THURSDAY, NOVEMBER 19, 1903.

VEGETATION IN HERCYNIA.

Die Vegetation der Erde. vi. Der Hercynische Florenbezirk. Von Dr. Oscar Drude. Pp. xix + 671; mit 5 Vollbildern, 16 Textfiguren, und 1 Karte. (Leipzig: W. Engelmann.) Price 30 marks; Subscription price 20 marks.

THIS work is an elaborate monograph on the distribution of the vegetation in the Hercynian district of Germany, and forms the sixth volume in Drs. Engler and Drude's series "Die Vegetation der Erde." Dr. Oscar Drude, the author, the professor of botany at Dresden, has long been an accepted authority on the various problems connected with plant geography. In his "Deutschlands Pflanzengeographie," published in 1895, he defined seven regions of vegetation in the German flora, and in the present work he deals much more exhaustively with the mountainous and hilly country which stretches from the Hartz to the Rhön, reaching to Lausitz on the east and to the Böhmer Walde. The botanical literature of the area with which he deals is extensive, as it has been known to botanists ever since the time of Valerius Cordus, who was born in 1515. In 1588 Johann Thal wrote his "Sylva Hercynia," which was a catalogue of the plants growing in that district, and in the same year Joachim Camerarius published a work containing some curious coloured figures of some of the plants.

Dr. Drude divides the various Hercynian "Formationen" or plant habitats into ten main groups; these he again subdivides, making in all thirty-two. He carefully traces the absence or presence of these through the fifteen subdivisions of his geographical area. It may be well to indicate briefly the character of these ten groups (with one or two examples of the predominant vegetation of each), as their discussion occupies much of the volume.

Group i.—Woods of the low country and hills reaching 500 metres. Predominant vegetation:—Fagus, Quercus, Carpinus. Accessory:—Ulmus, Tilia, &c. The first subdivision of this group contains many shrubs, Cornus, Caprifoliaceæ and Rosaceæ, and is specially prevalent in Hesse and South Hanover, Thuringia, and parts of Upper Saxony.

ii.—Woods within the inundation area of rivers, &c., upper limit about 500 metres. Alnus, Betula, *Populus tremula*, &c., while Fagus is absent. The first subdivision of this group is almost absent in the Hercynian highlands proper.

iii.—Woods from 1100–1360 metres. Fagus, *Acer Pseudo-platanus, Picea excelsa, Abies pectinata*, the latter species wanting in certain districts. This group, in all its subdivisions, predominates in the Hercynian highlands proper.

iv.—Sandy plains and heaths. Calluna, *Vaccinium Myrtillus*, and *V. Vitis Idaea*. Predominates in Hesse and South Hanover, Thuringia and Upper Saxony, but present to a very small extent in the Hercynian highlands.

v.—Sunny hill formation. Carpinus, Tilia, and *Quercus sessiliflora*, species of Teucrium, Thymus, Helianthemum, and Dianthus. The first three subdivisions of this group predominate in Hesse, South Hanover, Thuringia, and Upper Saxony, but with slight exception are absent in the Hercynian highlands.

vi.—Wet meadows, &c. Hydrophilous, Poæ, Cyperaceæ, and Juncaceæ.

The first subdivision of this group contains Dactylis, Phleum, *Avena elatior, Festuca elatior* and *arundinacea*, and occurs in all the subdivisions of the geographical area with the exception of the Bohemian forests.

vii.—Turf moors. Hydrocotyle, Rhynchospora, and *Gentiana Pneumonanthe*. Hill turf moors are absent in Thuringia and Upper Saxony.

viii.—Subalpine Hercynian hill formation, 900–1450 metres. *Lycopodium alpinum* and *L. Selago*, also *Empetrum nigrum*. The two subdivisions of this group predominate in the Hartz Mountains, in the Erz, and in the Bohemian Forest.

ix.—Inland watery situations. Nymphæa, Hydrocharis, Typha, Heleocharis, and Littorella. The first three subdivisions of this group predominate in Hesse, South Hanover, Upper Saxony, and to some extent are present in the Hercynian highlands. The last subdivision of the group, saltmarshes, &c., of which the characteristic vegetation is *Aster Tripolium, Triglochin maritimum*, Salicornia, *Obione pedunculata*, &c., is present in Hesse, South Hanover, Thuringia, but absent in Upper Saxony and the Hercynian highlands.

x.—Cultivated ground. Chenopodiaceæ, Solanaceæ, *Centaurea Cyanus, Agrostemma Githago*, and *Neslia paniculata*. Present in all the subdivisions of the area except the Bohemian forest.

The flora of Hercynia does not differ very materially from that of Britain, and nearly all the plants are found in similar situations in this country, so the volume is well worth the attention of our own local ecologists.

Fifteen chapters of the book are devoted to various portions of the geographical area, as, for instance, Das Weser Bergland, Das Braunschweiger Hügelland, and Hügelland der Werra and Fulda mit der Rhön, &c., and under each are discussed their orographic and geognostic character—the formations that occur in the area and the topography. Perhaps one of the most interesting of these chapters is that on the Hartz Mountains.

The Hartz is a detached chain, flat on the top, 2000 feet above the sea, with a number of peaks rising out of this, among which the Brocken, 3733 feet above the sea, is the highest. Its geological composition is granite. On p. 497 we have a figure showing the character of the vegetation surrounding the summit. The Weser Mountains are lower, averaging not more than 600 feet, the highest point being 1500 feet. The Rhöngebirge and several basaltic ridges are also low.

Many years ago it was pointed out that the Hartz Mountains present some curious peculiarities in their vegetation which deserve especial notice. In order to comprehend them in their true independence, we must

exclude the low promontories and ranges of hills around the great mass, since the vegetation of these, both geologically and botanically, agrees with those of the terraces of the Elbe and the Weser. The uniformity of structure of the great central mass of the Hartz, the rarity of lime, &c., causes a comparative poverty of peculiar forms of flowering plants, but, on the other hand, a subalpine character may be detected, and this at a height above the sea which would not lead one to expect it. Another feature, long ago pointed out, is the depression of the climatic tree-limit. Dr. Drude gives the following list of the twenty-four rarer or characteristic species of the Brocken flora:—*Listera cordata, Epipogon aphyllus, Trichophorum caespitosum, T. alpinum, Carex pauciflora, ? C. Heleonastes, C. rigida, C. limosa, C. sparsiflora, Geum montanum, Linnaea borealis, Hieracium alpinum, H. nigrescens bructerum, Andromeda poliflora, ? Pinguicula alpina, Pulsatilla alpina, Empetrum nigrum, Rumex arifolius, Thesium alpinum, Salix bicolor, Betula nana, Lycopodium alpinum, Selaginella spinulosa,* and *Athyrium alpestre.*

Saxifraga Hirculus was found by Kohl in the neighbourhood of Zorge in 1809, but does not seem to have been gathered by anyone since that date, and many other interesting notes on individual species are given.

Hampe, in his "Flora Hercynica," gives 1343 vascular plants as occurring within his area, and there is a good deal of additional information on the distribution of plants in this region in A. Andree's little pamphlet "Die Flora des Hartzes und des Östlichen Vorlandes bis zur Saale."

The Erzgebirge, a chain of mountains mostly of primary formation, are on the south-east of the area taken by Dr. Drude. A long list of the characteristic species is given, from which we select the following as particularly worthy of note:—*Orchis globosa, Herminium Monorchis, Coeloglossum viride, Gymnadenia albida, Listera cordata, Corallorhiza innata, Lilium bulbiferum, Streptopus amplexifolius, Polygonatum verticillatum, Luzula silvatica, L. sudetica, Trichophorum caespitosum, Carex pauciflora, C. rigida, C. supina, C. limosa, Calamagrostis montana, Poa sudetica, Scheuchzeria palustris,* &c.

Meum athamanticum, Orchis globosa, Gentiana spathulata, and *Phyteuma orbiculare,* which are present in the Erzgebirge, are wanting in the Upper Böhmer Walde, and only the Meum and the Phyteuma reach the Hartz. *Senecio crispatus,* in the Thuringen Wald, reaches its northern limit in Hercynia, but it is impossible in a brief notice to give any idea of the mass of detailed information which Dr. Drude has here collected together.

Much good work has recently been published on the distribution of plants in various portions of the globe. In Central Europe there have been the preceding volumes in the present series, Prof. Moritz Willkomm's "Iberian Peninsula," Dr. Pax's admirable work on the Carpathians, Dr. Gustav Radde on the Caucasus, Dr. Beck on the various countries included under Illyria, and Dr. P. Graebner on north Germany. In the United States we have had Prof. MacMillan's "Minnesota Plant Life," "The Plant Life of Alabama" by Dr. Möhr, and a report on the Dismal Swamp region by Mr. Thomas H. Kearney. In this country the late Robert Smith mapped out three districts in Scotland, and his brother, Dr. W. G. Smith, of Leeds, and his colleagues have already mapped out two districts in Yorkshire, and given lists, illustrated by photographs, of the characteristic plants of the different stations. A first instalment of a botanical survey of the basins of the rivers Eden, Tees, Tyne and Wear, by Mr. F. J. Lewis, was lately read at the British Association, and we hope the contemplated survey of the Pennines, from Derbyshire to the Cheviots, will be successfully carried out.

Dr. Drude in Hercynia has done his work most fully and conscientiously. Every possible plant-association connected with every varying physical condition of the country has been carefully noted, and both its phenogamous and cryptogamous constituents have been determined. But we feel that the work may somewhat bewilder the ordinary reader by reason of its excessive elaboration. E. G. B.

MEASUREMENT BY LIGHT WAVES.

Light Waves and their Uses. By A. A. Michelson. The Decennial Publications of the University of Chicago. Pp. 166. (Chicago: University Press, 1903.) Price 2 dollars net.

THE University of Chicago, in commemoration of the completion of the first ten years of its existence, is publishing a series of volumes dedicated "to the men and women of our time and country who by wise and generous giving have encouraged the search after truth in all departments of knowledge."

The publication committee is to be congratulated in that it has persuaded Prof. Michelson to contribute a volume to this series. Anything that he writes is sure to be worth careful and attentive study, and while the actual scientific results recorded do not, as a rule, in any way claim to be new, Prof. Michelson has succeeded in putting the important consequences of his own inimitable work in a manner which will render them known to many who could hardly be expected to follow the original papers.

The volume contains eight lectures delivered at the Lowell Institute in 1899. It starts with an elementary account of light waves and their properties, and in the first lecture some of the consequences of the principle of interference are skilfully developed.

But the distinctive tone of the work is not noticeable until we come to Lecture ii., which deals with a comparison of the microscope and telescope with the interferometer.

An account is given of the action of a lens, and the theory of the diffraction fringes formed by a microscope or telescope objective is outlined. This leads to the theory of the resolving power of a microscope, and to the conclusion that, while 1/250 of an inch is the limit of resolution for the human eye, that of the microscope is one four-hundredth of this, or about one hundred-thousandth of an inch. It is then shown that by limiting the aperture of a telescope to two parallel slits near the opposite ends of a diameter, the fringes formed become more distinct, though with a considerable loss of light, and from this the action of various

forms of interferometer in which the interfering pencils are separated and then reunited after reflections at a series of plane mirrors is deduced. It is explained, further, that with such instruments the accuracy of measurement possible with a telescope or microscope can be greatly exceeded, and that, too, without serious loss of light.

The application of interference methods to various measurements forms the subject of the remaining lectures.

One of the features of the Edinburgh meeting of the British Association in 1892 was Michelson's paper on the application of interference methods to spectroscopic research read before Section A and printed in full among the reports.

Fizeau had years before explained the gradual disappearance and reappearance of Newton's rings when formed by sodium light between a flat surface and a lens of small curvature as the distance between the two is increased. It is due to the fact that the D line is double; the ring system seen, therefore, is a complex one produced by the superposition of the two systems due to each line separately. When the bright rings of the two systems coincide, the visibility of the rings is a maximum; as the distance between the lens and plate is increased, the bright rings of the first system overlap the dark rings of the second, the intensity of the field becomes uniform, and the rings cease to be visible.

Michelson defined the visibility of the ring system and showed how it depends on the distribution of light in the source; he then proceeded to measure experimentally the visibility of the rings formed by various spectrum lines, and from this to analyse the distribution of light in the lines. By a stroke of genius he utilised the defects of the ring system to advance our knowledge to a surprising extent. Lecture iv. contains a most interesting account of his work.

The chapters that follow are no less fascinating; thus the next lecture describes the measurements undertaken by Michelson at the Bureau International des Poids et Mesures at Sèvres to determine the relation between the wave-length of cadmium light and the standard metre; cadmium light was chosen because of the simplicity of the lines of its spectrum, and it was shown that in air at 15° C. and at normal pressure the number of waves in a metre is for the red ray of cadmium 1553163·5, for the green ray 1966249·7, and for the blue 2083372·1. The absolute accuracy of these results is said to be about one part in two millions, the relative accuracy about one part in twenty millions.

In Lecture vii., application of interference methods to astronomy, it is shown how an examination of the visibility curve of a star enables the observer to detect double stars which are far too close to be resolved by any telescope, while the last lecture, on the ether, deals with a problem which is yet unsolved, the theory of aberration.

The aberration constant, the ratio of the velocity of the earth to that of light, is a quantity of the order 1/10000, and its accurate measurement had proved no easy task. Michelson, with the view of solving the question whether the earth is at rest or in motion relative to the ether at its surface, undertook a measurement which involved the square of this tiny quantity, or one part in one hundred millions, and carried it out successfully. The result of the experiment was to show that this relative motion, if it exists at all, must be extremely small, and that the ordinary explanation of aberration, which assumes that the ether remains at rest while the earth moves through it without disturbing it, is untenable. The only solution of the difficulty yet offered is that due to Lorentz and Fitzgerald, who pointed out, independently, that the motion of a body through the ether might, on certain assumptions as to the connection between ether and matter, cause the body to contract in the direction of motion, and that this contraction would depend on the square of the aberration constant, so that its effect might compensate for the effect looked for by Michelson.

In his first lecture the author apologises for using, as illustrations of his subject, his own researches.

"I do this," he says, "because I believe I shall be much more likely to interest you by telling what I know than by repeating what someone else knows."

Prof. Michelson has earned our thanks for putting some of his knowledge into so attractive a form; he will perhaps forgive us if, in closing, we express the wish that he will tell us more of what he knows.

R. T. G.

ALL ABOUT CATS.

The Book of the Cat. By Miss F. Simpson. Pp. viii+380; illustrated. (London: Cassell and Co., Ltd., 1903.) Price 15*s.* net.

THE "cult of the cat" has of late years increased to such an enormous extent that there can be no doubt as to the need for a thoroughly trustworthy and exhaustive account of the various breeds kept in this country, together with notices of those of other lands. Of this favourable opportunity Miss Simpson has taken full advantage in the handsome and beautifully illustrated volume before us, the exceedingly low price of which places it within reach of fanciers in all ranks of life. In addition to the description of the various breeds kept in this country, the author has also given chapters on the feeding, housing, and general treatment of cats (derived from her own extensive experience), as well as on the management of cat-shows; while other chapters by various specialists are devoted to foreign breeds, the cat's place in nature, and the diseases of cats and their treatment. The book is therefore a compendium of all that relates to domesticated cats, and it may be almost said that it contains practically all that is worth knowing about these animals.

Perhaps the least satisfactory portion of the book, so far as Miss Simpson is concerned, is to be found in the opening lines of the first chapter, where we find the statement that the origin of the cat has long puzzled the learned, and is still a zoological mystery. Neither does the second sentence—"Historians tell us that the feline race came into existence about the same

time as the horse "—tend in any way to mend matters. Moreover, when we turn to the chapter on some foreign cats, by Mr. H. C. Brooke, we find it stated, although somewhat guardedly, that the Egyptian cat is the probable ancestor of our domesticated breeds. There does not, therefore, seem to be complete accord in this respect between the two authors, and we venture to suggest that, although the pedigree of the original British breed of cat cannot be fully traced, the term "mystery" is scarcely appropriate to the real facts of the case. In this connection mention may be made of Mr. Brooke's error in referring (p. 297) to the European and Egyptian wild cats as "varieties" instead of "species." It is perfectly true that the mistake, in analogous cases, is very frequently made by amateur zoologists, but it is nevertheless quite inexcusable.

Passing over the chapters devoted to the housing and exhibition of cats, our attention may be directed to what Miss Simpson has to say with regard to the various breeds kept in this country. The first group taken into consideration is that of the long-haired or Persian breeds, of which quite a number of different strains, chiefly or entirely distinguished by colour, are recognised by fanciers. The author is of opinion that no satisfactory distinction can be drawn between Angora and Persian cats, and in this she is doubtless right. No reference is, however, made to the opinion current among zoologists that the Persians very probably trace their origin to the long-haired Pallas's cat (*Felis manul*) of Central Asia, which, with the exception of the tail and limbs, is a nearly uniformly coloured species. Neither is enough made of the fact that all imported Persians appear to be uniformly coloured, although a quotation from Mr. Harrison Weir to this effect is given. If this be really the case, there can be no doubt that all Persians with "tabby" and "tortoise-shell" markings are due to a cross between the pure breed and European cats. Strong confirmation of this is afforded by a statement of the author to the effect that so-called orange Persians tend to lose their markings and become uniformly coloured.

Under the heading of Manx cats the author alludes to the current belief that these are due to a cross between a cat and a rabbit! A whole chapter is devoted to the beautiful Siamese cat, although no reference is made to its possible origin from the bay cat (*F. badia*). To the author's account of ordinary short-haired cats we need not refer, and the remaining space at our disposal must be devoted to foreign cats (other than those kept in this country). Mr. Brooke, in chapter xxvi., has been fortunate in securing some very interesting photographs, notably those of the Burmese and Abyssinian breeds, the latter of which is also represented in a coloured plate, together with an Indian cat. Most remarkable of all is, however, the photograph of hairless New Mexican cats, now said to be all but, if not quite, extinct.

Although the book might have been improved if the proofs had been submitted to a zoologist, there can be little hesitation in pronouncing it a decided success, and indispensable to every student and breeder of cats.

R. L.

AMERICAN RAILWAYS.

American Railways. By Edwin A. Pratt. Pp. viii+309. (London: Macmillan and Co., Ltd., 1903.) Price 3*s.* 6*d.* net.

AS it appears to be the fashion just now to look upon British railroad management as antiquated, and its methods effete, it is interesting to study a book dealing with American practice, as its adoption in this country is looked upon by some as the only salvation of British railways from a dividend earning point of view.

The volume before us deals with the general question in a fair and open manner. Mr. Pratt evidently went to the States with the intention of seeing as much as possible, and comparing what he did see with home practice; he gives us in his book a very readable account of the result.

The big waggon question is, of course, interesting, and we read that twenty-five years ago the average freight box waggon in the United States had a capacity ranging from 16,000 lb. to 24,000 lb. Then, in 1881, the 40,000 lb. waggon was introduced, this being followed in 1885 by the 60,000 lb. waggon. After this, in 1898, a waggon, though no larger than its predecessors, was so constructed as to have a capacity of 80,000 lb., and to-day waggons are being extensively used with a capacity of 100,000 lb. This continual increase in waggon capacity is well illustrated by means of tables. The dead weight is gradually being reduced, and in the case of pressed steel waggons the proportion of paying weight to the total weight of the car when loaded is 73 per cent., and it is interesting to know that waggons of this type are being gradually introduced into this country, the most satisfactory being those designed and made by the Leeds Forge Company.

With the rapid increase in the weight of trains hauled came the heavier and more powerful locomotive, and it is here where the American locomotive engineer has the advantage of his British brother, it being possible for the American engine to be both higher and wider than the British engine, thus materially increasing its capacity.

We read that the majority of American officials with whom the author discussed the big waggon question did not care to commit themselves to any recommendation of the use of such large waggons in Great Britain. The nearest approach is the American type of enlarged freight waggon for the transport of coal from the collieries to the sea, and these are now being successfully used by the North-Eastern Railway.

An important conversation with a prominent official is reported on the general question of handling of traffic in the two countries. He said, ours is wholesale business, yours is retail. We get bigger lots than you do, and we can handle them to better advantage; but in regard to general merchandise your arrangements are far better than ours, &c. It is evident, therefore, that the conditions are so very different that the mere adoption of American methods *en bloc* is not sufficient in itself. No doubt there are many practices which can be assimilated with advantage, and these can only be discovered and thought out by sending

picked railway men on a tour of inspection over the American railways.

Chapter xx. is of value. The author gives us the benefit of his "conclusions," and states that

"before starting on my tour of the United States I had heard or read so much in praise of the conditions existing on American railways that I expected to bring back with me a long list of recommendations deserving consideration on this side. But the more I looked for and inquired after any special advantages that were really suited to British conditions, and desirable of adoption here, the greater my difficulty in finding or learning of any became."

There is no doubt, however, that the British railways are only too anxious to learn, for most of the important lines have sent their officials to study on the spot and to investigate anything that is new.

We can recommend this book to all students of railway practice as one containing much useful information and decidedly worth reading. N. J. L.

OUR BOOK SHELF.

Why the Mind has a Body. By C. A. Strong. Pp. x+355. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1903.) Price 10*s.* 6*d* net.

In this book Prof. Strong deals with the riddle of the universe, and contributes some original ideas toward its solution. Of the three sections into which the work is divided, the first deals with the current theories of automatism, parallelism, and interaction, and criticises them on their merits; the second gives us a metaphysical ground-work; the third resumes criticism on the bases of the results of the second part, and develops the new doctrine. The critical part must be left to the reader, who will not fail to find it vigorous and interesting; as the peculiar features of the author's thought emerge most clearly in the constructive work, our space will be best used in indicating these ideas.

The goal is psychophysical idealism, which is metaphysically monistic, but distinct from psychophysical monism. The world, as we then have it, is monistic in "stuff" and in "form"; in form, for the theory "conceives individual minds and other things-in-themselves as together constituting a single system"; in stuff, for all is mental. This conclusion rests on the doctrine of things-in-themselves which the second section is designed to prove. As to these, the nature of reality is known to us in consciousness; they are therefore not unknowable; we also have a transcendent knowledge of other minds, hence we know some extra-mental realities, and are saved from solipsism. Two such realities may stand in a causal relation each to each; Kant's limitation of causality to the sphere of experience applies only to phenomenal causality; but there is also a real causality to which this limitation does not apply which may be used to transcend experience. If we now ask how the causal chain, *e.g.* from A's anger to B's sensation of pain, is to be constructed, we find a gap which requires filling; hence a "cosmological proof" of other things-in-themselves which must be mental but are not consciousnesses.

It must be left to the reader to follow these arguments in detail; the bare outline here given will serve to show the trend of thought; the whole is not unworthy of the slightly paradoxical title. The author is always attractive, and his style is vigorous, though at times Transatlantic in diction; he anticipates the possibility of failing to convince his readers, in which he is not without justification, for he deals with the obscure obscurely. The most fundamental and most difficult point is the relation of one consciousness to another; here we have a "transcendent" knowledge hitherto overlooked by philosophers. This knowledge is founded "neither on reason nor experience, but solely on instinct" (p. 219). Deeper still, our own past experience stands to us in the same relation as another consciousness; "it literally *is* another consciousness, though one no longer existent" (p. 222). We reach this by a conjecture which bears "the closest analogy to the process by which we infer other minds" (p. 222). Then is our "instinct" after all an inference? And if we know another consciousness because it in some way acts upon us, do our own past experiences also in some way act upon us? As this is not a criticism, the question may be left without discussion. What should be noted is that, though we find the self-development of mind rejected, the evolution of things-in-themselves accepted, though we hear of the "imprinting" achieved by things upon minds (which seems convertible with evoking states of consciousness), we nowhere have a discussion of the problem of activity; that is why our gratitude for this work does not obliterate the feeling that one riddle has been solved by—another. G. S. B.

The Position of the Old Red Sandstone in the Geological Succession. By A. G. M. Thomson, F.G.S. Pp. vi + 224. (Dundee: John Leng and Co., 1903.)

More than sixty years ago Hugh Miller, in his classic on "The Old Red Sandstone," remarked, "There are some of our British geologists, too, who still regard it as a sort of debatable tract, entitled to no independent status. They find, in what they deem its upper beds, the fossils of the Coal Measures (*i.e.* Lower Carboniferous), and the lower graduating apparently into the Silurian System; and regard the whole as a sort of common, which should be divided as proprietors used to divide commons in Scotland half a century ago, by giving a portion to each of the bordering territories." One object of the present work is to show that the conditions under which the Old Red Sandstone was produced may not have been of the character of inland lakes without free connection with the sea; and another object is to show that these conditions may not have begun only after the close of those which produced the highest Silurian strata, nor have terminated before the date of deposition of the oldest of the Carboniferous beds.

It would seem as if we had made very little progress during the past sixty years, and, to a certain extent, this is true. The ancient physical geography of the Old Red Sandstone period has yet to be clearly depicted, and the precise relations of Old Red Sandstone and Devonian to Silurian and Carboniferous still require further detailed research among the fossil plants and animals, and among the rocks in which these organic remains are entombed. A book should in this, as in all other cases, be either useful or interesting, or it might, as with Hugh Miller's works, possess both attributes. The present work, however, seems to fail in both respects. The expressions used by the author, of "Prevertebrate" and "Vertebrate Silurian," "Prevertebrate" and "Vertebrate Old Red," eleven times on one page, and often six or seven times, and in one instance varied by the printer into "Pervertebrate," are, to say the least of it, tiresome. We read also of "Vertebrate Palæozoic times" and "'Vertebrate Old Red' rivers."

The work is mainly a discussion with regard to the distribution and succession of life, and with regard to the physical conditions, bearing on the objects previously expressed. It may afford some new suggestions to those studying the Old Red Sandstone, but it lacks precise stratigraphical evidence and tabula-

tion of facts. Too many sentences commence with "Suppose," or "It would not be surprising," or "It is just possible," or words with a like significance. If the author had put his views into an essay of ten or twelve pages, he would have done more to further his object, in which we cordially sympathise, of arriving "at the truth concerning the position of the Old Red in the succession."

Steel and Iron for Advanced Students. By Arthur H. Hiorns. Pp. xvi + 514. (London: Macmillan and Co., Ltd., 1903.) Price 10*s.* 6*d.*

EVIDENTLY based upon a course of lectures delivered at the Birmingham Municipal Technical School, this little book is primarily a text-book not of so highly advanced a character as the title might perhaps suggest. It is well up to date, and embodies the latest views on the subject expressed at recent meetings of the Iron and Steel Institute. The arrangement of the matter is very similar to that adopted in Bauerman's "Metallurgy of Iron" and in Greenwood's "Steel and Iron." The 131 illustrations are admirable, and well adapted to indicate to the student or intelligent workman the principles described. The index is the least satisfactory part of the book. The names of several authors cited (Brinell, Brustlein, Carvès, Chênot, Eyermann, Hoffmann, Lürmann, Massicks and Crooke, Mukai, McWilliam and Pourcel) are incorrectly spelt, whilst several authors to whom reference is made in the text (Berthier, Chernoff, Ewing, Faraday, Galbraith, Hautefeuille, and Wingham) are omitted. Similar errors in proper names occur in the text. Sir Lowthian Bell, for example, is described as Sir Lothian (p. 135) and as Mr. Bell (p. 380), and no distinction is made between Mr. Edward Riley and Mr. James Riley. Despite these faults, the book may be cordially recommended to science teachers as one which is eminently suitable for metallurgical classes.

Agriculture for Beginners. By C. W. Burkett, F. L. Stevens, and D. H. Hill. Pp. xii+267. (Boston and London: Ginn and Co., 1903.)

THE question of the introduction of instruction in agriculture or any other definitely technical subject into our elementary schools is one which has been much debated recently, but the opinion of most of those who have any working knowledge of teaching is very strongly against it. Agriculture in schools is very likely to become a book subject; it is far preferable to take up some question like the growth of a plant, which admits both of simple experiment on the part of the pupil and of abundant illustration from practical life, which again supplies a basis of reasoning and knowledge for anyone who happens in later life to be concerned in the raising of crops.

The authors, however, of the little book under notice consider that in the country schools of the United States something more definitely agricultural is wanted, since "most boys and girls reared on a farm get no educational training except that given in the public schools." They have, accordingly, prepared a text-book which, in the earlier stages, deals with the plant in the manner we have indicated, by simple experiments capable of repetition by the scholars. They pass on to more special topics, such as cross-fertilisation and the raising of new varieties, diseases of plants, insect pests, crops and stock, dairying, &c., all treated in a simple and attractive fashion, with a great wealth of illustrations, admirably selected and reproduced. The conditions dealt with are, however, so distinctively American as to render the book of little service in English schools, though the teacher himself may obtain from it some hints as to method and many excellent illustrations.

The Praxis of Urinary Analysis. A Guide to the Chemical Analysis of Urine. By Dr. Lassar-Cohn, Professor in the University of Koenigsberg. Authorised Translation by H. W. F. Lorenz, A.M., Ph.D. Pp. vi+58. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 1 dollar.

THE object of this little book is stated to be to give directions for the chemical determinations of the *ordinary* constituents of urine and of the stomach contents that are of value for diagnosis. Even with this limitation, the directions given are too brief, especially as regards those for quantitative estimations. For the detection of albumen the heat test, and for sugar Trommer's test, alone are mentioned. For the quantitative estimation of sugar, it is stated that titration with Fehling's solution is only suitable for chemical laboratories, because the solution must be freshly prepared, and, "secondly, and this is much more annoying, it is extremely difficult to determine the end of the reaction, for solutions of the proper strength can be bought nowadays" (p. 38). The translation must have gone astray here. As regards practical value, the two pages upon the quantitative estimation of sugar might have been omitted.

R. T. HEWLETT.

Studies in Physiology, Anatomy and Hygiene. By J. E. Peabody, A.M., Instructor in Biology in the Morris High School, New York City. Pp. xviii + 332; 147 illustrations in the text. (New York: the Macmillan Co.; London: Macmillan and Co., Ltd., 1903.) Price 5*s.* net.

THIS is one of a numerous class of books suitable for use in high schools and similar institutions. As its title implies, it gives, in addition to the principles of physiology, as much anatomy and also, it may be mentioned, chemistry as is necessary for the understanding of the bodily functions; the application of such knowledge to everyday life (hygiene) is also pointed out in a sensible and practical way. A book of this character does not call for any lengthy review; it is sufficient to say that after a careful perusal we are convinced that it will fulfil the *rôle* the author wishes it to play. It is clearly written, well illustrated, and, what is more important, is unusually free from errors.

Arithmetic. Part ii. By H. G. Willis, M.A. Pp. viii + 236 + xxxix. (London: Rivingtons, 1903.) Price 1*s.* 4*d.*

THE senior mathematical master of Manchester Grammar School here continues his plan of supplying examples in arithmetic grouped in series so as to furnish two or three lessons a week for a term. These exercises cover the parts of the subject studied in schools which were not dealt with in the author's former book. Oral questions are inserted at the beginning of each exercise, and answers to all examples are provided.

Arithmetical Types and Examples. By W. G. Borchardt, M.A., B.Sc. Pp. xii + 367. (London: Rivingtons, 1903.) Price 3*s.* 6*d.*

THIS volume is, the author states, intended to stand between the complete text-book of arithmetic and the mere compilation of examples. Each exercise is preceded by a model worked-out example, and a few explanatory notes are added. Most of the recommendations of the recent committee of the Mathematical Association have been adopted, and full answers are given. We notice that graphical methods are made use of, and logarithms are employed to facilitate the calculation of compound interest.

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.*]

Heating Effect of the Radium Emanation.

A FORTNIGHT ago I wrote to you respecting the rise of temperature observed in radium compounds. I pointed out that the experiments of Profs. Rutherford and Barnes seemed to show that the effect was largely due to the excited activity. I have since then made a few experiments confirming that view.

Air charged with radium emanation was led through a tube in which I placed a thermal junction formed by iron and nickel wires. The junction was left charged to a high negative potential during about ten minutes, then taken out and placed side by side with an unexposed junction in a metal vessel kept at constant temperature by a water jacket. The two junctions at first seemed to be at the same temperature, but the exposed one began to become warmer almost immediately, and after twenty minutes was about one-tenth of a degree higher than the other junction. The experiment was repeated with the same result. Test experiments were made in various ways to show that accidental temperature disturbances could not affect the experiment. Thus, after the wire had been treated exactly in the same way in a current charged with thorium emanation, the junction showed absolutely no change of temperature detectable by the galvanometer used.

We may draw an important conclusion from these experiments. Prof. Rutherford has given strong evidence to show that the excited activity really contains three successive stages of radio-active matter, the first changing into the second, and the second into the third; the fact that the maximum heating effect was only obtained thirty minutes after the wire was first exposed to the emanation seems to show that it is the last transformation in which the third excited activity finally disappears or becomes inactive which sets the energy free. Experiments are now in progress to test the matter further.

The experiment mentioned above with the thorium emanation was not altogether satisfactory, and I should not at present like to draw the conclusion that the excited activity due to thorium does not give a heating effect. I only mention it here to show that the treatment of the wire in the experiment independently of the presence of radium does not give rise to such variations of temperature as have been observed. Had any appreciable amount of the heating effect been due to the contact with the emanation, I should have expected the junction to show some rise in temperature when first introduced to the calorimeter. All these results should be considered as provisional only until a more detailed investigation has been made.

ARTHUR SCHUSTER.

The Owens College, Manchester, November 14.

Radium and Animals.

IN the issue of NATURE of November 5, Mr. Dixon gave a brief account of some interesting experiments with radium upon seedlings and upon Volvox, the results of which were almost entirely negative. Like Mr. Dixon, I have been investigating the action of radium rays upon living matter, but in my experiments animals of simple structure have been employed instead of plants, and my experience leads me to think that the negative result of his experiments may have been due to the distance which separated the small quantity of radium he employed from the seedlings.

In my experiments, which I have been carrying out in the university physiological laboratory, three lots of radium bromide were used, 5 mgr., 10 mgr., and 50 mgr. respectively. These were brought within 3 mm. of the cells containing the animals, the walls of which were made of thin mica instead of glass in order to lessen the absorption of the rays.

It is too soon to discuss that obscure problem, the nature of the influence of the rays upon living matter, but it is already clear that experiments with simple forms of life will furnish some data.

I have endeavoured to determine (α) whether the rays would provoke an immediate response of the nature of a contraction; (β) whether they would evoke the more generalised "tactic" response—that is to say, whether they would repel or attract the animals. Put very briefly the results are as follows:—

(α) Actinosphærium, with pseudopodia extended, exposed in daylight to 10 mgr. radium at 3 mm. did not retract its pseudopodia. In two hours, however, it was dead and breaking up. Controls were unchanged.

Stentor—a green species. Two specimens were kept in the dark for some hours to increase their sensitiveness to radiant energy. On examination with a minimum of light the animals were found extended with cilia in rapid movement. Exposed to the rays from 50 mgr. of radium at 4 mm. both slowly contracted, and slowly extended on removal of the radium. This observation was repeated three times. After the third exposure one Stentor refused to extend.

(β) Stentor. Sixteen free-swimming specimens were placed in the dark in a cell over a lead plate 3 mm. thick with a hole in the centre about 2 mm. in diameter under which was 50 mgr. of radium bromide. Next day fifteen of the animals had attached themselves clear of the pencil of β rays, and one injured specimen was in the path of the rays.

The cell was then moved so that a group of five came into the path of the β rays. In a few hours these were found to have detached themselves and moved out of the rays.

Similar results were obtained on other occasions, though it seems possible for the rays to kill feeble specimens before they respond to the repelling influence.

Hydra, both *viridis* and *fusca*, will, as a rule, detach themselves and move out of a pencil of β rays. If, however, the animal is again moved back into the rays from 50 mgr. at 4 mm. distance the third immersion is usually fatal—the tentacles drop off and the body slowly breaks up.

Perhaps the most interesting result was obtained with *Euglena viridis*. Encysted specimens under the influence of radium rays (β and γ) in the dark readily become motile and disperse without suffering any harm.

Newnham College, Cambridge. E. G. WILLCOCK.

Note on the Arctic Fox (Canis lagopus).

A RATHER peculiar error in regard to this animal seems in danger of being perpetuated in certain contemporary literature, in which it is stated that, while in the other regions of its distribution the Arctic fox generally acquires a white winter coat, in Iceland this change never takes place, but that all the foxes there are blue. As a matter of fact, this fox turns white in the Icelandic winter as elsewhere, with this reservation only, that the proportion of blue winter forms there is greater than the proportion in the Arctic regions generally, the white forms, however, probably still remaining in an actual majority. I believe this occurrence of the white phase in Iceland is so far well known that I need not dwell on the evidence for it; from personal experience, however, I can corroborate it. It is a small point, but in so far as error is abroad, it seems advisable to correct it.

In Iceland I was informed that the white form and the blue were distinct, and in his work on this island a century and a half ago, Horrebow was of the same opinion. This view is based on the fact that both Horrebow and the Icelanders had seen white foxes in full summer, and is no doubt to be explained by the fact that occasionally the white dress is not changed for the summer brown. On the other hand, I believe that some authors still maintain the distinctness of the two forms, though I am not aware how they overcome the evidence of those who have observed the phases intermediate between the two which occur at the moulting season.

In his "Colours of Animals" Prof. Poulton quotes the

case of three Arctic foxes from Iceland in the Zoological Gardens, of which "one turns perfectly white every winter, while the other two remain dark."

Cambridge, November 12. W. F. LANCHESTER.

The Magnetic Storm of October 31.

DR. GLAZEBROOK has asked me to send you a copy of one or more of the magnetic curves during the late storm, and also of a characteristically "quiet" day. For the latter I send copy of declination October 2–3, 1900, B_1, Fig. 2. It is not absolutely quiet—very few days are, if any—and parts show the tiny "magnetic waves" often met with. Here, as usual, there are two days' curves, each with its own base (or time) line on the same sheet. The paper is changed every second day, shortly after 10 a.m. In this quiet day declination curve, 1 cm. of ordinate in the original represents 8′.7, and increasing ordinate answers to increasing westerly declination.

The magnetic storm on October 31 commenced about four hours before the papers were changed, and the assistant in charge, noticing that a storm was in progress, arranged that the papers should be changed again next day, so as to have only one day's trace on the sheet, and so no mixing of two days' traces. As the commencement at 6.3 a.m. is of interest, I am sending two sheets of the horizontal force record, Fig. 1, the one, A_1, covering the interval October 29, 10.40 a.m., to October 31, 10.16 a.m., the other, A_2, October 31, 10.21 a.m., to November 1, 10.42 a.m. On October 31 some of the trace is off the sheet about 10 a.m., also between 2 and 4 p.m. and between 5 and 7 p.m. The time or base line answers to an arbitrary value (determined by the absolute observations), and 1 cm. of ordinate in the original curve represents 50 γ (where $1\gamma = 1 \times 10^{-5}$ C.G.S.), increasing ordinate representing increasing force.

I also send a copy of part of the declination record, B_2, Fig. 2, given by a Watson pattern magnetograph made by the Cambridge Instrument Company, sent to the Laboratory for test. The original shows, I think, all the movement, which was partly lost on our own magnetograph, the scale of ordinates of which is more open. In this curve 1 mm. represents in the original very nearly 1′ of arc, and increasing ordinate decreasing westerly declination. We had not set the clock driving this instrument quite correct, and the times shown in the trace are about four minutes wrong.

During the rapid movements the traces on the originals are faint, and consequently are not fully shown in the photographic copies sent you.

I ought to explain that the slight blurring and want of clearness on the horizontal force trace October 29–31 really arise from the electric trams. Their action, however, is hardly visible during the storm proper in either declination or horizontal force. In the vertical force, however—of which no copy is sent—the electric tram disturbance is much more considerable, and might easily be mistaken by the uninitiated for a fairly active magnetic storm.

In the accompanying illustrations, Figs. 1 and 2, 1 cm. represents practically 4 cm. of the original curves.

SUPERINTENDENT OBSERVATORY DEPARTMENT.

The National Physical Laboratory, Richmond, Surrey, November 7.

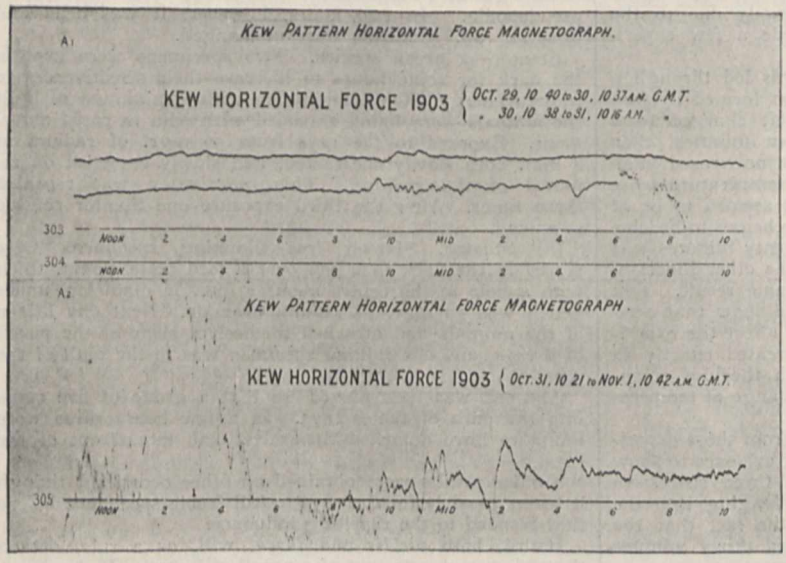


FIG. 1.—Reduced Registers of Horizontal Force.

Expansion Curves.

IN your issue of October 8 Prof. John Perry describes in a letter "an exceedingly simple, ingenious method" of plotting the so-called polytropic curve representing the law $pv^m = \text{constant}$, which method he found in a pamphlet by Mr. E. J. Stoddard, of Detroit. I may be permitted to state that this method was published for the first time eighteen years ago by Prof. E. Brauer in the *Transactions* of the Society of German Engineers, 1885, p. 433, and since Prof. Brauer's publication this method has been used in a number of treatises on thermodynamics published in Germany and France. It has been given for years in the very valuable handbook "Huette," which is undoubtedly known to Prof.

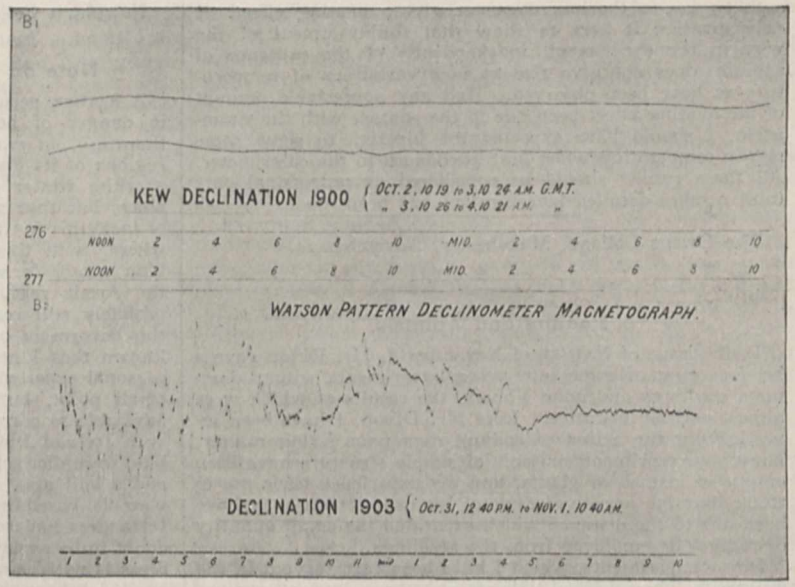


FIG. 2.—Reduced Registers of Declination.

Perry. Is it not surprising that a method which Prof. Perry himself considers very important should have to reach England from Germany by the circuitous path of the United States?

The reorganisation of technical education in England has occupied the wisest men in England for the past thirty years. It seems to be of so much importance that it has been made the subject of Sir Norman Lockyer's recent presidential address before the British Association. It seems to me that a plea might well be made for the acquisition of a reading knowledge of modern languages, especially French and German, in the advanced public schools. Prof. Perry re-discovered in an American paper, eighteen years after its first publication, a very important method for constructing a curve continually used in thermodynamics. Nineteen years ago Prof. Herrmann originated and described the entropy diagram, so often attributed to Mr. Macfarlane Gray, through whose admirable paper, read in 1889, the entropy diagram has since come into general use. There are a number of similar cases which might be cited in favour of the cultivation of a reading knowledge of those modern languages which are apt to contain valuable contributions to scientific knowledge. Forty-three years ago Prof. Huxley wrote, "What is it that constitutes and makes man what he is? What is it but his power of language—that language giving him the means of recording his experience—making every generation somewhat wiser than its predecessor—more in accordance with the established order of the universe? What is it but this power of speech, of recording experience, which enables men to be men. . . ." We might paraphrase Huxley's words and apply them to the advantage that a knowledge of the modern languages gives its owner in regard to utilising the experience of other men and nations.

B. A. BEHREND.

Station H, Norwood, Cincinnati, Ohio, October 26.

IT was of very little importance to me to find out whether the method was new; the important thing was that it was not generally known in England, that I, who read a good deal, had never seen the method, and that many of my friends who read French and German engineering books more than I do had never seen it. I may say without any contrition that there are useful things not only in French and German, but in Italian, Russian, and Chinese, as well as in English books unknown to me and to many other people, but surely this is not enough for an argument for the absolute necessity for a study of Chinese or German. Before our "advanced public schools" take up the study of French and German or Chinese, I should like to see them take up the study of English. In America and Scotland English is really well taught in many schools; this is not the case in England.

J. PERRY.

November 11.

The Leonid Shower of 1903.

QUITE an abundant and attractive display of Leonids was observed here this morning (Monday, November 16). I began to watch the north-eastern sky at midnight (following November 15), and found meteors increasingly numerous. After 2 a.m. November 16, the numbers appearing in alternate intervals of fifteen minutes were as follows:—

	h. m.		h. m.		Leonids
Nov. 16 ...	2 0	to	2 15	a.m.	10
	2 30	to	2 45	,, ...	14
	3 0	to	3 15	,, ...	13
	3 30	to	3 45	,, ...	13
	4 0	to	4 15	,, ...	26
	4 30	to	4 45	,, ...	34
	5 0	to	5 15	,, ...	28
	5 30	to	5 45	,, ...	42
	6 0	to	6 15	,, ...	21

The horary rate of apparition for one observer was approximately as under:—

			Leonids
0	to 1	a.m.	16
1	to 2	,, ...	20
2	to 3	,, ...	48
3	to 4	,, ...	52
4	to 5	,, ...	120
5	to 6	,, ...	140

Maximum 5h. 30m. to 5h. 45m. a.m., when the rate was nearly three per minute.

The position of the radiant point was at 151°+22°, and it formed an area about 6 degrees in diameter. The great majority of the meteors, however, diverged accurately from the central part of the area.

During the minute following 3h. 44m. a.m. five Leonids appeared.

The meteors generally were very bright, and comparatively few were seen fainter than second magnitude. The more conspicuous objects were as follow:—

Nov. 16 a.m.	Mag.	From		To	
		α	δ	α	δ
h. m.		°	°	°	°
0 36 ...	1	... 122	+ 24½	... 103	+ 23½
1 13 ...	1	... 119½	48	... 97	53½
2 36 ...	Sirius	.. 117½	26½	... 98	26¼
2 43 ...	1	... 162	38½	... 168	44
2 44 ...	2	... 73	72½	... 17	63
4 4 ...	1	... 168½	37	... 186	45
4 12 ...	2	.. 70	70	... 19	59
4 37 ...	2	... 138	35	... 133	39
4 45 ...	2	... 92	53	... 68	52½
4 45 ...	♀	... 138	12	... 134	7½
5 11 ...	1	... 213	29	... 223	27
5 14 ...	2	... 173	40½	.. 190	47
6 5 ...	2	... 182	51	... 195	55½

A few meteors were noticed from minor showers, two particularly interesting objects being:—

a.m. h. m.					
		°	°	°	°
3 41 ...	4	... 219	+ 63	... 209	+ 61¼
3 59 ...	2	... 178	19	... 223	41

These moved very slowly, and probably belonged to radiants at 262°+62° and 147°−11° respectively.

I should be glad to hear of duplicate observations of any of the above, as it is desirable to compute their real paths if the necessary materials can be obtained.

Bristol, November 16. W. F. DENNING.

Autophyllogeny in the Vine (Vitis).

I LATELY received from a neighbour a vine-leaf, taken from his own garden, exhibiting the uncommon phenomenon known as "autophyllogeny." A small green leaf had arisen from the midrib, near the apex of the central lobe, upon the upper surface of the leaf. The supernumerary leaf was sessile, and had its upper surface turned towards the corresponding surface of the primary leaf, in the same direction of growth. The leaflet appeared to be of the normal shape, but, owing to a slight malformation, it was not fully expanded, and I could not therefore entirely satisfy myself upon this point.

Dr. Masters, in his "Vegetable Teratology," cites instances in which supernumerary leaflets have been observed upon the upper surfaces of leaves of Heterocentron and Miconia, and upon the under surfaces of leaves of other plants, but I cannot find any record of their occurrence in the vine.

HERBERT CAMPION.

Walthamstow, Essex.

The "Dew-bow."

ON Wednesday and Thursday, November 4 and 5, fogs prevailed in this district and brought by mild winds great quantities of carbonaceous dust from over the town, which covered the surface of the top pond in Vernon Park with a dry film. On the morning of Friday, November 6, hoar frost covered the grass and walks; the film of dust on the pond was covered with a glistening coat of minute watery globules. At 11.20, standing with my back to the sun, I noticed a bright streak of light on the surface of the water, and on moving a few feet further saw that it was split up into the colours of the prismatic spectrum, and presented the appearance of the rainbow, as it appeared curved. There were two spectra, one fainter than the other. The phenomenon was visible for more than four hours, and I directed the attention of several gentlemen to it. In November, 1885, Mr. Thomas Kay, Moorfield, Stockport, saw a similar phenomenon on Lake Windermere, and pub-

lished the observation. The things necessary to produce it appear to be:—(1) a dry film of dust on surface of water; (2) a layer of fine globules of moisture on the film; (3) a dead calm, that the globules be not shaken into coalescence; (4) the sun shining brightly at a low angle through a clear atmosphere. EDWARD HEWITT.

Municipal Museum, Vernon Park, Stockport,
November 11.

Weather Changes and the Appearance of Scum on Ponds.

IF the scum referred to (NATURE, November 5, p. 7) be organic in character—algal, for instance—it would contain bubbles of gases.

Would not these bubbles tend to enlarge, from the expansion of their contained gases, on a lowering of barometric pressure, and the mass, becoming specifically lighter, to rise?

"Platanus orientalis" says "any decided change of weather." The above explanation would hold good only for a change of weather indicated by a falling barometer.

H. J. GLOVER.

Stationers' School, Hornsey, N., November 6.

Earthquake at Kashmir.

IT may perhaps be of interest to note (I do not find the fact recorded in NATURE) that on April 18, 1902, there was a sharp earthquake shock over North-west India and Kashmir, about 2.30 a.m. (local time).

O. ECKENSTEIN.

34 Greencroft Gardens, London, N.W., November 13.

A NEW THEORY OF THE SOIL.[1]

IT has long been recognised that the chemical composition of the soil affords a very imperfect index to its fertility, partly due to the fact that only recently have methods of analysis been devised to discriminate between the total plant food in the soil and that which is active and likely to be immediately available for the plant, but chiefly because the physical texture of the soil and its power of maintaining a supply of water to the growing plant is a much larger factor in crop production than its store of nutrient material.

But though the part played by the chemistry of the soil has doubtless been much exaggerated and requires to be studied more in connection with soil physics, it has been reserved for the chemists of the United States Bureau of Soils to deny its action entirely, and put forward a theory which considers all soils to be effectively the same from the chemical standpoint.

Briefly stated, the thesis developed in the *Bulletin* before us is as follows:—dissatisfied with the want of correspondence between the results of any of the methods of soil analysis in which the soil is attacked by either weak or strong acids, Dr. Whitney and his associates have fallen back on the aqueous solution obtained by shaking 100 grams of the soil with 500 c.c. of water and allowing it to stand for twenty minutes. For the rapid quantitative examination of the very weak solution thus resulting they have worked out various colorimetric methods, and in this way have been able to analyse several hundred soils of the behaviour of which in the field something was known.

From these results the authors come to the conclusion "that with occasional exceptions the composition of the soil solution and the concentration is about the same in all cultivable soils." "All our principal soil types, in fact, practically all cultivable soils, contain naturally a nutrient solution which varies within comparatively narrow limits with regard either to composition or concentration, and which is usually sufficient for plant growth. Apparently, therefore, all soils are amply supplied with the necessary mineral plant foods, and these plant foods are not in themselves a matter of such paramount importance to the agriculturist, for their supply as regards the plant is determined by the supply of soil moisture which the crop can obtain from the soil." The authors further suggest that fertilisers, if they have any effect in increasing the crop, do so in the main by altering the physical texture of the soil or by stimulating the root range of the plant. So novel a point of view from men with the experience of Dr. Whitney and his colleagues demands a careful consideration of the evidence in its support.

On the theoretical side the authors suggest that in the natural soil solution on which plants feed "the quantity of any constituent which can possibly enter the solution is . . . determined by definite equilibrium conditions with the but slightly soluble mineral from which it is derived . . . it may very well happen that the addition of comparatively small amounts of a readily soluble potassium salt to a soil would simply force back the dissociation and solubility of the potash minerals with no consequent gain of potassium to the soil solution." In support of this view the authors describe an experiment in which powdered potash felspar when shaken up with water is shown to yield a feebly alkaline solution, as indicated by phenolphthalein. On adding, however, a little soluble potassium salt the colour of the phenolphthalein is partly discharged, which the authors consider to indicate that some of the potash derived from the felspar has been forced back to the solid phase. We would suggest the consideration of another experiment; take a very weak solution of potassium phosphate, add a drop of phenolphthalein solution, and run in dilute alkali until a distinct colour appears; now add a little solution of some neutral salt, sodium or potassium chloride; the colour will again be partially discharged, although the salt added is strictly neutral.

In the latter experiment there is no question of the intervention of a solid phase; both experiments are, we think, equally explicable on the dissociation hypothesis, but the one does not bear the interpretation put on it by the American chemists.

Turning now to the analytical figures, we cannot agree that, except in a very general and average sense, they support the authors' case that the composition and concentration of the soil solution are about the same for all soils. Taking first of all the determinations of nitric acid, they are seen to vary within the widest limits, as is evident from the following summary of the results for four of the soils:—

	No. of analyses	Nitric acid. Parts per million of dry soil		Mean
		Highest	Lowest	
Windsor Sand	34	26·62	0·56	5·69
Norfolk Sand	98	23·76	0·67	3·81
Leonardtown Loam	62	62·00	trace	12·71
Sassafras Loam	80	38·40	0·50	7·79

Furthermore, if the number of the determinations falling within successive equal limits be plotted into a curve, the resulting figure is highly irregular, and shows nothing of the maximum about the mean which characterises the curve of error. The nitric acid figures are thus entirely opposed to the authors' thesis; they show no tendency to a constant value, but extreme accidental variations, *i.e.* due to factors independent of the classification here adopted. But in fact too

[1] "The Chemistry of the Soil as related to Crop Production." By M. Whitney and F. K. Cameron. U.S. Department of Agriculture, Bureau of Soils, No. 22. Pp. 71. (Washington, 1903.)

much is known of the origin of the nitrates in the soil from the results obtained by Warington at Rothamsted and by King in Wisconsin to allow one to suppose their amount would ever approximate to a constant even for the same soil, yet nitrates are perhaps the dominant factor in plant nutrition.

The phosphoric acid and potash figures are a little more in harmony, and we have examined those relating to the same four soils with the following results:—

	Phosphoric acid. Parts per million		
	Highest	Lowest	Mean
Windsor Sand	12·88	2·65	6·21 ± 0·25
Norfolk Sand	16·52	1·71	6·33 ± 0·19
Leonardtown Loam ...	16·5	2·9	7·16 ± 0·26
Sassafras Loam	21·45	2·24	7·61 ± 0·30

	Potassium. Parts per million		
	Highest	Lowest	Mean
Windsor Sand	46·11	10·90	24·27 ± 1·02
Norfolk Sand	44·9	11·64	22·19 ± 0·49
Leonardtown Loam ...	51·66	10·08	23·61 ± 0·65
Sassafras Loam	46·8	7·94	24·22 ± 0·63

These numbers would indicate variation round a mean which is practically the same for all soils as regards potash, but which as regards phosphoric acid has a different value for different types of soil, approaching one value for sands and another for loams. This agrees with the probability that the potash compounds are of the same type in all soils, whereas several distinct compounds of phosphoric acid must exist in relative proportions varying with the type of soil, and we surmise that these mean results might be correlated with the amount and solubility of the compounds appropriate to the various types of soil were more data available. But for the purpose of the argument we are not concerned with mean results, but with individual soils; the authors rest their case on the constancy of composition of the soil solution, and their own figures show variations too wide and too numerous to fall within any allowable limits. It may be true enough that the variations exhibited cannot be correlated with the known productiveness of the soils, but that is only a proof of the ineffectiveness of the analysis of the aqueous extract of a soil, not of the non-existence of a chemical soil factor in crop production. Indeed, it is not quite easy to see what the numbers do represent; the volume of water employed is so small, and the time of extraction so short, that they cannot stand either for the solution existing in the soil or for the material which water could extract during the growth of a crop. Some analyses are given of the actual solution extracted from various soils; all that can be said of them here is that they show no more constancy of composition than the laboratory extracts, nor do the old analyses of the drainage waters at Rothamsted lend any more support to the idea of a soil solution of constant composition.

Though Dr. Whitney's main argument is thus hardly tenable on his own showing, certain side issues are worth a little notice. Dealing with the action of fertilisers, he notices that, while the wheat crop on the best fertilised plot at Rothamsted averages about 33 bushels, on the plot which has been unmanured for sixty years it has fallen to 12 or 13 bushels. Yet on the similarly unmanured plot in the Agdell field, where the wheat is grown once every four years in rotation with roots, barley, and clover or fallow, but little falling off is apparent. Hence he concludes that, in virtue of the rotation, the fertility of the Agdell field is unimpaired, whereas in the continuous wheat field "the decrease can be ascribed only to some physical change in the soil, to some chemical change other than the actual loss of plant food taken up by the crops." But when any other crop on the unmanured plots in Agdell field is considered, the decline in fertility is enormous; roots and clover only yield minimal crops; so far as they are concerned the cultivation of the soil involved in the rotation has been quite unable to maintain the fertility. The wheat, with its powerful root system, holds up better, but its production is falling steadily; it is important to see how long it will be maintained, though it need never be expected to fall to the level of the continuous wheat, because the land is practically only cropped every other year, so trifling has the output of roots become.

When Dr. Whitney says that there are few instances showing that a given fertiliser is required by a certain soil, and that generally fertilisers have no consistent or continuous effect, he ignores too much the results both of experiment and experience in countries like our own. In England a body of knowledge has been accumulated concerning the requirements of particular soils and crops for specific fertilisers such as is hardly possible in America, where much of the land has only recently been brought under intensive cultivation involving the use of purchased manures.

In another place Dr. Whitney says "the beneficial effect of fallowing is not due to an accumulation of soluble plant food in the soil." Not wholly due, perhaps, but King's investigations show what a powerful factor the accumulated nitrates become, and a recent discussion of the Rothamsted results shows that after a wet autumn, to wash out the nitrates formed during the summer fallow, the benefit of fallowing disappears almost entirely, whereas after a dry autumn and early winter it produces an increase of crop of nearly 50 per cent.

Suggestive as Dr. Whitney's memoir must be to all agricultural chemists, we thus do not consider that the main theory it propounds possesses any permanent value. We should be sorry if we have failed to appreciate the argument properly, but it is not always easy to follow, the text being somewhat deficient in sequence and orderly arrangement; indeed, we are disposed to think that had the question been set out a little more nakedly at the outset, and the demonstration marshalled with more precision, a somewhat different conclusion would have been reached by the authors. The fundamental thesis is unimpeachable, that water content and temperature are the main factors in crop production, but the chemical composition of the soil is also a large factor, though its magnitude and relation to the other physical factors do not yet admit of complete determination. A. D. H.

THE SURVEY OF INDIA.

A VOLUME of extracts from narrative reports of the Survey of India for the season 1900–1901 [1] has recently been issued. These extracts, which used to be published in the same volume as the annual report, are now issued separately. The reports selected for publication show admirably the range of the operations of the Survey of India. They deal with seven subjects.

(1) *Zincography.*—For certain classes of maps reproduction from zinc is eminently suitable, and owing to the introduction of thin zinc plates, difficulties of

[1] Pp. 68. (Calcutta: Government Printing Office, 1903.) Price 2*s.* 3*d.*

storage have largely disappeared. For the rapid reproduction of maps photozincography was, until a few years ago, the method invariably used. Two new methods have now superseded photozincography; one of these, "heliozincography," was worked out by the Ordnance Survey, and subsequently adopted by the Survey of India; the other, the "Vandyke process," was invented by Mr. Vandyke, of the Survey of India, and has now been adopted by the Ordnance Survey. The first method consists in reproduction direct on a sensitised zinc plate in contact with a reversed negative. The Vandyke process consists in reproduction direct on a sensitised zinc plate in contact with the original drawing. Lately, at Southampton, it has been even found possible to reproduce maps drawn on thick drawing paper. The process has been patented by Mr. Vandyke, and is a cheap and very efficient means of reproducing cadastral maps.

(2) *Geodetic Triangulation in Burma.*—The principal point to note is the determination of the coefficient of terrestrial refraction by night as well as by day, the coefficient being the absolute refraction divided by the terrestrial arc. By day (from observations to heliostats between noon and 3 p.m.), the coefficient was 0.072; by night (from observations to lamps), 0.083. It is possible that if the night observations had been taken from midnight onwards the coefficient would have been smaller.

Some interesting secondary triangulation (the Manipur series) was also carried out, one of the rays being 95 miles long.

(3) *Latitude Operations.*—The average probable error of 14 latitudes observed with a zenith telescope was ±0″.063, or say six and a half feet. India is, of course, committed to the system of refined latitudes, and comparatively few of them.

(4) *Experiments with the Jäderin Base Apparatus.*—A base was measured at Dehra Dun with the following results:—

By Jäderin apparatus...	...	39,187.272 feet
By Colby's bars ...	...	39,187.462 ,,

a discrepancy of 1/194,000.

It was found that the 80 ft. wire was the most convenient, and various practical suggestions are made on the use of the apparatus. It was apparently in contemplation to measure a Jäderin base in Burma. There would appear to be no doubt as to the gain in speed, and also no doubt that it is possible under suitable conditions to do away with base-line figures by the use of, say, 15 mile bases.

(5) *Magnetic Survey of India.*—This has been commenced, and there are now five base stations, Calcutta, Bombay, Rangoon, Dehra Dun, and Kodaikanal. It was intended in 1901 to send out three field detachments to work in an area west of a line joining Dehra Dun and Bombay, two to work along railway lines, and a third in the desert.

(6) *Tidal and Levelling Operations.*—Tidal observations have been, or are being, taken at forty-one ports in, and adjacent to, the Indian Empire. Tables are given of the tidal constants at various ports deduced from the 1900 observations. As regards the accuracy of prediction, at fourteen open coast stations during 1900 it was found that the mean error of prediction of the time of high or low water was thirteen minutes, and the average error of predicted heights was one twenty-fifth of the range.

The tide-predicting machine belonging to the Indian Government (due, it is believed, to Lord Kelvin and Mr. Roberts) is in London, and the Survey of India sends home annually the latest values of the tidal constants to Mr. Roberts, who sets the instrument for the port in question, and causes it to describe graphically the tide curve for any future year required. As Prof. Darwin has remarked in his book on "The Tides," it is characteristic of England that this admirable machine has not been made use of for any of the home ports.

(7) *Topographical Surveys.*—The seventh report deals with some details of one-inch work in Burma, and incidentally serves to emphasise the necessity of keeping cadastral and topographical work distinct. The topographical surveys are fully described in the annual report, the most interesting being the survey on a scale of half inch to one mile of 17,000 square miles carried out in China during the expedition.

When shall we have an Imperial Survey capable of doing for the Crown colonies, protectorates and occupied territories what the Survey of India does for India? C. F. C.

ISAAC COOKE THOMPSON.

LIVERPOOL has lost a well-known naturalist in the death of Mr. I. C. Thompson, who was hon. treasurer of the Liverpool Marine Biology Committee from its foundation nearly twenty years ago. He had a wide knowledge of the Crustacea, and especially of Copepoda, the group upon which most of his original work was done, but he was also a keen field-naturalist, interested in the lives and habits of his animals, and preferring to catch the specimens himself and to examine them in the first place alive. He was always a prominent member of the party during the dredging expeditions in the Irish Sea and at the Port Erin Biological Station. Little more than a month before his death he was one of the leaders in the British Association dredging excursion which followed the Southport meeting.

Thompson's early papers on the Copepoda dealt with the forms found in Liverpool Bay and other parts of the Irish Sea, but he collected wherever he went, and, as the result of vacation travels, published papers on the Mediterranean and Norwegian species and on collections from Madeira, the Canaries, the west coast of Ireland, the Færöe Channel, and a traverse through the North Atlantic to Quebec. He also described Copepoda from the Bay of Bengal, the Antarctic, the Red Sea and east coast of Africa, and recently from the *Oceana* Expedition in the North Atlantic. In these papers he described many new forms, aided in the elucidation of not a few obscure points, and greatly extended our knowledge of the geographical distribution of the group. Thompson's last piece of scientific work was a large report, undertaken jointly with Mr. Andrew Scott, upon the Copepoda of the Ceylon pearl banks, recording more than 280 species, of which 76 are described as new to science. This extensive work was completed some weeks ago, and Thompson passed the last of his sheets for press shortly before he was struck down; it has been referred to by one who saw the proofs as the pioneer work on tropical Harpacticidæ and Lichomolgidæ. Thompson's papers have been published for the most part in the *Transactions* of the Liverpool Biological Society, the *Journal* of the Linnean Society, the *Annals and Magazine of Natural History*, and the reports of the British Association. He was in correspondence with Claus, Richard, Giesbrecht, and other Continental workers, and frequently supplied them with British specimens required for comparison or description in their monographs.

There were few of the local organisations in Liverpool for the advancement of science and the applications of scientific teaching in which Mr. Isaac Thompson did not play a prominent part, and his posi-

tion, even twenty years ago, was fitly indicated by his selection, in April, 1882, to attend Darwin's funeral in Westminster Abbey as the representative of the Liverpool scientific societies. On the occasion of the last visit of the British Association to Liverpool, in 1896, Thompson was one of the local secretaries, and his colleagues can testify how well he did his share of the hard work, and how much the success of that large meeting depended upon his admirable business arrangements and careful attention to detail. He was a fellow of the Linnean Society and a regular and active member of Section D at British Association meetings. He was one of the founders of the Liverpool Biological Society and the L.M.B.C., and it was in connection with the latter, and during the last fifteen years, that most of his original scientific work was done.

Isaac Thompson was a good example of the serious amateur who does sound systematic work and makes lasting contributions to science. His loss will be keenly felt, not only in Liverpool, but by the large number of scientific men throughout the country who were his personal friends. We all admired his sterling, upright character and his sympathetic loving nature.

W. A. H.

NOTES.

PROF. J. H. VAN 'T HOFF and Dr. Robert Koch have been elected honorary members of the Vienna Academy of Sciences. Sir William Ramsay, Prof. G. B. von Neumayer, Prof. H. Poincaré, Prof. E. J. Marey, and Prof. K. Golgi have been elected foreign correspondents of the same Academy.

THE death is announced of Prof. Robert H. Thurston, of Cornell University, at the age of sixty-four. From 1866 to 1871 Prof. Thurston occupied the chair of natural philosophy at the United States Naval Academy. Subsequently he became professor of engineering at Stevens Institute, where he remained until he proceeded to Cornell, in 1885, as professor of mechanical technology.

DR. EINAR LÖNNBERG has been appointed director of the zoological department of the Museum of Gothenburg.

REUTER reports that two earthquake shocks were felt at Shuraz, Persia, on the night of November 14.

MR. W. J. PALMER, a graduate of the Ontario Agricultural College, has been appointed director of agriculture in the Orange River Colony at a salary of 1200*l.* per annum.

THE sixth International Congress of Applied Chemistry is to be held at Rome in 1906. Prof. E. Paterno, of Rome, has been elected president of the organising committee.

IT is stated by *La Nature* that the body of a Tyrolese guide who fell into a crevasse on the glacier of Grossvenediger, in the Austrian Alps, thirty years ago, has been found in a remarkable state of preservation at the foot of the glacier.

A MONUMENT to the brothers Haüy was unveiled at their birthplace, Saint-Just-en-Chaussée (Oise), on November 8. The elder brother, René Just Haüy, who died in 1822, was the eminent mineralogist. The ceremony was presided over by M. Edmond Perrier.

AT a meeting of the Royal Statistical Society held on Tuesday, the president, Major P. G. Craigie, C.B., delivered his opening address. Before doing so he presented, on behalf of the council and the society, a Guy medal in silver to M. Yves Guyot, for his paper on "The Sugar Industry of the Continent," which was read before the society on May 29, 1902.

THE Craggs research prize, for the best piece of original work done during the current year by present or past students of the London School of Tropical Medicine, has been awarded to Dr. Aldo Castellani for his researches into the etiology of sleeping sickness. Dr. Travers has been awarded honourable mention for his paper "Beri-Beri."

COMMANDER PEARY was, on November 12, in Edinburgh, presented with the Royal Scottish Geographical Society's Livingstone gold medal. Previous awards of the medal were to Sir Harry Johnston for discoveries in Africa, and to Dr. Sven Hedin for exploration in the central region of the Ural-Asian continent.

MR. M. H. MAW, of Walk House, Barrow-on-Humber, states that the radiant point of meteors seen by him in the early hours of Monday seemed to be about ten degrees south of the zenith. Meteors under the Pole Star seemed to move vertically down through 30° in about half a second. Taking the altitude of such a meteor to be eighty miles, the length of the arc described in half a second would be forty-two miles if the motion were at right angles to the line of sight.

A REUTER telegram from Rome reports that experiments made by the Italian naval authorities with a new system of radio-telegraphy originated by Prof. Alessandro Artom have conclusively proved that the new system enables electric waves to be transmitted in a given direction. The Minister of Marine has instructed Lieutenant Pullino, director of the wireless telegraph station of Monte Mario (Rome), to give every assistance in further experiments with the Artom system.

THE *Times* reports that the expedition to Tibet, under Captain Rawling and Lieutenant Hargreaves, of the Somerset Light Infantry, which left Leh in Ladak last May, arrived in Kashmir territory on October 4. Triangulation was extended as far as longitude 85° E., the highest latitude being 35° 45′, and lowest 32° 45′. Many new lakes were discovered, the largest having an area of 70 square miles. One hundred points were fixed by triangulation, and latitudes of all the camps by astronomical observations; 38,000 square miles of country were surveyed.

THE following prizes have been awarded by the council of the Royal Society of Edinburgh:—(1) the Keith prize for 1899–1901 to Dr. Hugh Marshall for his discovery of the persulphates, and for his communications on the properties and reactions of these salts, published in the *Proceedings* of the Society; (2) the Makdougall-Brisbane prize for 1900–1902 to Dr. Arthur T. Masterman for his paper entitled "The Early Development of *Cribrella oculata* (Forbes), with remarks on Echinoderm Development," printed in vol. xl. of the *Transactions* of the Society. The prizes will be presented at the meeting of the Society on December 7.

A CORRESPONDENT of the *Times* reports that on November 12 a balloon belonging to MM. Lebaudy, and called *Le Jaune*, started from Moisson, about 55 kilometres from Paris, at 9.10 a.m., arrived at the Eiffel Tower at 10.50 a.m., and effected its descent on the Champ de Mars. According to M. Juchmès, an aëronaut and one of two passengers, the balloon encountered at first a south-south-west wind travelling at the rate of six metres a second. Almost the whole way he had to keep the point of the balloon somewhat to the right of the direction he intended to take. The maximum altitude attained was 300 metres, but the average was about 100.

ANNOUNCEMENT is made of the proposed publication of a new journal under the title *Archivio di Fisiologia*, edited by Prof. Giulio Fano, director of the physiological laboratory at Florence. The journal will be especially concerned with experimental work, but synthetic reviews and philosophical disquisitions will not be excluded from it. Contributions will be published, according to the wish of the author, in English, Italian, German or French. The *Archivio di Fisiologia* will appear every two months, forming a yearly volume of about 500 pages. The English agents are Messrs. W. Heffer and Sons, Cambridge.

MR. E. KITTO, superintendent of the Falmouth Observatory, sends some particulars of the recent magnetic storm registered at that observatory. Commencing on October 31 at 7 a.m., the disturbance continued until 5 a.m. on November 1. It was severe from 7 a.m. to 7 p.m. on October 31, but the period of exceptional severity was between 1 p.m. and 7 p.m., during which time the declination magnet swung through an arc of 2 degrees 2 minutes, as determined by actual measurements of the declination curve. The Falmouth Observatory magnetic records are continuous from January, 1887, but the magnetic storm of October 31 stands out as the most remarkable record of magnetic disturbance ever made at the observatory.

IT is reported by the *Pioneer Mail* that the Secretary of State for India has definitely sanctioned the scheme for establishing an agricultural college at Pusa, in the Muzaffarpur district. The intention is to combine a large experimental farm and an agricultural college with an institution for research, so as to form a great Imperial institution. The fine Government estate at Pusa will be the headquarters of the staff of various experts, including an agricultural chemist, who will be mainly an analyst and cryptogamic botanist, whose business it is to investigate the diseases which attack the principal indigenous crops, and an entomologist, charged with the study of insect pests. A cattle farm for the improvement of the local breed of cattle will also be included.

A LECTURESHIP has been endowed in the University of Birmingham by an anonymous friend in memory of the late Prof. Huxley. We learn from the *British Medical Journal* that the lecture is to be given annually, either in the winter or spring terms, and to be open to all members of the university without payment. It is to be called the Huxley lecture, and for its endowment a sum of 20*l*. per annum has been given. The lecture will also commemorate the opening of Mason's College, the predecessor of the university, by Prof. Huxley. As the donor has expressed a wish that the first lecture should be given by someone who knew the late Prof. Huxley intimately, and who was associated with his work, it has been decided by the council on the recommendation of the Senate to invite Sir Michael Foster, K.C.B., F.R.S., to deliver the first lecture.

ON the completion of the portrait of the late Prof. P. G. Tait for the Hall of Peterhouse, Cambridge, the treasurer was able to announce a surplus in hand. It was therefore suggested that an attempt should be made to increase this amount until it should suffice for the establishment in the college of a prize associated with Prof. Tait's name, and to be given for excellence in his subject, physics. Mention was made of this project in our issue of October 22 (p. 603); and we now learn that a final report made to the master and fellows of Peterhouse on October 29 showed that the amount of the fund had reached the substantial total of 200*l*. A committee was appointed to draw up regulations for the award of the prize, and record was made of the gratitude of the college to all who have united in establishing this worthy memorial of a renowned *alumnus* of Peterhouse.

MR. R. KAYE GRAY, in his presidential address to the Institution of Electrical Engineers last Thursday, dealt with a number of subjects of importance and interest. He referred at some length to the development of electric traction and power-supply in this country, and laid considerable stress on the difficulties caused by faulty legislation, which had hampered the progress of these branches, and, indeed, to a certain extent, of all electrical engineering in England. All engineers will join in his hope that the Government will speedily carry out the promises made to the deputation headed by Mr. Swinburne last year, and will both introduce and carry through really effective amending measures. Mr. Gray referred to the fact that the Institution had recently purchased a site for building a permanent home for itself, and said that there was no intention of building as yet, partly because it was possible that in the near future the various engineering interests might unite to build "one large temple of engineering," in which all might find a home.

FOR several years past valuable statistics of rainfall and other meteorological phenomena recorded at Zomba, in British Central Africa, have been published by the scientific department of that protectorate; the head of that department is Mr. J. McClounie. We are somewhat surprised to find that, as the head of a public department, he has ventured to depart from the orthodox scientific methods adopted by official meteorologists, and has issued daily rainfall forecasts from June 1903 to May 1904, and estimated monthly amounts for various parts of Nyasaland. He states that "the forecasts have been framed according to the relative positions of the moon and the sun on the dates noted, and the estimates formed according to the various movements of the moon, and proportionate to our knowledge of the average rainfall of each month as regulated by latitude and altitude." Prof. Pernter, in the paper referred to in our issue of last week, has pointed out, as, indeed, Herschel stated many years ago, that the influence of the moon on weather is so small as to be almost inappreciable. We are not prepared, without further inquiry, to endorse Prof. Pernter's opinion that the adherents of the lunar theory carefully note the days on which their forecasts have been successful, but take no heed of the failures; we are, however, not yet prepared to admit that this method of forecasting weather is likely to lead to any useful results.

SOME further particulars with regard to the alleged discovery of the cancer parasite by Dr. Schmidt (see NATURE, November 12, p. 34) are published in the *Lancet*. These are given by Mr. H. J. Johnson in a paper read before the Abernethian Society at St. Bartholomew's Hospital. Dr. Schmidt claims not only to have isolated the parasite, but to have cultivated it, though no details are given. By the use of killed cultures a vaccine is prepared, the injection of which into a patient with cancer is stated to be followed by a reaction and by curative effects. By injecting animals with the cultures, their serum acquires antidotal properties, and may also be used for treatment. At present there is no supply either of the vaccine or serum available for treatment.

IN a recent number of NATURE (vol. lxviii. p. 8) a brief summary was given of the position of the present epoch in relation to Brückner's long weather cycle of 35 years, and it was there shown that as regards the total rainfall of the British Isles we have now passed a minimum or "droughty period," and are commencing a wet cycle, which will reach

a maximum about the year 1913. Mr. Douglas Archibald, in a letter to the *Times* for November 16, gives some figures which represent the variation of the rainfall over the London area from the year 1813, using Greenwich and Mr. Dines's observations. Arranging these 90 years in groups as suggested previously by Brückner, he gives an interesting table showing not only the excess or defect of rain, but also the excess or defect of atmospheric pressure and the variations of the price of wheat since 1856.

Group of years assigned by Brückner	Character of the Period	Total excess or defect of rainfall in the period	Total excess or defect of barometric pressure, Greenwich	Mean annual fluctuations of yield of wheat from the true average over the United Kingdom
		Inches	Inches	Bushels
1806–25	Wet	+15·54 [1]	−0·065 [1]	
1826–40	Dry	− 6·17	+0·165	
1841–55	Wet	+ 4 35	−0·045	
1856–70	Dry	−11 85	+0·150	+1·7
1871–85	Wet	+19·65	−0·120	−2·0
1886–1902	Dry	−29·75	+0·272	+2·2
1903–1920(?)	Wet	—	—	—

[1] 1813 to 1825 for both.

Mr. Archibald concludes his letter by saying that "we are apparently entering upon a period of more than average rainfall, less than average barometric pressure, and about two bushels less than the average wheat yield per acre."

MESSRS. W. J. MCNEAL AND F. G. NOVY report that they have succeeded in cultivating the trypanosome parasite of the rat, *T. Lewisi*, in a mixture of sterile defibrinated rabbit's blood and ordinary nutrient agar. Ordinary nutrient agar is prepared, sterilised, and allowed to cool to 50° C. One-third of its volume of defibrinated rabbit's blood, obtained with aseptic precautions, is then added, and the test-tubes containing the mixture are allowed to solidify in the oblique position. Loopfuls of rat's blood containing the parasite are then sown into the condensation water at the bottom of the tubes. In this the trypanosomes readily develop at 34–37° C. During a year eleven passages were made from tube to tube, and a small quantity of the culture from the tenth tube readily infected a rat inoculated with it (ref. in *Bull. de l'Inst. Pasteur*, i., No. 16, p. 602).

THE current number of the *Journal of the Sanitary Institute* (October) is mainly devoted to the papers read at the congress at Bradford and the discussions thereon. Several papers deal with the question of sewage disposal and with the bacterial systems of sewage disposal, the standardising of sewage being the subject of a joint discussion in the engineering and biological sections. The "Standardisation of Disinfectants" is the title of a paper by Messrs. Rideal and Ainslie Walker, and it is proposed to test all disinfectants under the same conditions of time, &c., and to compare the results with those obtained with carbolic acid solution. Thus if a 1 in 70 solution of disinfectant X possessed the same disinfecting action as a 1 in 80 solution of carbolic acid, the efficiency of disinfectant X compared with carbolic acid would be 70/80=0·87. This is termed the carbolic acid coefficient.

A REPORT has been issued by Prof. K. R. Koch dealing with the gravitational measurements conducted under the auspices of the Württemberg Geodetical Commission at ten stations on the line from Ulm to Freudenstadt. In these experiments a new pendulum made of Delta metal has been used with satisfactory results.

IN a short paper reprinted from the *Rivista di Fisica* (Pavia), Ingegnere G. Zanotti Bianco deals with the history of determinations of the earth's mean density, with especial reference to the investigations of several Italian writers whose work has received but little attention, at any rate in this country. Among them are C. I. Giulio, Menabrea, and Saigey.

MR. A. CANCANI has published a paper reprinted from the *Atti dell' Accademia Gioenia* (Catania) dealing with the relation between the temperatures of springs and those of the air. A noteworthy feature of this paper is the bibliography of the subject. The principal previous bibliography was published by the Weather Bureau at Washington in 1899, and as only a limited number of copies were lithographed, it is probable that the present enlarged list will be of much use for purposes of reference.

THE problem of correlation in hyperspaces forms the subject of an important paper by Mr. Giovanni Zeno Giambelli in the *Memorie* of the Lombardy Institution of Sciences and Letters. The author refers to the work of Hirst, Sturm, Visalli and others on correlation in plane and ordinary spaces. In regard to correlation in hyperspaces, the fundamental formulæ were published without proof by Schubert in 1890, and again in 1894–5. Mr. Giambelli now gives proofs of Schubert's formulæ, and obtains others of a more general character. The results are obtained by the method of "degeneration" introduced by Schubert in dealing with ordinary space and with quadrics in hyperspaces.

PAPERS by Messrs. Epsteen and Shaw in the last two numbers of the *Transactions* of the American Mathematical Society deal with the interesting subject of linear algebras, and bear witness to the value and originality of Peirce's researches. Another noticeable paper, in the July number, is that of Van Vleck on continued functions, on the lines of Stieltjes's memoir of 1894. The October number of the *Annals of Mathematics* contains the first part of a paper by Prof. Greenhill on the mathematical theory of the top, and a contribution by Mr. E. B. Wilson which deals with a generalised definition of area which does not involve the conception of length.

THE September issue of *Annotationes Zoologicae Japonenses* deals solely with Japanese invertebrates. Mr. E. Klocke records the occurrence of the crustacean genus Bosminopsis in Japan, Mr. A. Izuka describes a new polygordian worm, while Mr. E. Ikeda treats of the development of the sexual organs in the phoronis larva.

IN the *Morphologisches Jahrbuch* (vol. xxxi., part iv.), Dr. H. Fleischmann's essay on the morphology of the head-skeleton of the Amniota is continued, Dr. A. Beecker contributing a section on the nasal region in reptiles, birds, and mammals. Mr. G. Tornier describes numerous instances of the development of supernumerary digits in the fore-feet of members of the deer-tribe, due, in most cases at any rate, to injury during fœtal life. None of these appear to be atavistic.

A REPRINT from the *Cape Times* of the report of the recent annual meeting of the Game and Trout Protection Association of the western districts of South Africa affords very satisfactory reading. The laws for the protection of big game are apparently working well, certain attempts to curtail the close season having been vetoed by the Government. In some districts it has been found advisable to have a special close season for certain kinds of game, and to include therein a few species of birds which do not properly come under that category. A large tract of country in the

Bushmanland division of Namaqualand has been created a game reserve, in which it is unlawful to kill, hunt, or trap any description of game animal. Despite the Boer war, certain species of antelope, which have long been on the verge of extermination, still survive. Blesbok, for instance, are stated to be represented by about 650 head in the Steynsburg division, and bontebok by some 250 in Bredasdorp and 25 in Swellendam. Reedbuck include about 200 head in Komgha, where they are specially protected, and 50 in Kimberley. Nothing is, however, said with regard to the white-tailed gnu, which has been reported extinct, the "wildbeest" referred to being apparently the brindled gnu. Of zebra about 340 individuals survive, mostly in Cradock, George, Oudtshoorn, and Uniondale.

We have on our table two parts (vol. lxxv., i. and ii.) of the *Zeitschrift für wissenschaftliche Zoologie*, from among the contents of which a few articles are selected for brief mention. In the first part the light-organs of the glow-worm receive attention at the hands of Mr. J. Bongardt, while Mr. Haack treats of the glands in the mouth of the lampreys. In the second part Dr. E. Rohde continues the account of his important investigations into the structure of the organic cell, discussing, in this instance, the structure and mode of division of the wandering bodies known as "sphæres" and "centrosomes" which are found moving free in many cells and their nuclei. The gill-filters of fresh-water fishes form the subject of an article by Dr. E. Zander. It is shown that while carnivorous types like the pike have the inner sides of the gill-arches, the bones of the branchio-palatal apparatus, and the pharyngeals studded with minute villiform teeth, in forms like the perch, carps, and herrings there is a strongly developed sieve-like appendage ("Siebfortsätze") on both branches of the gill-arches. The fineness of this filtering arrangement is correlated with the habitat and food of the groups in which it occurs, attaining its extreme development in this respect in those subsisting on "plankton."

To the *Proceedings* of the American Academy of Arts and Sciences a list of new flowering plants obtained from Mexico and Central America is contributed by Miss J. Greenman. Most of the species belong to the Sympetalæ, so that they do not overlap with those recorded by Dr. J. N. Rose, which would be mainly included in the Archichlamydeæ.

A comparison of the characters of the European and Australian Alpine floras is made by Mr. Weinsdorfer in the *Victorian Naturalist*. Flowers in the Australian Alps display less brilliancy of colour and are not so strongly scented, both of which facts may be correlated with the paucity of insects, but a longer vegetative period and a lower summer mean temperature must also tend to diminish the marked characters which are developed at high altitudes.

The report of the Meteorological Service of Canada for the year ending December 31, 1901, by Mr. R. F. Stupart, the director of the department, has been received from Ottawa. The volume runs to 370 foolscap pages of meteorological statistics.

Messrs. Crosby Lockwood and Son have published a second edition of Mr. Tyson Sewell's "Elements of Electrical Engineering," which was reviewed in our issue for November 20, 1902. The second edition has been revised, and three chapters dealing with alternating currents have been added.

A copy of the seventh volume of the *Transactions* of the Rochdale Literary and Scientific Society has been received. It contains an account of the proceedings of the Society for the years 1900–1903, as well as a number of the papers read before the association during these sessions. The Society is to be congratulated upon its flourishing condition, both as regards its activity and finances. The *Transactions* are published by Mr. James Clegg, of Rochdale, at 2*s*. 6*d*.

In the review of Prof. Henrici's "Vectors and Rotors" in Nature of October 29 (p. 617), it was mentioned that Prof. A. Lodge had suggested the use of the word "locor" to indicate a vector which has definite position, but does not indicate rotation or any rotative function. Prof. R. H. Smith writes to say that the word "locor" is used in this way throughout his book "Graphics," published by Messrs. Longmans in 1888, "rotor" being used for rotative quantities.

Parts 9 and 10 of the first volume of the *Bulletin* of the Department of Agriculture in Jamaica are devoted to the consideration of the best means of improving the breed of horses in the island

We have just received the report for 1902–3 of the work done in the Government Laboratory at Trinidad under the direction of Prof. Carmody. The results of a large number of seedling cane experiments, showing the relative sucrose value of different canes, form a special feature of the report.

A remarkably graphic map of the British Empire, devised by Mr. Stephen Smith, is published in the October number of the *Geographical Teacher*. This map shows the British lands each in proportion to its area, and in such a position that the direction and distance from London are approximately correct. Somewhat similar results are obtained by drawing a hemisphere on an equal area projection with London in the centre, if Australasia is tacked on. Other ways of securing equivalence of area are the Mollweide and the Sanson-Flamsteed projections, where the world is shown within an oval framework. Such an oval map of the British Empire has lately been published by Messrs. Darbishire and Stanford, Ltd., Oxford.

The question of space interference, a phenomenon first observed by V. Meyer in the case of ortho-substituted aromatic acids which can only be esterified with great difficulty, and in some cases not at all, is discussed by Prof. Skraup in connection with the cinchonine alkaloids. This interesting paper, which indicates that the alkaloids cinchonine, α-*i*-cinchonine, β-*i*-cinchonine, and allocinchonine have probably no fundamentally different chemical structure, but the reactions of which differ in certain respects by reason of space interference, appears in vol. xlii. of the *Sitzungsberichte* der Wiener Akademie.

In the current number of the *Zeitschrift für physikalische Chemie*, Prof. van 't Hoff gives an account of the investigations which have been going on for some years in his laboratory relative to the transformations of gypsum. It is shown that gypsum $CaSO_4.2H_2O$ changes at 107° C. into the so-called half-hydrate $2CaSO_4.H_2O$. At this temperature, however, these two bodies are only meta-stable, for at 93° gypsum changes into the soluble form of anhydrite $CaSO_4$, which itself is in reality not stable, for under favourable conditions gypsum actually breaks up at 63°·5, and forms insoluble anhydrite found in nature and identical with dead-burnt gypsum. The laboratory investigation of these changes is rendered extremely difficult by the occurrence of retardation phenomena analogous to supercooling and supersaturation.

A RECENT number of the *Electro-Chemist and Metallurgist* contains an able article by Mr. W. C. D. Whetham on the present position of the theory of electrolysis. The investigations which led up to the theory of electrolytic dissociation and the modern convective views of electrolysis are traced, and it is clearly shown that a vast number of important observations are easily explained by the modern views. As the author points out, experiments on the comparison of the electrical and the osmotic values of ionisation are of little use from the point of view of the controversialist seeking arguments for or against the ionic dissociation theory. The deviations between the two values are, however, in most cases easily explainable by a consideration of the interionic forces, which probably exert an effect even at dilutions at which the intermolecular forces are negligible, and, further, of the complex ions which are so often formed in solution.

THE additions to the Zoological Society's Gardens during the past week include a Red-fronted Gazelle (*Gazella rufifrons*) from Senegal, presented by Lieut. F. P. Crozier; two Common Mynahs (*Acridotheres tristis*) from India, presented by Mr. H. Munt; a Hawk-billed Turtle (*Chelone imbricata*) from tropical seas, a Testaceous Snake (*Zamenis flagelliformis*) from South United States, deposited.

OUR ASTRONOMICAL COLUMN.

BRIGHT METEORS.—An exceedingly bright meteor was observed by Mr. W. Moss at South Kensington at about 11.15 p.m. on Saturday. Although not looking in the direction of its path, Mr. Moss's attention was directed to the meteor by its remarkable brightness, which he estimated as exceeding that of Jupiter. The part of the path that he observed was about 5° long, and commenced at a point near to the equator, and about 8° E. of δ Orionis. The same object was independently observed by Mr. Mills, who describes it as the brightest he has yet seen, and states that it first appeared about 5° due east of γ Orionis, and, travelling in a south-easterly direction, appeared to burst when approximately 8° or 10° to the N.E. of Rigel.

Several meteors, six of which were probably Leonids, were observed by Mr. W. E. Rolston at South Kensington during an intermittent watch which lasted from 10 p.m. on Saturday until 4.30 a.m. on Sunday. The brightest of the six was one which appeared at about 3.15 on Sunday morning in R.A. 7h. 10m. Dec. +6°, and disappeared at R.A. 6h. 30m., Dec. +5°, leaving behind it a green broken trail which lasted for about two seconds. The same observer also saw more than 50 Leonids during a watch from 2.15 to 3.45 on Monday morning. These meteors presented the characteristics of the November shower inasmuch as they were exceedingly swift and left broken trails of a reddish hue.

Mr. A. M. Davies, writing from Amersham, Bucks, states that about 10.45 p.m. on November 14 he saw a brilliant meteor with a train move westwards in an almost horizontal path at about the altitude of η Ursæ Majoris.

SEARCH-EPHEMERIS FOR FAYE'S COMET.—Herr E. Strömgren publishes a further portion of his ephemeris for Faye's comet in No. 3913 of the *Astronomische Nachrichten*. This ephemeris takes the time of perihelion passage as June 3·64, and is given below:—

Ephemeris 12h. (M.T. Berlin).

1903	α	δ	log *r*	log Δ
	h. m. s.	° ′		
Nov. 15	9 42 59	+1 45·0	0·3565	0·3288
,, 19	9 46 23	+1 11·5		
,, 23	9 49 25	+0 39·5	0·3655	0·3180
,, 27	9 52 3	+0 9·3		
Dec. 1	9 54 16	−0 19·0	0·3743	0·3067
,, 5	9 56 5	−0 45·1		
,, 9	9 57 29	−1 8·8	0·3830	0·2952
,, 13	9 58 26	−1 30·1		
,, 17	9 58 57	−1 48·7	0·3916	0·2840
,, 21	9 59 1	−2 4·3		
,, 25	9 58 38	−2 16·9	0·4000	0·2736

THE SECULAR VARIATION OF STARLIGHT.—In a research on the secular variation of starlight, that is, the minute yet regular variations in magnitudes which take centuries to become evident, Mr. J. E. Gore has compared the present magnitudes of a number of stars with their respective magnitudes as recorded by Al-Sufi and Ptolemy. Recognising the important bearing of these variations on the theory of stellar evolution, he selected a number of stars having spectra of the first and second types for the comparison, and has published the details of his research in the November number of the *Observatory*, giving in each case the type of spectrum, the recently estimated magnitude, and the magnitude as recorded by Al-Sufi and Ptolemy, together with remarks on the validity of the latter. Mr. Gore has prepared two lists, one of which contains the data concerning 26 stars which are apparently decreasing in magnitude; the other deals with 20 stars which show an apparent increase. He points out in his remarks that in many cases the stars which are decreasing in magnitude have spectra of Pickering's "A" type, which, according to Sir Norman Lockyer's classification, would place them amongst those which are decreasing in temperature, and therefore, presumably, in magnitude; a well-known example of this agreement occurs in the case of β Leonis, which, according to Sir Norman Lockyer, must be placed on the *descending* side of his temperature curve, and, according to Mr. Gore's result, has decreased in magnitude from 1·0 in Al-Sufi's time to 2·2 at the present day.

SOLAR OBSERVATIONS AT LYONS OBSERVATORY DURING 1902.—In his annual report for 1902, M. J. Guillaume, director of the Lyons Observatory, states that the solar surface was observed on 236 days during the year, and was reported as being free from spots on 161 days. Thirty-three groups of spots were observed, their mean latitude being 21°·0, an increase of 5°·3 over last year's value. According to the Lyons observations the last sun-spot minimum took place at the end of 1901.

The observations of faculæ show an increase in the number of groups, and the area covered by them, over the two preceding years; they also indicate that the mean latitudes of spots and faculæ do not show a parallel variation, and from this, and the differences exhibited in their persistence and activity, M. Guillaume arrives at the conclusion that it is really the faculæ which indicate the regions of principal activity, the spots being only of secondary importance in this matter. This conclusion is supported by the various tables which accompany the report in the November issue of the *Bulletin* de la Société de France.

METEOROLOGICAL OBSERVATIONS WITH KITES AT SEA.

THE following extracts from a communication to our contemporary *Science* by Mr. A. L. Rotch indicate the rapid progress which is being made in the exploration of the upper air by means of kites from ships, and a scheme for further investigation.

The first to repeat the pioneer experiments of the late Mr. Sweetland and the writer during their voyage across the North Atlantic in 1901 were Messrs. Berson and Elias, of the Prussian Meteorological Institute, who, last August, made a voyage from Germany to Spitzbergen and back, achieving satisfactory results with their kites. Meanwhile Prof. Köppen, of the Deutsche Seewarte, carried out analogous experiments on the Baltic Sea. About the same time, Mr. Dines, aided by grants from the Royal Meteorological Society and the British Association, employed a small steamer for kite-flying off the west coast of Scotland, in connection with a fixed station on land.

Meteorological kites have recently been flown from steamboats on Lake Constance by Count von Zeppelin and Prof. Hergesell on some of the term-days of the international balloon ascensions. Similar experiments upon the smaller lakes of Prussia and Russia have also shown that kites may be rendered nearly independent of the wind even in the interior of the continents.

A most remarkable campaign has been conducted by M. Teisserenc de Bort, who, with the aid of Scandinavian colleagues, established last summer a kite-flying station in Jutland, Denmark, where aërial soundings were made day and night, wind permitting, during nine months. After the termination of this work the apparatus was transferred to a Danish gunboat, and on a cruise in the Baltic Sea the following extraordinary results were obtained on five consecutive days:—April 22, at an altitude of 9450 feet a temperature of +14°·8 F. was found; April 23, at 13,500 feet, the temperature was 9°·1; April 24, at 4660 feet, 38°·3. On April 25 an altitude of 19,360 feet, which is probably the greatest height ever reached by a kite, was exceeded, and an instrument on the lower portion of the wire, at a height of 7415 feet, recorded 24°·4. In this flight the total length of the wire was 38,000 feet, and the upper 4000 feet, with the highest registering instrument, broke away, but were recovered. On the morning of April 26 an altitude of 8140 feet, with a temperature of 15°·2, was obtained, and in the afternoon 13,320 feet, with a temperature of 3°·2. Since the gunboat steamed only nine and a half knots, the kites could not be flown when there was a complete absence of wind.

These various experiments amply prove the practicability of the writer's project to investigate the atmospheric strata lying above the doldrums and trade-winds, by means of kites flown from a specially chartered steamship. This plan received the approval of the International Aëronautical Congress at Berlin last year, and an application for a grant to aid its execution is now before the trustees of the Carnegie Institution. On the vessel which the Baltimore Geographical Society sent last month to the Bahamas, Dr. Fassig, of the Weather Bureau, expected to fly kites, but, owing to the substitution of a schooner for a steamer, this could not well be done, and therefore the kites were probably flown only at Nassau. These observations might serve as a starting-point for the work of the expedition proposed by the writer, which would proceed across the equator and be capable of sounding the atmosphere to the height of four miles, notwithstanding the fact that winds either too light or too strong for the kites may be encountered when the steamer is stationary.

THE COUNTY TECHNICAL LABORATORIES, CHELMSFORD.

ESSEX is one of the counties which, since the passing of the Local Taxation (Customs and Excise) Act of 1890, has devoted the whole of the funds thus provided to the purposes of higher education. At first almost the entire grant was distributed among some forty local technical instruction committees for the purpose of lectures and classes in the areas under their supervision, but by degrees the greater part has been diverted to the erection, equipment, or support of secondary and technical schools in the more important centres.

In 1892, when Sir Henry Roscoe and Prof. Meldola were members of the Essex Technical Instruction Committee, the site of an old grammar school in the centre of Chelmsford—the county town—was purchased, and part of the old school buildings were fitted up at a cost of about 300*l.* as the county laboratories for teaching biology and chemistry, the two sciences which are of greatest importance to the principal industries of the county, viz. agriculture, horticulture, dairying and fisheries. In the temporary accommodation thus provided most of the work of the past ten years has been carried on, and readers of NATURE have from time to time had an opportunity of judging its character.

From the commencement until he was appointed agricultural biologist to the Irish Board of Agriculture in the spring of 1902, the committee had the advantage of the services of Mr. David Houston as staff-teacher of biology. Mr. Houston's influence was directed towards basing the teaching of science on practical laboratory work. It thus comes about that the institution has always been known as, and still remains, the Laboratories for Technical Instruction of the County of Essex. Moreover, the subcommittee, which now has the supervision of the laboratories, a committee which, with the single exception of the chairman, entirely consists of Essex farmers, adopted plans for the new buildings, opened by the President of the Board of Agriculture on October 30, which mainly consist of laboratories and work-rooms, and include only one lecture-room in the whole institution.

The part of the old site on which the new buildings are placed is within a stone's throw of the market-place and corn exchange, and the intention is to provide, not merely a technical school for the younger men, but also a centre at which farmers and others can readily obtain scientific and practical information respecting farming and the allied industries. Thus the principal room, near the entrance on the ground floor, is the large agricultural room, provided with demonstration and work tables for the agricultural instruction of students, and also containing an agricultural museum and reference library, together with diagram frames for displaying the most recent results of agricultural experiments. The room will be kept supplied with the agricultural papers, and will serve for the meetings of farmers which are held from time to time on market days to discuss agricultural problems.

On the same floor are the rooms for the head of the chemical and agricultural department, the work-room of the assistant who has the management of the field experiments, a small physical room with dark room for optical and photographic work, the common rooms for men and women students, and one of the biological laboratories.

On the first floor is a chemical laboratory capable of accommodating twenty students at a time; each working bench is provided with drawers and lockers for four sets of students, so that eighty students can be taught in a term. All the students' benches face the demonstration table, and thus the teaching can be carried on by revision, demonstration or experimental work without the students leaving their benches. Adjoining are the balance room and store room, the latter in direct communication with the chemical lecture room, and a private laboratory for the analysis of soils, manures, feeding-stuffs, milk, &c., for farmers, a department of the work which is found to be a most potent means for spreading information.

On the same floor are some of the rooms of the biological department, but shut off from the chemical department and reached by a separate staircase. Thus horticultural students, for whom the biological staff is responsible, are kept separate from the agricultural students, for whom the chemical staff is responsible. The common room for all the male students stands between the two departments. This system of separate staircases has the additional advantage of saving room, for a striking feature of the general plan is that there is only one corridor in the whole building. The biological department includes two large laboratories, each provided with a preparation or private work-room, a lecturer's private room, a store room, and museum galleries. The two laboratories each accommodate twenty students, and, as in the chemical laboratory, the working tables all face the demonstration table and black board.

A cool, lofty and well-lighted basement serves admirably for the dairy. The accommodation includes a milk receiving room, which it is proposed to equip with separator, pasteuriser, and steam apparatus for cleaning milk churns, &c., the dairy proper, with butter churns for twelve students, a cheese-making room, a cheese-ripening room and store. A top floor of six rooms is at present used as a part of the County Education Offices, but these are to be diverted to teaching purposes at the end of two years, when it is expected that the teaching or experimental work of the laboratories will demand increased space. The whole building is lit with electricity. The electric current is also used for motive power where required, and adapted to electrolytic purposes in the chemical and physical laboratories.

Within three-quarters of a mile of the laboratories is the school garden, which has already been planted about five years. It is three acres in extent, and is provided with a students' potting shed and glass houses, and consists partly of botanical plots and partly of fruit, vegetable and flower borders for the practical instruction of gardening students in each branch of horticulture. There is no farm in connection with the laboratories; the agricultural students make excursions to well-managed farms in the neighbour-

hood, and the field experiments are carried out on farms in all parts of the county, this system having the double advantage that manurial trials can be made on every class of land, and that farmers in each district are able to see for themselves the results.

THE NEWCOMEN ENGINE.[1]

A GREAT deal has been written on the steam-engine generally, but the author has not met with any connected record of the invention and construction of the first steam-engine—the atmospheric engine of Newcomen. Unfortunately it does not appear that very detailed information is available, but the author has been able to bring together some facts which, with the aid of appendices contributed by others and some illustrations of the engine itself, may be found to be a useful contribution to place on record in the *Proceedings* of the Institution. There are not many examples of the engine now in existence, and when they are consigned to the scrap heap, the receptacle of great efforts of the past, all will perhaps be forgotten.

Towards the end of the seventeenth century, philosophers and mathematicians searched for a new method of obtaining motive power. Mining was an important industry requiring in most cases a new power, that the mines might be worked to greater depths. Water-power, where available, was often insufficient, and manual and animal power was altogether too small and too expensive for working any but shallow mines. Deep mining was, and is, only possible with pumping machinery. Water-wheels were used for working pumps. The construction of the common pump was known. Papin had proposed to transmit power by means of pistons moving in cylinders acted on by the atmosphere, a vacuum having been formed under the pistons by the explosion of gunpowder, and he even hinted that it might be done by steam.

It was claimed for Papin that he invented the steam-engine, because in 1685, in one of his letters, he illustrated what was known of the properties of steam by saying that if water was put in the bottom of a cylinder under a piston, and the cylinder be put on a fire, the water would evaporate and raise the piston, and that if, after the piston had been raised, the cylinder were removed from the fire and cooled, the steam would condense and the piston would descend; but this was only an illustration of common knowledge. Sir Samuel Morland had, in 1683, stated[2] that steam occupied about two thousand times the space of the water from which it was produced, and made some calculations as to the powers to be obtained from different sized cylinders, but suggested no practical mode of operation. An experiment to determine the density of steam was made by John Payne in 1741. Payne concluded, as the result of his experiments, published in the *Phil. Trans.*, vol. xli. p. 821, that one cubic inch of water formed 4000 cubic inches of steam. Beighton calculated, from an experiment with the Griff engine, the second Newcomen engine erected, that the specific volume of steam was 2893.

The properties of steam were, probably, no better known to philosophers than to the ordinary observer who had seen the lid of a kettle dance under pressure, or steam issue from the spout. The only practical application of steam was made by Savery, who, in 1696, described his invention in a pamphlet entitled "The Miner's Friend." Savery's engine was a pistonless steam pump—in fact, the pulsometer of to-day without its automatic action. It remained for Newcomen to associate the bits of common knowledge in his mind for inventing the steam-engine. He was a blacksmith, probably accustomed to invent methods of construction in the prosecution of his art. At that time mechanics were more self-reliant than they are now. He knew from experience what a lever was, a pump, a piston, a cylinder, a boiler, and he knew that the atmosphere had pressure, and that steam possessed a far greater volume than the water which produced it. It did not require much more than common knowledge and observation to realise that. To produce the steam-engine from such known facts required invention. Philosophers probably knew what might be done, but Newcomen had the advantage of seeing what could be done, and he did it. The engine, when produced, was imperfect, but defects became obvious to the designers and constructor of steam-engines, and the want of perfection at the present day is not from want of theory, but because of practical limitations and want of practical invention.

At this distance of time it is difficult to appreciate the invention required to produce the atmospheric engine from the crude ideas of Papin and others. It appears, from papers in possession of the Royal Society, that Dr. Hooke had demonstrated the impracticability of Papin's scheme, and, in a letter addressed to Newcomen, advised him not to attempt to make a machine on that principle, adding, however, that if Papin could produce a speedy vacuum, his work would be done.[1] A great deal of controversy hangs about this as about all things historical, and little is to be gained by minute research into disputed claims. What we do with certainty know is that with the common knowledge existing, and the mechanical contrivances available, Newcomen alone succeeded in making a workable engine.

In 1698, Thomas Savery, of London, obtained a patent for raising water by the elasticity of steam.[2] It is stated in many popular histories that in 1705 Thomas Newcomen, John Cawley, of Dartmouth, and Thomas Savery, of London, secured a patent for "condensing the steam introduced under a piston and producing a reciprocating motion by attaching it to a lever," but no record of such a patent exists in the Patent Office. Stuart gives a list of patents commencing with 1698, and in that list is one said to have been granted in 1705. Dr. Pole, author of "The Cornish Engine," had a search made at the Patent Office and no such record could be found. It is possible that Savery's patent was thought to cover Newcomen's invention (as Savery was associated with Newcomen).[3] This was sixty-four years before Watt invented his separate condenser. Very little is known of Newcomen. It is recorded that he was a blacksmith or ironmonger residing at Dartmouth, in Devonshire, and that he was employed by Savery to do some work in connection with his water-raising engines. In this way he had some experience in the condensation of steam.[4]

Newcomen appears to have conceived the idea of using a piston for giving motion to pumps. He became associated with John Cawley, a glazier of Dartmouth, probably for business reasons. His connection with Savery was doubtless because of Savery's patent for condensing steam for raising water. He must, however, have been a good mechanic, because the construction of such an engine at a time when there was no previous experience or data to guide him was a task of no ordinary magnitude. He could not get workmen skilful enough to do his work until, erecting an engine near Dudley in 1712, he secured the assistance of mechanics from Birmingham.

The Newcomen engine was soon brought into use, for in 1712 Newcomen, through the acquaintance of Mr. Potter, of Bromsgrove, erected an engine, near Dudley Castle, for a Mr. Back, of Wolverhampton. The cylinder of this engine was surrounded with water. The piston was packed and had a water seal. It is reported that by accident a hole in the piston admitted water into the cylinder, and the condensation thereby became so rapid compared with that produced by cooling the cylinder from the outside that the engine worked much quicker. This may or may not be correct, but it is certain that, by accident or design, the first improvement in the engine was condensation by injection in the cylinder. It appears that the second engine was erected at the Griff Colliery, in Warwickshire, in 1715. It had a 22-inch cylinder. At this time the cocks and

[1] Abstract of a paper read before the Institution of Mechanical Engineers on October 16 by Mr. Henry Davey.

[2] See Tredgold's "Steam Engine."

[1] See Stuart's "History of the Steam Engine."

[2] Savery was born at Shilston, near Modbury, in Devonshire, in 1650; died in London 1715.

[3] It appears that there is every reason to believe that Newcomen had no patent, and that his invention was supposed to be covered by Savery's patent of 1698, and that the latter was kept in force for thirty-five years, the original patent having been extended for twenty-one years.

[4] Newcomen was born at Dartmouth about the middle of the seventeenth century, and died in London in 1729. It is stated in Haydn's "Dictionary of Dates" that at the time of his death he was in London trying to secure a patent. A sketch of the house in Dartmouth occupied by Newcomen when he invented the steam-engine is shown in a pamphlet published in 1869 for Mr. Thomas Lidstone of Dartmouth.

valves were all worked by hand, but automatic devices were soon introduced. The first appears to be that of actuating the injection-cock by means of a buoy in a pipe connected to the cylinder. Desaguliers thus describes the apparatus:—"They used to work with a buoy in the cylinder enclosed in a pipe, which buoy rose when the steam was strong and opened the injection and made the stroke." It is said that a boy, Humphrey Potter,[1] added a catch or "scoggan" which the beam opened, and by this means the speed of the engine was increased from 8 or 10 to 15 strokes per minute.

Barney's illustration of the Dudley Castle engine (erected in 1712) was made in 1719, and contains the plug-frame and tumbling-weight device attributed to the invention of Beighton in 1718. It is possible that the tumbling-weight had just been added for actuating the steam-valve. The injection-valve is released by the buoy said by Desaguliers to have been enclosed in a pipe attached to the cylinder, but here shown in a pipe attached to the boiler. The scoggan is also shown, and it is clear that the only thing that Humphrey Potter added, if he added anything, was a cord to cause the plug-frame to actuate the scoggan instead of the float doing it.

Newcomen had associated with him Cawley, a plumber and glazier, and it will be observed that the pipes of the engines were at first made of lead with plumber's joints. In the early days the steam cylinders only were obtained from iron-founders, and the other parts of the engine were built by local blacksmiths, carpenters, and plumbers, under the direction of an engineer.

The engine was first fixed on a boiler of haystack form, but the vibration of the engine so loosened the joints that it was found advisable to secure the cylinder to strong wooden beams above the boiler. At a later date the engine was fixed on a separate foundation by the side of the boiler, and as time went on iron pipes were substituted for lead, and the waggon-boiler was introduced to take the place of the haystack.[2]

Among the first erectors of the Newcomen engine were the Hornblowers, in Cornwall. Newcomen visited Mr. Potter, of Bromsgrove, and erected an engine near Dudley Castle in 1712. This is the historical engine in which injection in the cylinder was first used. In the vicinity lived Joseph Hornblower, an engineer who became acquainted with Newcomen's engine, and who was sent for into Cornwall about 1720 to 1725 to erect an atmospheric engine at Wheal Rose Mine, near Truro.

It may be interesting here to observe, on the authority of Cyrus Redding, a greatgrandson of Joseph Hornblower, and author of "Yesterday and To-day," &c., that the Newcomen engine was not such a simple machine as only to require the attention of boys as stated in popular histories, but that it required the united exertion of three men to start the engine.

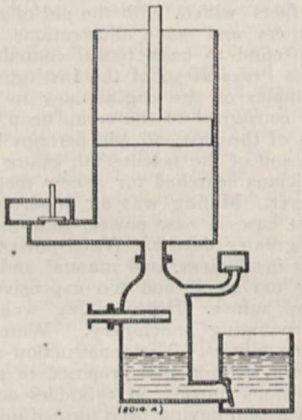
A second engine, it appears, was erected by Hornblower at Wheal Bury or Chasewater Mine. A third at Polgooth. Joseph Hornblower then left the county, and his son Jonathan came down and erected his first engine at Wheal Virgin, about 1743. The fourth son of Joseph was Jonathan Carter, the inventor of the compound engine and the double-beat steam-valves, who died at Penrhyn in 1815.

From 1720 to 1740 few engines were erected in Cornwall because of the high duty on sea-borne coal. In 1741 an Act of Parliament was passed for the remission of the duty on coal used for fire-engines for draining tin and copper mines in the county of Cornwall.[3] The effect of the passing of this Act was that by the year 1758 many engines had been brought into use; one engine at Herland had a 70-inch cylinder.

Rotative Atmospheric Engines.—It appears that attempts were made as early as 1768 to produce a rotative motion from a Newcomen engine, but it was not until about 1780 that it was successfully accomplished by the use of the crank.

It does not appear that any attempt was made, before Watt's separate condenser was invented, to reduce the cooling effect of the injection-water on the cylinder by effecting the condensation in a small vessel attached to the cylinder. It is, however, evident that after Watt's patent, Newcomen engines were made with separate condensers without air-pumps, the air being discharged through a snifting-valve. Such condensers were known as "pickle-pots."

FIG. 1.



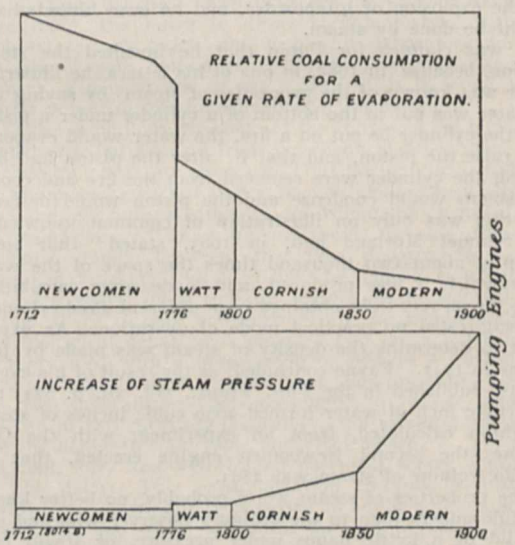


FIG. 2.

Diagrams illustrating the progress in economy of fuel and the increase of steam pressure.

In Fig. 1 will be found a sketch of the "pickle-pot" condenser. Such condensers were operated without air-pumps, as already described. It is more than probable that such condensers were not known until after Watt's invention of the separate condenser, and that they were applied to improve the economy of the Newcomen engine and to evade Watt's patent.

In Fig. 2 will also be found a diagram constructed by the author to indicate the economy of fuel resulting from various improvements commencing with the earliest engines of Newcomen. A diagram below also indicates

[1] It is curious to observe that the first engine was erected for Mr. Back through the influence of a Mr Potter. Mr. Norris writes that John and Abraham Potter were engineers in Durham, and erected an engine for Mr. Andrew Wauchope in Midloth an in or abou 1725. See also Bald's "View of the Coal Trade of Scotland," pp. 18, &c., for a full account of this engine. He prints the contract in full, giving many interesting details.

[2] A drawing of almost the first Watt engine for the Birmingham Canal was illustrated in the *Engineer*, July 15, 1898. This is now erected in the yard at Ocker Hill, near Wednesbury.

[3] The Act referred to is the 14th Geo. II., Cap. xli., and intituled:—An Act for granting to His Majesty the sum of one million out of the sinking fund, and for applying other sums therein mentioned for the service of the year 1741: *and for allowing a Draw-back of the Duties upon Coals used in Fire Engines for drawing Tin and Copper mines in the County of Cornwall, &c* . . .

the rise in steam pressure corresponding to the increased economy.

The steam-engine has held its own as a prime mover for two centuries. The gas-engine has now become a more efficient heat engine, and a powerful competitor, and electricity has become an economical transmitter of power.

Heat, electricity, and mechanical work are mutually convertible. The time may come when heat may be converted into electric current with as little loss as that involved in the conversion of electric current into mechanical work; when that time comes, the heat efficiency of the prime mover will exceed that of the gas-engine in a greater degree than the gas-engine has exceeded that of the steam-engine.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Public Orator, Dr. Sandys, of St. John's College, spoke as follows in presenting, for the complete degree of Master of Arts *honoris causa*, Mr. Howard Marsh, recently elected professor of surgery in succession to Sir George Humphry, who died in 1896.

Haud ita pridem, ut meministis omnes, plenus annis, plenus honoribus, e vita excessit vir insignis, per annos plurimos primum anatomiam, deinde chirurgiam, inter nosmet ipsos praeclare professus. Qui qualis quantusque vir fuerit, quanto scientiae amore, quanta animi alacritate, quanta sermonis facundia praeditus, non est quod longius exsequar: vosmet ipsi vobiscum recordamini. Chirurgiae vero professoris nostri primi in locum, annorum septem intervallo interposito, nuper electus est vir egregius, quem, tot aliis ministrum salutis, Academiae nomine hodie ipsum jubemus salvere. Viri talis autem inter laudes, non nostrum erit hodie scientiae tam reconditae penetralia perscrutari, non artis intimae mysteria occulta et abstrusa in lucem proferre; ne corporis quidem mala illa dura verbis duris expressa, ut ἀρθρῖτις, ut ἀγκύλωσις, totiens ab hoc viro feliciter levata, coram vobis hodie commemorabuntur. Mentis potius ad bona praeclara transibimus, et professorem nobis nuper datum propterea praesertim animo laeto accipiemus, quod ingenio tam vivido, judicio tam subacto est praeditus, in rebus minutissimis observandis tam subtilis, in rebus obscurissimis explicandis tam lucidus. Viro in ea parte medicinae quae manu curat insigni manus libenter tendimus, dextraeque tam sollerti dextram libenter jungimus. Duco ad vos baronetti quidem illustris, Jacobi Paget, quondam adjutorem, equitis autem insignis, Georgii Humphry, nunc demum successorem, virum nobis omnibus acceptissimum, Professorem Marsh.

A special course of advanced lectures on certain general aspects of zoology, to be given at the zoological laboratory during the Michaelmas and Lent terms, on Tuesdays and Saturdays at noon, commenced on November 17. The course includes lectures by the following:—Mr. Brindley, regeneration; Mr. Doncaster, (1) Weismann and his work, (2) experiments with Echinoderm eggs and larvæ; Mr. Fletcher, cell-structure, cell-division and maturation of germ-cells; Mr. J. S. Gardiner, marine fauna; Mr. Hopkins, animal pigments; Mr. Punnett, metamerism; Mr. Shipley, parasites. The first two lectures are on parasites, by Mr. Shipley. The order of the other lectures will be arranged later.

Mr. Bertram Hopkinson, son of the late Dr. John Hopkinson, F.R.S., has been elected professor of mechanism and applied mechanics in succession to Prof. Ewing. Prof. Hopkinson was placed in the first division of the first class of the mathematical tripos, part ii., in 1895, and was *proxime accessit* for the Smith's prizes in 1896.

Mr. W. Morley Fletcher, Trinity, has been appointed demonstrator of physiology.

A Clerk Maxwell studentship for research in physics will be filled up at the end of this term. Applications are to be sent to Prof. J. J. Thomson by December 18. Candidates must have worked at least one term at the Cavendish Laboratory.

The special board for medicine proposes to establish a post-graduate examination and diploma in tropical medicine and hygiene, intended to meet the needs of military, colonial, and missionary practitioners. Mr. Chamberlain and Mr. Brodrick have expressed their approval of the proposal in the interest of the imperial medical services.

A syndicate consisting of Dr. Guillemard, Dr. A. Macalister, Dr. Haddon, Prof. Ridgeway, Mr. J. G. Frazer, Mr. A. E. Shipley, Mr. W. L. H. Duckworth, and Dr. Rivers, is proposed to consider the better organisation of the study of anthropology in the University.

THE Advisory Board on Military Education and Training, appointed by the Secretary of State for War in April last, has stated some of the conclusions which have been arrived at, and now carry the approval of the Secretary of State. With regard to the selection of the candidates for commissions through Sandhurst and Woolwich, it is proposed to subject them to a twofold test, consisting of a preliminary qualification and a competitive examination. The Advisory Board is of opinion that the subjects covered by the qualifying certificate (which is to be given not by a special examination, but some substitute in the shape of a "leaving certificate") must include:—(1) English; (2) history and geography; (3) mathematics (elementary); (4) French or German; (5) either (*a*) Latin or Greek, or (*b*) science. By "science" in this scheme is meant such combination of experimental or natural sciences as the Board may approve. Provided always that the sciences recognised shall have been taught in a sufficiently extended course, say three years, involving a sufficient amount of laboratory or field work. In the competitive examination the Board considers that for Woolwich candidates it should consist of three compulsory subjects, viz. English, either French or German, mathematics i., and of any two out of the following:—mathematics ii., science, history, French, German, Latin, Greek. For Sandhurst candidates they propose that there should be two compulsory subjects, viz. English, and French or German, with any two of the following:—mathematics i., mathematics ii., science, history, French, German, Greek, Latin. It consequently seems possible, and in view of public school traditions highly probable, that we may have young officers in training under the new regulations who are completely ignorant of scientific method.

SOME severe criticisms of our system of education for officers in the Army were made by Lieut.-Colonel F. N. Maude at the Royal United Service Institution last week in a lecture on "Military Education." He remarked that the rising generation of young officers as a body were leaving the public schools with less education than that of many of our rank and file. In his experience, Militia, Sandhurst, and Woolwich candidates were all willing to learn, and were easily interested in their work for a time, but as a body they were mentally incapable of "concentration" for more than a few minutes. He suggested that the Government should appoint a committee of the highest specialists in nervous diseases, loss of control, and similar troubles, and get them to report on the psychological, not the physiological, influence of "drill" exercises in restoring and developing will-power in the individual. Having secured concentration, what were they to teach? Primarily, they needed the power to observe facts accurately—*i.e.* scientific teaching; next, the knowledge of facts previously registered—*i.e.* history; and, thirdly, the power to reason accurately from given data—*i.e.* mathematics. But neither history nor science could be studied without a knowledge of modern languages. History was unintelligible without physiography, geography, and topography—hence these subjects should form integral parts of its teaching. Let the Government, he said, settle a course of instruction which could only be accomplished in the time by concentration of purpose on the decisive factors, and would require in every school a thoroughly modern equipment of educational means and appliances, and, to start the system, let it send its own experts round to advise and assist headmasters. In conclusion, he strongly urged the importance of securing for the Army a good supply of older university and Militia candidates, men who joined the service not only with a fuller sense of responsibility than one found in the average schoolboy, but also with a far wider and surer basis of knowledge.

UNDER the joint auspices of the Technical Education Board of the London County Council and of the Geographical Association, two conferences will be held on Thursday, January 7, 1904, in the South-western Polytechnic, Manresa Road, Chelsea. In the morning, at 11 o'clock, Mr. H. J. Mackinder, reader in geography at Oxford, and the appointed teacher of geography in the University of London, will open a discussion on the development of geography out of nature-study. In the afternoon practical methods of teaching geography will be dealt with. Mr. Lomas, of Liverpool, will take up the question of teaching geography by excursions; Mr. T. Alford Smith, St. Dunstan's College, Catford, will describe a method of using the globe and lantern views; Mr. P. F. Kendall, of the Yorkshire College, will discuss methods of making and using models; and Mr. A. J. Herbertson, of the Oxford University School of Geography, will advocate the employment of Ordnance maps in teaching geography, and will, in particular, deal with sheets which are illustrative of typical land forms. In connection with these conferences an exhibition of geographical appliances, maps, and books of use to teachers will be arranged. It will probably be open from Tuesday, January 5, to Saturday, January 9, at the South-western Polytechnic. The Geographical Association has appointed a special committee to select exhibits.

LORD KELVIN on November 13 received the honorary degree of D.Sc. from the University of Wales. On the evening of the previous day he received the honorary membership of the South Wales Engineers' Institute, and in expressing his thanks for the honour, he remarked that engineers all over the world had still a good deal to learn as to the real value of university training. In the matter of the education of foremen in engineering works the Germans had learned how to give them scientific knowledge in a way in which we in England had not given it. It was necessary for the young engineer to learn the practical as well as the theoretical, and this could only be accomplished satisfactorily by the student's spending half his year at the university and half in the workshop, where he might learn to apply the scientific knowledge which he had acquired in the university.

AT the Sir John Cass Technical Institute, Aldgate, on Tuesday, November 17, the prizes and certificates gained by students during the past session were distributed by Sir Henry Roscoe. The institute is one of the polytechnics aided by the Technical Education Board of the London County Council and by the City Parochial Foundation. In addition to general instruction in the experimental sciences, art, commercial subjects, and domestic economy, special attention is given to the study of metals both from the scientific and the artistic side. Sir Henry Roscoe, in addressing the students, said that he hoped all present would agree with him that enough had been said about the value of the application of the principles of science and of art to industry, and that the time for work had come. Over and above the ordinary courses of instruction it is of the utmost importance that the higher work of students, especially research work, should be encouraged. What original work teaches is—how to overcome difficulties, how to obtain a mastery over opposing forces, how, in fact, successfully to tackle new problems when they present themselves, as they are ever doing to those who have eyes to see. Without this capability a man can only run in the beaten track, with it he has a weapon in his hand which gives him power to strike out new paths and to open up fresh and fertile ground. As in the scientific sphere, so also in the domain of art—the same guiding spirit holds the fort. Taste needs refinement, hand and eye require training, the craftsman, like the man of science, must be imbued with the spirit of progress as well as with a love of his art. Referring to the relation between the London University and polytechnics as regards internal students, Sir Henry Roscoe remarked that instruction given in the polytechnics must be of a real university type. It would be fatal to the prestige of the university were its necessarily high standard of efficiency lowered to meet the exigencies of the case. The course of study must be an extended one, as the hours devoted to work in the evening are necessarily shorter than those in the day; but the total time spent in study must be the same for both day and evening students, though a substantial reduction in time has been granted to those regularly employed during the day.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society.—"The Vapour Pressure of Liquid Oxygen on the Scale of the Constant-volume Oxygen Thermometer filled at different Initial Pressures." By Dr. Morris W. **Travers** and Dr. Charles J. **Fox.** Communicated by Sir William Ramsay, K.C.B., F.R.S. Received June 26.

The vapour pressures of liquid oxygen and of liquid hydrogen on the scales of the constant-volume hydrogen and helium thermometers have recently been determined by one of us in conjunction with Dr. A. Jaquerod and Mr. G. Senter, and it has been found that two scales of temperature differ by amounts which increase as the temperature falls (*Phil. Trans.*, A., vol. cc.).

	Vapour pressure	Hydrogen scale	Helium scale
Liquid oxygen	760 mm.	90°·10	90° 20
Liquid hydrogen ...	760	20°22	20°41

These results are in accordance with Callendar's calculations of the deviation from the thermodynamic scale of measurements with thermometers filled at an initial pressure of 1000 mm. of mercury at the melting point of ice. Whether the deviation becomes smaller when the thermometers are filled at a lower pressure has not been determined, and, indeed, with the means at our disposal it would be practically impossible to do so. In order, therefore, to investigate the variation of the readings of the gas thermometer with change of initial pressure, we decided to measure the vapour pressures of liquid oxygen on the scales of the constant-volume oxygen and nitrogen thermometers, for which the deviations from the thermodynamic scale are considerably greater.

Makower and Noble, using the method of Travers and Jaquerod, have found that the pressure coefficient of oxygen at an initial pressure P_0 may be expressed by the formula

$$\alpha = 0{\cdot}0036642 + 0{\cdot}00000001457\ P_0,$$

where P_0 is expressed in millimetres. Values derived from this expression were employed in calculating the temperatures corresponding to the vapour pressure of liquid oxygen on the scale of the oxygen thermometer filled at different initial pressures.

The results are stated in the following table:—

Gas in thermometer	Pressure on gas in thermometer at ice point	Pressure coefficient	Boiling point of liquid oxygen
Helium	1000 mm.	0·00366255	90·20
Oxygen	1000	0·0036788	88·7[1]
	731	0·0036748	89·02
	658	0·0036738	89·09
	484	0·0036713	89·31
	336	0·0036692	89·48
	0	0·0036642	99·8[1]

[1] By extrapolation.

The results show that for very low pressures in the thermometer the oxygen scale converges towards the helium scale. The fact that the deviation does not appear to vanish at low pressures may be due to a tendency on the part of the gaseous molecules to associate at higher pressures.

Mathematical Society, November 12.—Prof. H. Lamb, president, in the chair.—The council and officers for the ensuing session were elected. They are as follows:—president, Prof. Lamb; vice-presidents, Prof. Elliott, Dr. Hobson, Dr. Baker; treasurer, Prof. Larmor; secretaries, Prof. Love and Prof. Burnside; other members of council, Mr. Campbell, Dr. Glaisher, Mr. Grace, Mr. Macdonald, Major MacMahon, Mr. Mathews, Mr. Western, Mr. Whittaker, Mr. A. Young.—The following papers were communicated:—Prof. J. D. **Everett,** Note on Borgnet's method of dividing an angle in an arbitrary ratio. The method, which depends on the construction of a certain transcendental curve, was given by Borgnet in *Rouen. Acad.*

Travaux, 1839.—Prof. A. E. H. **Love**, The propagation of wave-motion in an isotropic elastic solid medium. The chief object of the paper is to remove a difficulty in Stokes's memoir on the dynamical theory of diffraction. Stokes's theory was built upon certain expressions for the cubical dilatation and the components of rotation, but these expressions are not always correct. A new foundation is now obtained for the theory in an independent investigation of the effects produced by force applied at one point. A knowledge of these effects renders possible the solution of a number of problems relating to wave-motion in an isotropic elastic solid, among them being the problem discussed by Stokes of the effects of arbitrary initial disturbances. It is proved that, unless certain relations connect the initial velocity and initial strain at points on the boundary of the portion of the medium which is disturbed initially, the strain in the neighbourhood of the centres of principal curvature of this surface will tend to become infinite, and fracture of the material will be produced.—Mr. H. **Hilton**, On spherical curves. The paper contains a general discussion of the curves on a sphere formed by the intersection of the sphere and any other algebraic surface.—Mr. W. H. **Young**, On sequences of sets of intervals containing a given set of points. A set of points being taken, intervals are constructed so that each interval has one of the points as an internal point, and the lengths of the intervals are diminished without limit. The author discusses the nature of the aggregate of points which throughout the limiting process remain internal points of the intervals.—The Rev. F. H. **Jackson**, A formal generalisation of Maclaurin's theorem.—Dr. H. F. **Baker**, On the Weddle quartic surface. Of the quadric surfaces which pass through six given points, those which pass through a seventh point pass also through an eighth; when these two coincide they must lie on a locus which is the surface under discussion. There is a birational relation between this surface and Kummer's sixteen-nodal quartic, and this relation is interpreted as a linear projection in space of four dimensions. From any point of Weddle's surface there can be derived by linear projections in three dimensions a remarkable figure of 32 points lying on the surface, and the formulæ by which the coordinates of these points are connected with those of the first point constitute an Abelian group.—Mr. W. H. **Jackson**, The theory of diffraction.—Mr. G. H. **Hardy**, A general theorem concerning absolutely convergent series.—Prof. R. W. **Genese**, Notes on quaternions, including a geometrical interpretation of $V\alpha\beta\gamma$.—Mr. E. T. **Whittaker**, On the expression of the electromagnetic field by means of two scalar potential functions. It is shown that the electric displacement and magnetic force due to any system of moving electrons can be expressed by second derivatives of two scalar potential functions.—Mr. P. W. **Wood**, Analogue of the Jordan lemma for four variables.

Entomological Society, October 21.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. J. H. **Keys** sent for exhibition a black variety of *Carabus nemoralis*, Müll., from Dartmoor.—Mr. G. C. **Champion** exhibited a series of *Rosalia alpina*, Linn., found by himself on old beech trees at Moncayo, north Spain, in July last.—Mr. A. J. **Chitty** exhibited a larva of *Dytiscus flavescens*, taken at Eastling, Kent, near the school buildings.—Colonel J. W. **Yerbury** exhibited *Gastrophilus nasalis*, Linn., taken at Torcross, Devonshire, from August 19 to 31 last. He said that as this rare species differs in a marked degree in its mode of flight, &c., from the common horse bot-fly, *Gastrophilus equi*, it would be as well to direct attention to these differences. *Gastrophilus equi*, when flying round a horse, visits as a rule the belly and the forelegs. The ♀ carries her ovipositor almost horizontal, and she looks, when on the wing, like the lower two-thirds of the letter Z (*L*), *G. nasalis*, on the other hand, carries the ovipositor tucked under the belly and almost parallel to the axis of the body; this gives her, when on the wing, a peculiar ball-like appearance; *G. nasalis*, too, always flies to the horse's head. As a rule, the horse paid no attention to *G. equi*, but *G. nasalis* caused him great alarm. The eggs of *G. equi* were in hundreds on the shoulders and forelegs of one cart-horse, but although the face and nostrils were searched carefully no signs of eggs or larvæ could be found thereon. Exhibiting *Chersodromia hirta*, Walk., he said these little Empids were common on the shore near Prawle Point; some were obtained by sweeping over seaweed, while others were running about over the sand. Colonel Yerbury also exhibited *Pamponerus germanicus*, Linn., from Barmouth and Porthcawl. He said this rare species appears to be struggling to keep its place in the British list. It appears to frequent the marram grass on the sand hills, and a ♀ taken at Barmouth on June 27 was preying on a beetle.—Mr. A. H. **Jones**, Mr. H. **Rowland-Brown**, Dr. T. A. **Chapman**, and Mr. R. W. **Lloyd** exhibited specimens of the genus Melitæa from various European localities. A discussion on the probable affinities of the several named species which occur in the Alps took place.—The president also exhibited some forms of *M. aurinia* taken by Mr. A. H. **Hamm** at Basingstoke and elsewhere, and forms of *M. athalia*, *M. didyma*, and *M. phoebe* from Asia Minor and Persia.—Dr. T. A. **Chapman** exhibited an album showing a series of photographs of the development of the embryo within the egg of *Psammotis hyalinalis* taken by Mr. W. H. Hammond and Mr. W. R. Jeffrey.—The president read, and commented upon, a paper received by him on protective coloration in its relation to mimicry, common warning colour, and sexual selection, by Mr. Abbot H. **Thayer**.

Zoological Society, November 3.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—Dr. W. B. **Benham** communicated a memoir dealing with the aquatic Oligochæta of New Zealand.—Mr. Oldfield **Thomas** read a paper on the mammals collected at Chapadá by Mr. A. Robert during the Percy Sladen Expedition to Central Brazil, and presented to the National Museum by Mrs. Percy Sladen. No modern specimens had hitherto been obtained from this little-known region. Thirty-seven species were enumerated, four of which were described as new.—Accounts were also given of the Coleoptera by Messrs. C. J. **Gahan** and G. J. **Arrow**, and of the Lepidoptera by Mr. F. A. **Heron** and Sir George **Hampson**, Bart., collected during the Percy Sladen Expedition. The former contained an enumeration of 175 species, of which fifteen were described as new, while the latter gave a list of nineteen species, one of which was described as new.—Prof. B. C. A. **Windle** and Mr. F. G. **Parsons** communicated a paper on the muscles of ungulates; in it the muscles of the hind limb and trunk were discussed.—Dr. P. Chalmers **Mitchell** read a note on the distribution of the cypriote spiny mouse. Specimens of this form, recently described as a new species (*Acomys nesiotes*) by Miss Bate, had been presented to the Gardens, and their localities showed that this mouse extended practically all over Cyprus.—Mr. F. E. **Beddard**, F.R.S., read a paper on some points in the anatomy, chiefly of the heart and vascular system, of the Japanese salamander (*Megalobatrachus japonicus*).

Anthropological Institute, November 10.—Mr. H. Balfour, president, in the chair.—Dr. F. W. **Edridge-Green** exhibited a collection of pictures painted by colour-blind persons. Dr. Green divided the colour-blind into two distinct, independent, but associated classes. The first class consisted of persons with a spectrum shortened at one or both ends, who consequently cannot see certain rays. An individual with a shortening of the red end would not be able to see a red light at a distance, although he could pick out all the pieces in a bundle of coloured wools. The second class made mistakes through their inability to recognise the difference between certain colours. Normal sighted persons see six colours, some even seven; the second class of the colour-blind see five, four, three, two, or one colour, according to the degree of their defect, and are called pentachromic, tetrachromic, &c.—The president, on behalf of Mr. **Annandale**, read a paper on the survival of primitive implements in the Færöes and Iceland, and illustrated the paper with an exhibition of many of the implements alluded to. These included bone skates, a shovel made out of the bone of a whale, a stone lamp, and stone hammers. In the discussion which followed, the great importance of collecting these primitive implements before they entirely vanish with the advance of civilisation was insisted upon.

PARIS.

Academy of Sciences, November 9.—M. Albert Gaudry in the chair.—On the storage of the *n*-rays by certain bodies, by M. R. **Blondlot.** The rays from various sources of light, after being filtered through an aluminium screen, possess the property of increasing the luminosity of a feebly phosphorescent screen. It was noticed when a quartz lens was used that this effect continued after the source of light, an incandescent mantle, was extinguished, and it was then found that quartz, Iceland spar, fluorspar, and various other substances possessed the same property. The rays are stored throughout the whole mass, and take some time to penetrate.—On the determination of invariant figures of cyclic transformations, by M. **Rabut.**—On the approximation of functions by quadratic surds, by M. S. **Pincherle.**—Generalisation of the fundamental property of potential, by M. A. de **Saint-Germain.**—On the laws of displacement of chemical equilibrium, by M. E. **Ariès.**—The dielectric cohesion of gases at low temperatures, by M. E. **Bouty.** The dielectric cohesion of a gas at constant volume is constant to within one per cent. for temperatures between $-100°$ C. and $+200°$ C.—On a practical solution of the problem of photometry of lights of different colours, by M. Charles **Fabry.** The method involves the use of a secondary standard of the same colour as the light to be measured. For this standard, the use of a flame is recommended with two coloured solutions of definite composition.—On the scintillation of phosphorescent zinc sulphide, in presence of radium, revivified by electric discharges, by M. Th. **Tommasina.**—Remark on the latest group of solar spots and the magnetic disturbances, by M. F. **Quénisset.** Photographs of the spots taken on October 31, the date of the magnetic storm, show that the area of the sun-spots was only one-third of the area of the spots on October 11, but that on October 31 the spots were accompanied by enormous faculæ, and hence the magnetic disturbance is probably to be attributed to the latter.—On the transparency of the sea, by M. **Thoulet.** A simple relation is given between the distance, y, at which a white circle on a black background just disappears, and the amount of solid matter in suspension, x, xy being constant. The relation has been applied to the determination of the weight of the sediment in suspension in sea water.—The use of balloons containing a subsidiary air balloon according to the theory of General Meusnier, by M. Henry de la **Vaulx.** An account of two voyages in a balloon fitted with small air balloons, the latter possessing independent valves, and with a rain shield. The device of a subsidiary air balloon, suggested by General Meusnier in 1783, was found to be of great practical value. The balloon is easily kept below the clouds, and a great saving of ballast is effected, rendering longer voyages practicable.—The conditions of separation of iodine in the form of cuprous iodide, in a mixture containing alkaline chlorides, bromides, and iodides, by MM. H. **Baubigny** and P. **Rivals.** The separation is effected by an excess of copper sulphate, in the presence of an alkaline arsenite and a little ferrous sulphate.—The action of organo-magnesium compounds upon acetol and its esters, by M. André **Kling.** In no case was any haloid organic compound formed, hence, comparing with the corresponding reaction with ethylene oxide and epichlorhydrin it follows that acetol and its esters behave as ketonic compounds, and as internal ether oxides of the ethylene oxide type.—The evolution of the compound Ascidians, by M. Antoine **Pizon.**—On the regeneration in Amphibia of the posterior members and the tail, in the absence of the nervous system, by M. P. **Wintrebert.** The regeneration of the limbs is not dependent on the nervous system.—Study of the digestive ferments in some invertebrates, by M. Victor **Henri.** A comparison of the activity of the amylolytic and proteolytic ferments of *Octopus vulgaris, Sepia officinalis, Spatangus purpureus,* and *Salpa africana* with the activity of the corresponding ferments from the dog.—A new hybrid obtained by grafting, by M. Lucien **Daniel.**—On the extra floral nectars of Hevea, by MM. Aug. **Daguillon** and H. **Coupin.**—Cytological researches on *Galactinia succosa,* by M. R. **Maire.**—On the oxidation of glucose in the blood, by M. L. **Jolly.** Alcohol exists naturally in ox blood, in very minute proportion, a portion of which is further oxidised in the blood to acetic acid.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 19.

ROYAL SOCIETY, at 4.30.—The Physiological Action and Antidotes of Colubrine and Viperine Snake Venoms: Dr. L. Rogers.—On the Rapidity of the Nervous Impulse in Tall and Short Individuals: Dr. N. H. Alcock.—Electrometer Records of Secreto-motor Changes: Dr. A. D. Waller, F.R.S.—On the Nematocysts of Aeolids: G. H. Grosvenor.—The Cell Structure of the Cyanophyceæ: H. Wager.

LINNEAN SOCIETY, at 8.—A General View of the Genus Pinus: Dr. Maxwell T. Masters, F.R.S.—Contributions to the Embryology of the Amentiferæ. Part II.—*Carpinus Betulus*, Linn.: Miss Dr. M. Benson and Miss Elizabeth Sanday.

FRIDAY, NOVEMBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Roofing Existing Shops while Work is Proceeding: R. H. Fowler.—Experiments on the Efficiency of Centrifugal Pumps: Dr. Thomas E. Stanton.

MONDAY, NOVEMBER 23.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Recent Exploration and Economical Development in Central and Western China: Lieut.-Colonel C. C. Manifold.

SOCIETY OF ARTS, at 8. The Mining of Non-Metallic Minerals: Bennett H. Brough.

TUESDAY, NOVEMBER 24.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—An Engraved Tablet from Easter Island: O. M. Dalton.—The Early Pot Fabrics of Asia Minor: J. L. Myres.

INSTITUTION OF CIVIL ENGINEERS, at 8.—On the Distribution of Mean and Extreme Annual Rainfall over the British Isles: Dr. H. R. Mill.

WEDNESDAY, NOVEMBER 25.

SOCIETY OF ARTS, at 8.—The Universal Exposition at St. Louis, U.S.A., 1904: George F. Parker.

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