information as is given is easily accessible in Mr. Marconi's published papers, whereas a careful comparison of the systems devised by the various workers would be a valuable addition to the literature of the subject.

In the theoretical portions of the book the author has largely drawn his inspiration from Prof. Lodge's "Modern Views of Electricity." Without wishing in any way to disparage Mr. de Tunzelmann's explanations, we doubt whether they would be intelligible to readers who, as he says in the preface, "know little or nothing of electrical theory." A clear comprehension of the constitution of the ether and the mechanism of ether waves is not to be obtained without serving a long and severe apprenticeship in the study of physical science. Yet it is supposed that the lay mind, because it is attracted by the wonderful results of wireless telegraphy, is capable of appreciating the intricate physical theories with which the subject is bound up. It is as though a man should be expected to be able to weigh the merits of the electrolytic dissociation theory because he admires the electroplate upon his dinner-table. We doubt whether any useful end is served by such "popular" expositions, which can only lead to the spread of pseudo-scientific ideas based on ill-digested theories. It must be admitted, however, that on the whole Mr. de Tunzelmann has treated the subject broadly and clearly, and his explanations should at any rate be of considerable service to the student.

M. S.