THURSDAY, NOVEMBER 11, 1897.

MIMICRY IN BUTTERFLIES AND MOTHS.[1]

Researches on Mimicry on the Basis of a Natural Classification of the Papilionidæ. Part ii. *Researches on Mimicry.* By the late Dr. Erich Haase, Director of the Royal Siamese Museum in Bangkok. Translated by C. M. Child, Ph.D. Pp. 154, and 8 coloured plates. (Stuttgart: Ernin Nägele. London: Baillière, Tindall, and Cox, 1896.)

II.

WE have now to inquire as to the treatment accorded to Haase's work by publisher, translator, and editor.

The eight coloured plates are perhaps the most satisfactory feature of the work as it appears in this country. The English translation is limited to Part ii. of Haase's complete memoir, of which the plates still retain the numbering, viz. 3, 4, 9, 10, 11, 12, 13, and 14. In spite of this, there are frequent references in the text to the other plates (*e.g.* Plate i.) without the slightest indication that the plate in question is not to be found. This is all the more tantalising inasmuch as some of the most interesting figures, viz. those of *Papilio merope* and its allies have their place in the omitted plates.

References to the parts which are not translated appear in the irritating form of "Part i., pages — —," the exact page of the German original being given in the margin, or, as on p. 35, withheld altogether.

The quality of type and paper leave nothing to be desired, and it is very unfortunate that these great advantages should be rendered of little avail for the want of an intelligent proof-reader, to say nothing of an editor.

The names of authorities quoted are frequently misspelt: thus, Jenner Weir appears as J. Wier on p. 12, while on p. 20 it is rendered J. Weis; de Saussure is de Saussare (p. 6); Grose-Smith is rendered by Grosse-Smith (p. 84); Mansel Weale by Wheale (pp. 45 and 104); J. W. Slater by J. W. Sclater (p. 95); while in the footnote of the same page the name appears as F. M. Sclater. Mr. A. G. Butler and the present writer are let off comparatively easily with the initials A. E. B. (p. 33) and E. G. P. (p. 20).

Even more misleading are the frequent mistakes in scientific names, such as *candata* for *caudata* (p. 32), *Euploræ* for *Euplææ* (p. 25), *Argynns* for *Argynnis* (p. 119), *Decopeia* for *Deiopeia* (p. 98), *biconius* for *bicornis* (p. 147), *Cheysomelid* for *Chrysomelid* (p. 137), *Glancopid* for *Glaucopid* (p. 73), &c. Then avian is rendered by arian (p. 126), while genus becomes ganus (p. 137). The words Pierinæ and Pieridæ are both used; but the combination of these into Pieridinæ (p. 64) is, I believe, peculiar to this volume. A conspicuous and important position is no guarantee against the most absurd errors. In the heavily-printed headings of important sections of the work, Coleoptera appears as Colcoptera (p. 18), Mimetic as Numetic (p. 19), and Hypolimnas as Hypolinopas (p. 29).

After this it is hardly necessary to allude to the innumerable blunders in ordinary words which are scattered thickly throughout the work. Some of these mistakes are, however, worthy of quotation merely to illustrate some of the curious forms which printers' errors may assume. Thus we meet with "altoogether to slight" (p. 137), while "exclusively" becomes "exclusive by" (p. 119); in "a bee" the words are transposed and fused, becoming "beea" (p. 72). In many cases the wrong letter makes a different word, which may sometimes be mistaken for that which was intended. Thus "ledges" becomes "lodges" (p. 7), "wavy" becomes "wary" (p. 148), "than" becomes "then." It is an interesting speculation to attempt to determine the intended word in the passage which tells us that the Jamaican *Aristolochia grandiflora* emits such an unpleasant smell that "even pigs she from eating it" (p. 97).

Errors of punctuation also occur, sometimes producing the most ludicrous effect, sometimes merely serving to confuse the reader. The Zygænidæ are described as possessing "large legs beset with numerous spines and short antennæ" (p. 73). A good example of the difficulties introduced by want of style and want of correct punctuation is to be found in a sentence on p. 123: "This similarity among inedible species is, as first pointed out by Fritz Müller and Wallace, *mutually advantageous* to the participants in the resemblance for the type of the immune forms becomes in this way *more distinct*, being expressed in few forms." The reference number is so displaced on p. 98, that "Indian Danaids" appear in the footnote as "this sluggish little Bombycid," and it becomes a matter of conjecture as to the insect which is really intended—probably *Deiopeia*. On p. 14 *centrali* is hyphened with *Biologia* instead of with *americana*.

The names of species are generally printed in italics, but curious exceptions occur. Thus on p. 127 the generic name of a species is printed in ordinary type, the specific in italics, an arrangement which is reversed with another species on p. 55; while on page 58, half of the word Passifloræ is printed in one way and half in the other.

We have now to judge how far the translator has given us a fair idea of the immense amount of labour which the author bestowed upon his work. The two chief and essential qualifications for a translator are (1) the knowledge of the two languages, and especially of that into which the work is being rendered; (2) knowledge of the subject-matter, without which the most skilled linguist must come hopelessly to grief.

The knowledge of English possessed by the translator of Haase's work may be inferred from the frequency with which a sentence is preceded by an unnecessary and inexplicable "thus," by the use of the word "momentarily" where we should say "temporarily" (114), of "irrelevant" for "unrelated to" (136), of "aside from" for "besides." On p. 105 it is suggested that the "secondary shading of the wings" of certain butterflies may be "a reaction of the *morbidly sensitive* organism against the physical and chemical influences of the hotter climate." On p. 100, pupæ are said to be protected "by often very artistic cocoons"

All those who see much of children at Christmas-time will have had occasion to notice the printed directions accompanying toys which bear a familiar legend. It will often be observed that these directions remain as a constant source of amusement long after the toys themselves have come to their natural end in the dustbin.

[1] Continued from p. 4.

C

Any one who is familiar with this class of literature will probably infer that the following sentences were also "made in Germany."

"Trimen also observed that an Acacia tree with exuding sap, the sporting ground of the sucking insects, was also visited by predatory Mantids, which found here numerous victims" (p. 40).

"I regard these females therefore, not as does Butler, as mimics of the *Euplœæ*, but as normally coloured, for they resemble closely other *Satyridæ*" (p. 32).

"As much as the coloration of the wings varies within narrow limits in different species of this genus, it is, however, in general similar" (p. 26).

"In the Neotropic genus *Phoraspis*, Serv., the forms with a light longitudinal fillet on the indistinctly ribbed elytra and with pronotum cleared to a glassy appearance on the sides, between which the head appears, resemble somewhat the 'Lampyridæ'" (p. 7).

Seitz is made to say that a nauseous odour is emitted by a certain butterfly (*Eueides*) "only when danger threatens or on direct insult." He is thus made to describe the evidence on which this conclusion was based: "I approached two of these insects during copulation and smelled of them, but could perceive nothing." Such conduct is evidently regarded as not sufficiently insulting to produce the desired effect (pp. 56, 57).

Schilde is represented as saying

"that the (mimetic) *Pieris* 'would become extinct if it were not otherwise compensatingly protected in its own garb, long before the first traces of the aping of the gaily-colored species had been teleologically selected on its white wings'" (p. 124).

The mimetic female *Pierinæ*, we are told on p. 66,

"flutter in low flight and little exposed through the thickets visiting at most the edge of the forest, where their models suck the juices of flowers."

Haase argues that in certain butterflies transparency is even more effectual for protection than a conspicuous "warning" appearance; the metaphor in which he expresses this opinion is thus rendered on p. 98:

"We must conclude that for protection against the obstinate enemies a 'tarn cap' is more advantageous than a 'gorgon's head.'"

We have now to inquire whether the translator possessed the requisite knowledge of the details of the subject-matter. The following examples will show that he must have been absolutely ignorant of it; and the blunders due to this cause are far more injurious than the others already treated of, and detract in a still more serious manner from the scientific value of the work. The want of technical knowledge causes many words and sentences to be rendered in a manner entirely at variance with their true meaning.

Thus the hooked hairs of certain crabs are spoken of as "angling hairs" (p. 151). The *Attidæ* are said to "suffer greatly from the persecutions of their spider-enemies" (p. 5): the author evidently stated that they suffered from the attacks of the "enemies of spiders." The "lepidopterologist" (p. 123) may well fail to recognise the familiar cyanide bottle under the description of "potassium glass" (p. 47).

Even the familiar words "Lepidoptera," "butterfly," "moth," are sometimes used in an entirely wrong sense. Thus on p. 138 we are told that "Mimicry of members of *other genera of the same subfamily* occurs not only in the Lepidoptera, but also among *Danainæ*" and several other well-known Lepidopterous sub-families. Speaking on p. 37 of a moth (*Chalcosia*), the author is made to say that "the pinned insect was more tenacious of life than any other butterfly with which I am acquainted." On p. 146 the common hawk-moth *Smerinthus ocellatus* is spoken of as a butterfly. The "empty pupal case of a butterfly," alluded to on pp. 147 and 154, should certainly be the "empty cocoon of a moth." Again, the word for butterfly is sometimes (p. 38) rendered by *Papilionidæ*. By a similar blunder, on p. 41, the genus *Papilio* is itself excluded from the *Papilionidæ*.

Instead of rendering the German descriptive terms by the corresponding English ones, the translator merely attempts a literal translation of the former. The absurd results of this procedure are so thickly spread over the book, that they form one of its worst features. Thus we are constantly told of "shaded," "secondarily shaded," and "cleared" wings, of "fillets" (*e.g.* "four orange fillet remnants," p. 7, "cellular fillets," p. 29), and of "limbal" markings. We read of the "yellow flanks" of a female Papilio (p. 93), and of "smeary" larvæ (p. 65). A "New Hollandish" genus (p. 133), the "lemon butterfly" (p. 148), and the "stem" of the aculeate abdomen (p. 134), are doubtless intelligible to an entomologist, although not the terms we should employ in this country.

I should wish, in conclusion, to express regret that Haase's painstaking and, in many respects, useful work—marred as it is by excessive arrogance, by its imperfect acquaintance with the literature of the subject, by its numerous errors, and by the rashness and frequent absurdity of its confident conclusions—should have been introduced to the English-speaking public in a form which is completely destructive of such merits as it may be fairly claimed to possess. E. B. P.

THE ACTION OF MEDICINES.

Lectures on the Action of Medicines: being the Course of Lectures on Pharmacology and Therapeutics delivered at St. Bartholomew's Hospital during the Summer Session of 1896. By T. Lauder Brunton, M.D., D.Sc., LL.D., F.R.S., F.R.C.P., &c. 8vo. Pp. xv + 673. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1897.)

DR. BRUNTON, in his preface to this substantial volume, writes as follows:

"I acknowledge at once that the lectures are imperfect. They are redundant in some parts and scanty in others; they are not well adapted for the purpose of cramming, and any man who tries to pass an examination upon them alone will not be at all likely to get the maximum number of marks. But I do not think that lectures are intended for the purpose of cramming. Their use is not to supply the student with all the information he needs, but to awaken his attention, to excite his interest, to impress upon him certain points which will form a nucleus for his knowledge, and around which he may afterwards group more information."

Wise and experienced teachers will regard as a merit, what the author thus modestly admits as an imperfection. His lectures, like Sir Thomas Watson's and others that are placed among the classics of medicine, do not contain a complete statement of all that can be said on their subject; but they do excite the reader's interest, they do arrest his attention, they make him perforce reflect for himself, and they in this way truly subserve his education in the best sense of that much-abused word.

The lectures must have been delightful to listen to; every sentence bears the impress of their author's genial personality. Nothing connected with drugs and their actions is without interest to him; and he assumes, and rightly assumes, that his hearers must share his interest. His style is artistically simple and direct; allusions, illustrations, analogies, experiences, anecdotes, are introduced at every turn, and the light of his gentle humour plays effectively over many a passage. The old-fashioned *materia medica* lecture used to be regarded as the driest and dullest of the medical course: Dr. Brunton has transfigured it into one of the brightest. It is his special merit that the change has been brought about without the least sacrifice of scientific method or scientific precision; for the whole book is instinct with the spirit of modern physiology and pathology. Empirical *axiomata media* cannot yet be wholly excluded from therapeutics, but Dr. Brunton is never content with a mere induction from experience when it is possible to suggest a rational explanation. And if the suggestion is capable of being tested by experiment, the experiment is made.

"I was once demonstrating the action of ammonia before a class here many years ago, and showed that if you held either ammonia or chloroform before the nose of a rabbit the heart stopped instantaneously. This stoppage of the heart takes place reflexly through the fifth nerve as an afferent, and through the vagus as an efferent nerve. After the lecture was over, a student came up to me and said: 'If ammonia held before the nose stops the heart, how is it that it is of use in fainting? It ought to be exceedingly bad in fainting, and yet everybody knows it is good.' Well, I simply did not know. I said: 'I think it may possibly be that it tends at the same time to cause a deep inspiration, and thus stimulates the heart indirectly.' But I was not satisfied with this explanation, and so I put the question to the test of experiment. I found the answer to be this: At the same time that you stop the heart through the vagus by ammonia or any other irritating volatile substance held before the nose, you stimulate reflexly the vaso-motor centre, cause contraction of the arterioles, and raise the blood-pressure enormously."

This specimen is typical; it can be paralleled by a multitude of others, and it exemplifies at once the style and the spirit of Dr. Brunton's teaching.

The general plan of the book follows the lines of the schedule recently adopted by the Royal College of Physicians as defining the scope of an examination in pharmacology for students aspiring to their licence. Before, however, any examination had been held, a retrograde step was taken by a majority of the Fellows, and this special examination was abolished. Among the grounds alleged for so unusual a course were the supposed vagueness of the limits of the science, and the absence of appropriate text-books. It cannot be doubted that, had the present work been then accessible to students, these grounds of objection would have proved untenable. "The action of medicinal agents on the body in health and disease" forms, indeed, the essential scientific foundation for the "practical art of therapeutics" which every medical licentiate is assumed to have acquired; without this foundation he must needs be a mere empiric. The author has shown that the ascertainable facts in reference to medicinal action constitute already a coherent and orderly body of knowledge, and that future progress in rational treatment is dependent on the pursuit of the methods of scientific pharmacology in this sense of the term. He has furnished the student with an excellent guide to both facts and methods, and has thus removed the last excuse for the maintenance of mere rule-of-thumb tradition. It is to be hoped that, at no distant day, the Royal College will reconsider its last decision in the light of better knowledge and broader conceptions of medical education.

In accordance with the plan of the above-mentioned schedule, the actions of medicines are first considered from a physiological point of view, as they affect the various functions and systems of the body, normal or morbid. The movements of the alimentary canal and digestion; the composition of the blood, nutrition and metabolism; the heart and blood-vessels, and the circulation; disorders of the circulatory function, such as inflammation; absorption of inflammatory products; secretion and excretion; respiration; the nervous system and sleep; the sensory functions and pain; the reflex and motor activities of the nervous system; the regulation of bodily temperature and fever; specific poisons and infections; all of these are capable of being altered, modified, or controlled by medicinal agents, and the mode in which the latter exert their special action and produce their recognised effects is fully set forth.

But in many cases the practitioner has to ask himself not only what agents at his command are capable of modifying a given function in a desired way, but also what organs or functions may be affected by a given remedy administered in a particular manner. It is therefore necessary again to traverse the ground, at least in part, arranging the subject-matter under the heads of the chief medicines and therapeutic methods in ordinary use, and summarising their numerous primary and secondary actions on the body at large. The last half-dozen chapters do this clearly and succinctly. There is perforce some repetition of the earlier chapters; but the student is made to feel that not a page could be dispensed with, and the book ends long before his attention is fatigued or his interest exhausted.

It would, however, be a mistake to regard the book as good for students only: it is full of wise aphorisms and sagacious hints of the greatest value to men engaged in actual practice. There is scarcely a page from which even a practitioner of long and wide experience could not cull a suggestion, leading to the better use of his familiar tools, or to the elucidation of some old-standing puzzle. Alike to the student who is learning the subject for the first time, to the medical man in search of light and leading in the perplexities of treatment, and to the "intelligent reader" who desires to appreciate the advances made by modern medicine to a place among the sciences, we can cordially commend this fascinating work.

ORGANIC CHEMICAL MANIPULATION.

Organic Chemical Manipulation. By J. T. Hewitt, M.A., D.Sc. Pp. xi + 253. (London: Whittaker and Co., 1897.)

THIS is in some respects a useful little book, but it might easily have been made much more useful. It is divided into two parts. The first portion—102 pages—is occupied mainly with a very brief description of processes of purifying organic substances, namely, crystallisation, distillation, melting-point determination, and sublimation; and a short outline of the processes of ultimate organic analysis. A large part of the matter in this section of the book is what the student will find in almost any text-book on quantitative analysis, and might perhaps with advantage have been omitted here, and its space devoted to an extension of the matter in Part ii., and to more exact and detailed directions for carrying out the "manipulations" therein described. The second part of the book, covering 150 pages, is on the "preparation of organic substances." This, at least, is what it professes to be; but there is so much "descriptive" matter distributed throughout it, that in parts it more resembles a simple text-book on organic chemistry, with experiments thrown in. For example, after giving very fair directions for the preparation of methane from sodium acetate, and the performance of two or three experiments illustrative of its properties, the author proceeds to describe, in the true text-book style, the various other methods for the preparation of marsh gas. Thus:—

"To obtain perfectly pure methane, zinc-methyl is decomposed by water:

$$Zn(CH_3)_2 + 2H_2O = 2CH_4 + Zn(OH)_2.$$

An interesting synthetical method for the formation of methane was discovered by Berthelot, who led a mixture of sulphuretted hydrogen and the vapour of carbon disulphide over red-hot copper:

$$CS_2 + 2H_2S + 8Cu = CH_4 + 4Cu_2S.$$

The following general methods of the formation of paraffins, *i.e.* hydrocarbons of the general formula C_nH_{2n+2}, may be mentioned."

And so on, and so on (pages 106-7).

Again, we read:

"The aldehydes are nearly always produced by the oxidation of the corresponding primary alcohols, the process being usually carried out with potassium dichromate and sulphuric acid, *e.g.*:

$$3CH_3CH_2OH + K_2Cr_2O_7 + 4H_2SO_4 = 3CH_3 \cdot CHO + K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O.$$

Another way is to distil a mixture of the barium or calcium salt of an acid with the corresponding formate; the following reaction then takes place:"

And so on for nearly three pages. This is all very true, and good enough of its kind; but it savours too much of the ordinary descriptive text-book, and too little of "Organic Chemical Manipulation."

Why such "manipulations" as taking the density or specific gravity of an organic liquid, or finding the optical activity of a sugar solution, should be introduced in the part of the book supposed to be devoted to the "preparation of organic substances" is not quite evident. The directions given for the preparation of the various compounds dealt with, although often very good, are not always above criticism; for example, in the preparation of ethylene the student is directed to mix 25 grams of alcohol and 150 grams of strong sulphuric acid in a flask of two or three litres capacity. Why such an enormous flask? The total volume of the mixture is barely 100 c.c., with at most another 50 c.c. to be added as the operation goes on, and to employ a flask of 20 or 30 times this capacity is simply ridiculous. Without adopting any of the well-known precautions against frothing up (which, by the way, are not hinted at), if the flask is not more than one-fourth filled with the liquid it will be amply large enough. The author then goes on to direct that the gas shall be passed through two wash-bottles in succession,

"the first being charged with concentrated sulphuric acid to remove the vapours of alcohol and ether, the second with caustic soda solution to hold back any carbon dioxide, and towards the end of the experiment sulphur dioxide."

As water, in the form of steam, is expelled from the generating flask in considerable quantity along with the ethylene, the strong sulphuric acid in the first wash-bottle will soon become *weak* sulphuric acid, and moreover will become so hot as to render the fracture of the bottle extremely probable. If these two wash-bottles are to be used, the order should be reversed; but as a matter of fact they are quite unnecessary. If the temperature is properly regulated (for which purpose a thermometer should be passed through the cork of the generating flask, and should dip into the liquid), practically no ether is produced; and if the gas is passed through a single wash-bottle containing water, any alcohol which passes over will, for the most part, be retained there. So also will any sulphur dioxide, should the operation be pushed to such extremes that this gas is generated. Any traces of carbon dioxide which accompany the ethylene are quite immaterial, but they can if necessary be absorbed by the addition of a little caustic soda to the water in the pneumatic trough.

Lastly, after directing that the gas is to be passed through two bottles containing bromine, for the preparation of ethylene dibromide, the author adds, "the tube leading from the bromine absorption bottles must not open directly into the air, but should go into the bottom of a lime-tower which is charged from the constriction upwards with alternate layers of broken glass and soda-lime." Why not simply bubble the gas through a little caustic soda in a small beaker?

On p. 112 the following equation is given for the preparation of cuprous acetylide:—

$$C_2H_2 + CuCl + NH_3 = C_2HCu + NH_4Cl.$$

One would like to know upon whose authority this is given.

The book contains sixty-three illustrations, most of which are of the very roughest description. Fig. 36, p. 67, represents a crucible balanced in an impossible position upon a pipe-clay triangle. Again, in Fig. 60, p. 183, it is difficult to see why an exit tube is to be soldered into a hole in the tin can, instead of using the obvious two-holed cork which will carry both the safety tube and the exit tube.

In spite of these faults, however, the book will no doubt be of some use both to teachers and students of practical organic chemistry classes. N.

OUR BOOK SHELF.

Nights with an Old Gunner, and other Studies of Wild Life. By C. J. Cornish. With illustrations. Pp. xii + 307. (London: Seeley and Co., Ltd., 1897.)

MR. CORNISH'S books are widely known, and thoroughly deserve their popularity. He delights in the observation of live animals, especially birds; he describes with detail, yet with animation; and his sketches are rich in human interest. Few better books could be offered to a young fellow fond of nature, but not loving to take his pleasure too seriously. They inspire the love of close observation, and will help to make naturalists of a particularly good kind—men who will study their animals alive, and amidst natural surroundings. The illustrations are attractive, and some of the photographs from life included in this volume are acquisitions to natural history.

Critics are bound to be critical, and we shall notice the trifling matters which we would see amended in another edition. A naturalist, bred in another part of England, may be puzzled by such local words as "marrum grass," "crab grass," and "king crab." The present writer wants to know what they are, but cannot easily find out. The comparison of the shrimp and prawn (p. 87) is not exact, and we are startled to read of the hundred mouths of the sea-anemone (p. 81). A little more information might have been given about the food, and especially about the winter-food, of the beaver. This would have led to an explanation of the purpose of the dam. But Mr. Cornish does not attempt to tell all; what he tells is told so pleasantly that we long for more. L. C. M.

Untersuchungen über den Bau der Cyanophyceen und Bakterien. By A. Fischer. Pp. 132, and 3 plates. (Jena: G. Fischer, 1897.)

THIS little volume is very full of information on methods of fixing and staining, and on the results of high power observations of these minute organisms. Fischer's principal conclusions are that staining depends on physical and not chemical properties of the dyes and cell-substances, and consequently there are no such things as nuclear stains.

That the cell of the Cyanophyceæ consists of a central body clothed with a true chromatophore and devoid of a nucleus.

That neither the sulphur-bacteria nor the other schizomycetes examined contain a nucleus, and that the interpretation of bacteria as composed of a nucleus denuded of protoplast is incorrect. Also that "Die starke Färbbarkeit der Bakterien mit Kernfarbstoffen ist ein Mythus."

With regard to these and many other points concerning the structure of the bacterium-cell, it would appear probable that Bütschli—whose conclusions are especially criticised—should have something to say: and judging from certain extremely pretty preparations of *Tolypothrix* which Dr. Scott exhibited a few years ago, and from recent work by Mr. Wager on the nuclei of bacteria, it may be that Fischer's interpretation of the stained groups of chromatin-like filaments, granules, &c., as "probably reserve materials," will not be accepted as final.

In any case, the work is a most acceptable contribution to the controversy on this extremely difficult subject, and two of the three plates suggest the question why can we so rarely have English memoirs so well illustrated?

Electricity and Magnetism for Beginners. By F. W. Sanderson. Pp. ix + 244. (London: Macmillan and Co., Ltd., 1897.)

THIS little book is "intended to form a first course for boys who have already learnt the elements of mensuration, statics, dynamics, and heat"; the object being "to introduce the student to the principal laws of" electricity and magnetism, "and give him a working knowledge of the quantities involved."

This object is, on the whole, well attained, though we cannot help thinking that the book would be more valuable to beginners if it covered less ground, and dealt with the elementary portions at somewhat greater length.

The experiments described are well chosen and well arranged. It is intended that the student shall repeat them himself, and for this purpose they are admirably adapted, the apparatus required being of the simplest character. The diagrams, too, are excellent, both in execution and design.

Each chapter ends with a set of numerical examples.

Altogether, a boy who has mastered the book will possess a very creditable acquaintance with the elements of his subject. A. P. C.

Organic Chemistry for the Laboratory. By Prof. W. A. Noyes, Ph.D. Pp. xi + 257. (Easton, P.A.: Chemical Publishing Company, 1897.)

IN this attractive-looking and admirably printed work the chief practical methods of modern organic chemistry are illustrated by directions for the preparation of a large number of compounds by means of typical reactions. The various substances involved are classified according to their constitution, one chapter of the book dealing with acids, another with hydrocarbons, &c., and in all cases the chemistry of the reactions is discussed. Nearly a hundred different preparations are described, some of them of considerable difficulty; but in all cases the directions are clear and sufficient, without being unnecessarily detailed, whilst copious references to original literature are given. The book is intended to serve both for advanced students and for beginners; but, like many other works on the same subject, it is somewhat lacking in suitable experiments to illustrate the earlier portion of the lecture course from which the student derives his acquaintance with the theoretical side of the science. A. HARDEN.

The Reliquary and Illustrated Archæologist. Edited by J. Romilly Allen. New series, vol. iii. Pp. 256. (London: Bemrose and Sons, Ltd., 1897.)

THIS fine volume does credit to British archæology. It is made up of the four quarterly numbers issued this year, and is the most attractively illustrated publication that has come before us for some time. The periodical is, to quote the sub-title, "devoted to the study of the early Pagan and Christian antiquities of Great Britain; mediæval architecture and ecclesiology; th development of the arts and industries of man in the past ages; and the survivals of ancient usages and appliances in the present." The volume has thus a very comprehensive scope, and it contains articles of interest to every archæologist, numerous critical reviews, and notes on archæology and kindred subjects.

The Commercial Uses of Coal Gas. By Thomas Fletcher, F.C.S. Pp. 104. (Warington, Manchester, and London: Fletcher, Russell and Co., Limited).

GAS engineers and fitters will find this little volume, which is a supplement to one on "Coal Gas as a Fuel," worthy of attention. The book contains many notes which will be found particularly serviceable in workshop practice, and in the laboratory as well. One of the chapters "On the Use of the Blowpipe," for workshop purposes, deserves special mention. The book may be taken as a statement of the advantages of coal gas as a fuel.

LETTERS TO THE EDITOR

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The Law of Divisibility.

MAY I briefly supplement my former letter by a few suggestions for the development of the above law?

(1) When δ (or a multiple) appears in N, it may be replaced by cyphers.

Thus if $\delta = 3$, for 235697 write 205007,
$= 7$, do. 200690 or 230090
$= 23$, do. 5007.

(2) Any member of the recurring period r_n may be represented by its negative complement which reaches its maximum at $\frac{1}{2}\delta$.

Thus if $\delta = 7$, period $= \pm 1, 3, 2$;
$= 11$, do. $= 1, -1$;
$= 37$, do. $= 1, 10, -11$;
$= 41$, do. $= 1, 10, 18, 16, -3$.

(3) If the final remainder be negative, its complement must be taken.

Thus if $\delta = 7, 17, 29, 41$,
and $R = -2, -14, -25, -32$,
true value $= 5, 3, 4, 9$.

(4) Final remainders may be found by repeated applications of the requisite formula.

Let $\delta = 41$,
$N = 3205175$ or 3000175
$N_1 = 5 + 70 + 18 + 30$
$= 123 = 3 + 20 + 18 = 41$,

Let $\delta = 37$,
$N = 87172$
$N_1 = 2 + 70 - 11 + 7 + 80$
$= 159 - 11 = 148 = 8 + 40 - 11 = 37$.

Let $\delta = 7$,
$N = 8638$
$N_1 = 8 + 9 + 12 - 8 = 21 = 1 + 6 = 7$.

(5) The group principle may be applied to $\delta = 99, 999, 9999$ &c., where $N_1 = a_2 + b_2 +$ &c.; $a_3 + b_3 +$ &c.; $a_4 + b_4 +$ &c. The first is a test for 11, the second for 37, the third for 101.

(6) Another method is the following:—

Let $N \div \delta + 1 = Q_1$ with remainder r_1,
$Q_1 \div \delta + 1 = Q_2$ do. r_2,
$Q_2 \div \delta + 1 = Q_3$ do. r_3,
&c. = &c.

$$\therefore N = (\delta + 1)Q_1 + r_1$$
$$= (\delta + 1)^2 Q_2 + (\delta + 1) r_2 + r_1$$
$$= (\delta + 1)^3 Q_3 + (\delta + 1)^2 r_3 + (\delta + 1) r_2 + r_1$$
$$= \text{\&c.}$$

Eliminating multiples of δ, we get, when $Q_n = 0$,

$$N_1 = r_{n-1} + r_{n-2} + \text{\&c.} + r_1.$$

If $\delta \pm a$ be used, we get

$$N_1 = a^{n-1} r_{n-1} \pm a^{n-2} r_{n-2} + \text{\&c.} \pm r_1.$$

Putting $a = 1, 2, 3$ we may deal with a wide series of primes, such as

19, 29, 59, 79, 89, 109 &c.
31, 41, 61, 71 &c.
23, 43, 53, 73, 83 &c.;

also with composites, as

119 for 17 and 7, 129 for 43 and 3,
159 for 53 and 3, 201 for 67 and 3,
301 for 43 and 7, 501 for 167 and 3, and so on.

As examples, let $\delta = 399 = 3 \times 7 \times 19$.

$$N = 8293177893$$

$$\div 400^3, r_1 = 293$$
$$r_2 = 144$$
$$r_3 = 232$$
$$r_4 = 129$$
$$400)\ 798 = 398$$
$$1$$
$$399 = 19 \times 7 \times 3.$$

Let $\delta = 299 = 13 \times 23$,
$N = 166371972$
$\div 300^4, r_1 + r_2 + r_3 + r_4 = 72 + 173 + 48 + 6 = 299$.

Let $\delta = 501 = 167 \times 3$
$N = 640550043$
$\div 500^4, 5 - 62 + 100 - 43 = 0$.

From the foregoing I have derived many simple rules not requiring division. HENRY T. BURGESS.

Tarporley, West Norwood, November 4.

A Link in the Evolution of a Certain Form of Induction Coil.

AT a time when much interest is taken in the oscillatory electric discharge and its effects, it may not be out of place to mention that a link in the evolution of the Tesla coil is to be found in a paper by Dove (Royal Academy of Sciences, Berlin, October, 1844; *Electrical Magazine*, vol. ii. p. 67). It is as follows:—The external coatings of two Leyden jars were connected together by a wire spiral. This spiral was surrounded by a secondary insulated spiral. When the jars were so charged that a spark was produced on joining their internal coatings, electricity was induced in the secondary spiral. If to this arrangement of Dove, a cistern of insulating oil be added to contain the coils, and the jars, furnished with a spark gap, be charged from an induction coil, we have one of the combinations which has given such excellent results in the hands of Tesla. In 1831 Faraday ("Experimental Researches," vol. i. § 24) arranged an experiment to discover whether the electrical discharge of a Leyden jar would produce an induced current in his induction coil; he writes: "Attempts to obtain similar effects by the use of wires conveying ordinary electricity (*i.e.* from a jar) were doubtful in results."

The combination due to Dove, is probably the earliest instance of an apparatus in which electrical oscillation in one circuit set up a definite disturbance in a neighbouring coil.

Oxford, November 8. F. J. JERVIS-SMITH.

The Leonid Meteors.

I SHOULD be glad to receive accounts of any brilliant meteors that may be observed on the nights of November 13 and 14 next, for the purpose of computing their real paths in the air. The date and time of appearance of each object should be given, together with its apparent magnitude (compared with the moon, planets or brighter stars), observed course amongst the stars in R.A. and Declination, and estimated duration of flight. Though moonlight will be strong, many observers will be on the look-out for the vanguard of the Leonids, so that should any brilliant meteors appear, they are likely to be noticed at several different stations. W. F. DENNING.

51 Brynland Avenue, Bishopston, Bristol.

Insects and Colour.

THE following incident may throw some further light on the subject brought forward by your correspondent, Mr. J. Parkin, in his letter in your issue of November 4, on "A Bee's Movements in a Room." In the year 1893, the humming-bird hawk moth was particularly common here. On one or two occasions, driving out in a little trap, with a Shetland pony, whose head-gear was ornamented with pyramidal blue rosettes, one of these beautiful insects would fly straight at one of the rosettes, and hover over it for a few seconds, though the pony was going at a trot. It would seem that in this case the colour alone was the chief attraction; the odour being insignificant. But there are, I believe, numerous other instances of insects being attracted in the first instance by colour. I may add that these insects visited chiefly the *scarlet* geraniums in my garden.

ALFRED THORNLEY.

South Leverton Vicarage, Notts., November 5.

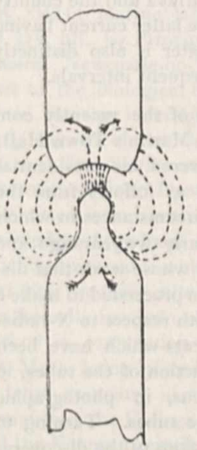
HIGH PRESSURE ELECTRICITY.[1]

THIS book is not a mere ordinary *édition de luxe*, for it is probably the most sumptuous book in connection with electricity that has ever appeared. The life-like vividness of forty-one beautifully executed photographic reproductions of electric brushes and streamers make you hear the banging of the battery of many "ten-gallon" Leyden jars; while the description of these illustrations, from the largeness of the type used, the wide spacing of the lines, the two- to three-inch margin that surrounds them, and the blank page that intervenes between every two pages of printed matter, induces a feeling of luxury in the reader, and makes him hope that the theoretical inferences will be as good as the very thick paper on which they are printed.

Lord Armstrong starts with the very striking experiment which he performed with his hydro-electric machine half a century ago. Two glasses of distilled water were placed near together, and a thread of cotton, which was coiled up in the one, had its end placed so as to dip into the other glass. Then on highly electrifying the glass of water in which the cotton was coiled negatively, and the other glass of water positively, the thread crept out of its glass into the other one, while a stream of water passed in the opposite direction.

From this he has been led to conclude that an electric current consists of two streams—a negative one in the form of a core flowing in one direction surrounded by a sort of sleeve of positive electricity flowing in the opposite direction; and he suggests, on page 24, that instead of negative and positive the names "Inward" and "Outward" would better meet his views.

He cites as an illustration of his theory the formation of the crater at the end of the positive carbon of an electric arc, and the knob at the end of the negative carbon; both of which he considers are produced by the scooping out effected by the "lines of force," which he considers follow some such path as that indicated on the accompanying figure copied from the book.



There are various reasons, however, with which Lord Armstrong is apparently unacquainted, for believing that the scooping-out theory is not correct; for example, when a thin carbon rod is put endways into an arc the rod is simply pointed like a pencil, with no appearance of any directed scooping action. Whereas, if Lord Armstrong's "lines of force" were correct, we should expect to find a cavity scooped out on one side of the carbon rod near the middle of the arc, and another on the other side near the edge. But this only happens when the carbon rod is wide, and is placed so as to split up the arc into two *distinct* arcs.

Some of the illustrations are photographic reproductions of dust figures obtained with brush discharges, while others of them were produced by causing a violent discharge from a large battery of Leyden jars to take place from a metallic disc resting on an insulated photographic plate, the disc being in some experiments positive, in others negative. In other cases two photographic plates were placed back to back with the sensitive sides outwards, and the positive and negative electrodes were placed against the two sensitised surfaces respectively.

The figure formed at the negative electrode was found to be smaller than that produced at the other, and in answer to the question "How can this be reconciled with the assumption that negative and positive action are equal?" the author remarks on page 26:—

"The answer is obvious if we admit that the negative represents suction, and the positive pressure, because in that case the negative flow will be resisted by condensation, while the positive will be helped."

And on page 44 he suggests, as a possible hypothesis, that as in a pump,

"The negative stroke, representing suction, must take the lead of the positive, and will have to draw from a neutral atmosphere. In doing so it will create a deficit in the environment which will aid inductively the impulsive energy of the positive."

On page 49 are described experiments in which negative streams were projected from an annular electrode upon a dust plate with a positive metallic ring beneath, and the author, in reference to the dust figures produced, remarks:—

"Their general appearance is strikingly like pictures of physiological cells; and what is more strange, we see them in every state of fission, from small beginnings to complete separation, and in every case the divided form displays the same internal structure as the original form from which it springs. I have already spoken of electricity as organised motion, and we have here an example of it carried to the very verge of life."

All this is probably intended only as a poetic fancy, but it reads strangely in close juxtaposition with a discussion on matter and motion, ether and atoms.

But, whatever may be the opinion of the theoretical portion of this book, whether we consider that the inward flow of negative electricity and the outward flow of positive are supported by the experiments, there can be no doubt that the illustrations form a series of valuable records of electric discharges. W. E. A.

[1] "Electric Movement on Air and Water, with Theoretical Inferences." By Lord Armstrong, C.B., F.R.S. Pp. vii + 55, and plates. (London: Smith, Elder and Co., 1897.)

THE REV. P. B. BRODIE, M.A., F.G.S.

IN the death of the Rev. P. B. Brodie geological science has lost one of its oldest cultivators, one who so long ago as 1834 was elected a Fellow of the Geological Society, and who was widely known for his researches on the fossil insects of the Secondary formations of England.

Mr. Brodie, who was born in 1815, was the son of an eminent lawyer, and nephew of the distinguished surgeon Sir Benjamin C. Brodie, Bart. He was educated at Emmanuel College, Cambridge, and coming under the influence of Sedgwick, a taste which he had previously manifested for geology was developed into a life-long enthusiasm for the science.

Entering the Church in 1838, the duties of his calling took him as Curate to Wylye, in Wiltshire, and for a short time to Steeple Claydon, in Buckinghamshire. Later on he became Rector of Down Hatherley, in Gloucestershire, and finally Vicar of Rowington, in Warwickshire. In all these districts he found that a rich harvest of geological facts could be gathered.

His earliest observations were on the Purbeck strata of the Vale of Wardour, and he then discovered many insect-remains, and also the Isopod which was named, by Milne-Edwards, *Archæoniscus Brodiei.* Continuing his researches in the Vale of Gloucester, on the Lias and Lower Oolites, he soon found many unrecorded fossils, and notably many remains of insects, and he thus came to publish, in 1845, his well-known "History of the Fossil Insects in the Secondary Rocks of England." An active member, for a time, of the Cotteswold Naturalists' Field Club, Mr. Brodie was later on a staunch supporter of the Warwickshire Natural History and Archæological Society, and a founder of the Warwickshire Naturalists' and Archæologists' Field Club. He was the life and soul of field-meetings, full of energy and high spirits; and at the time of his death he was President of both Warwickshire societies.

Mr. Brodie was the author of many geological papers communicated to the Geological Society, the British Association, and various scientific journals. In 1887 the Council of the Geological Society awarded to Mr. Brodie the Murchison Medal for his long and valuable geological labours; an agreeable testimony to good work achieved by one who, all his life, was a dweller in the provinces. H. B. W.

NOTES.

THE Royal Society's medals have this year been adjudicated by the President and Council as follows:—The Copley Medal to Prof. Albert von Kölliker, Foreign Member R.S.; a Royal Medal to Prof. Andrew Russell Forsyth, F.R.S.; a Royal Medal to Lieut.-General Sir Richard Strachey, F.R.S.; the Davy Medal to Dr. John Hall Gladstone, F.R.S.; the Buchanan Medal to Sir John Simon, F.R.S. Her Majesty has signified her approval of the award of the Royal Medals.

THE following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1898 at the anniversary meeting on November 30:—President: Lord Lister. Treasurer: Sir John Evans, K.C.B. Secretaries: Prof. Michael Foster, Prof. Arthur William Rücker. Foreign Secretary: Sir Edward Frankland, K.C.B. Other Members of the Council (the names of new Members are printed in italics): Prof. William Grylls Adams, Prof. Thomas Clifford Allbutt, *Sir Robert Stawell Ball*, *Rev. Thomas George Bonney*, *Prof. John Cleland*, Prof. Robert Bellamy Clifton, Prof. James Alfred Ewing, *Alfred Bray Kempe*, *John Newport Langley*, *Joseph Larmor*, *Prof. Nevil Story Maskelyne*, Prof. Raphael Meldola, *Prof. Edward Bagnall Poulton*, *William James Russell*, *Dukinfield Henry Scott*, Prof. Walter Frank Raphael Weldon.

WE learn from the *Times*, with regret, that in consequence of the heavy demands on his time in connection with his duties at the Natural History Museum, Sir William Flower, acting on medical advice, has reluctantly resigned the presidency of the International Congress of Zoology, which is to meet at Cambridge on August 23, 1898. Sir John Lubbock, on the unanimous invitation of the General Committee, has accepted the office, and will accordingly preside over the Congress.

WE announce with great regret the death, on October 31, of Prof. Haughton, of Trinity College, Dublin. We hope in a subsequent number to publish an obituary notice of Prof. Haughton.

IT is with much regret that we record the death of Herr Geheimrath Prof. Ernst Schering, of Göttingen, who passed away at Göttingen on November 2, at the age of sixty-four, after a long illness. Schering, besides being professor of mathematics at the University, was director of the Magnetic Department of the Observatory, the seat of Gauss' monumental researches in this branch of science.

THE Queen has conferred the Jubilee Medal upon Prof. W. R. Smith, the President of the Royal Institute of Public Health; Sir George Duffey, President of the Royal College of Physicians, Ireland; Sir William Thomson, President of the Royal College of Surgeons, Ireland; and Mr. Walter Hills, President of the Pharmaceutical Society of Great Britain.

PROF. A. A. MICHELSON, of the University of Chicago, has been elected a member of the International Committee of Weights and Measures, in the place of the late Dr. B. A. Gould.

PROF. HENRY S. PRITCHETT, of Washington University, St. Louis, has been appointed superintendent of the U.S. Coast and Geodetic Survey, as successor to General Duffield.

MR. EDGAR WORTHINGTON has been elected secretary of the Institution of Mechanical Engineers, in the place of Mr. Alfred Bache, who has retired on account of ill-health.

SIR WILLIAM GOWERS is to be entertained at dinner by the Society of Medical Phonographers on November 25. The dinner, over which Sir William Broadbent will preside, is to take place at Limmer's Hotel, and has been arranged for the purpose of congratulating Sir W. Gowers upon his honour of knighthood.

THE members of the Gerlache Antarctic expedition were entertained at Rio de Janeiro by President Moraes, and left on October 28 for Buenos Ayres, *en route* to the Antarctic region.

ON the day of his arrival in New York, Dr. Nansen was the guest of the American Geographical Society, which elected him an honorary member and conferred upon him the Cullum Geographical Medal. He was subsequently the recipient of receptions by the Swedish and Norwegian inhabitants of the city, and the National Geographical Society, Washington, and read a paper on "Some of the Scientific Results of Recent Arctic Explorations" before a special meeting of the American Philosophical Society of Philadelphia. He delivered his first public lecture at New York on November 6.

A REUTER telegram from Rome states that for some days past Vesuvius has been in active eruption, and large quantities of lava have been pouring from the crater called Atrio del Cavallo, which was opened in 1895. The lava has divided into two large streams flowing towards Vitrava and the country north of Piano del Tristre respectively, the latter current having again divided into two. The central crater is also distinctly active, throwing forth ashes and lava at frequent intervals.

ON Friday last the inaugural meeting of the recently constituted Röntgen Society took place at St. Martin's Town Hall, when Prof. Silvanus P. Thompson delivered his presidential address, particulars of which we gather as follows from the *Times*. After giving an account of the circumstances in which Prof. Röntgen made his famous discovery nearly two years ago, and referring to the antecedent investigators of whose work that discovery was a development, Prof. Thompson proceeded to make a brief review of what has been achieved with respect to X-radiations. He first discussed the improvements which have been made in appliances, such as in the construction of the tubes, in the materials used for fluorescent screens, in photographic plates, and in the methods of exciting the tubes. Turning to advances in results attained and to applications of the discovery, he said that, excepting only Lister's introduction of antiseptics and the discovery of anæsthetics, no discovery in the present century had done so much for operative surgery as that of the Röntgen rays. The first great application of the rays had been to the diagnosis of dislocations and fractures, the study of bone disease, and the detection of foreign bodies in various parts of the human frame. The localisation of foreign bodies embedded in more transparent tissue had claimed the attention of many surgeons. In this department Mr. Mackenzie Davidson had devised an ingenious apparatus by which any intelligent person could at once localise to within one-hundredth of an inch the exact position, say, of a needle in the hand or foot, the complicated geometry of oblique projection being simplified down by the instrument itself, and reduced to the application of callipers and a divided scale. As regards the physical problems presented by the rays, while there was much progress to chronicle, there was also a vast prospect opening out of problems awaiting solution. The rays had been found to possess a dissociating, or, more strictly, an ionising effect on the molecules of gases through which they passed, with the result that electrified bodies placed in an atmosphere thus affected were discharged. Further, it was now generally admitted that the rays were not themselves homogeneous—that they were of many kinds, differing in penetrative power, the quality of the mixture depending on the state of the vacuum as well as on the form of the tube and the nature of the emitting surface. The relations between the Röntgen and the kathode rays had been investigated, and important contributions to our knowledge had been made by Mr. A. A. Campbell Swinton, by M. Perrin, and by several Italian investigators. Many speculations had been put forward as to the physical nature of the rays themselves. Crookes, Tesla, and others held them to consist of flights of minute atoms or hyper-atoms; on the other hand, there was an hypothesis that they were merely an extreme sort of ultra-violet light, consisting of transverse waves of excessively minute wave length. Jaumann and, apparently, Röntgen regarded them as due to longitudinal vibrations, while Sir George Stokes had put forward the view that they might be transverse waves, not in regular trains, but consisting of innumerable solitary waves. Another wide field of research was opened up by the discovery of other analogous kinds of rays. That the salts of uranium, glow-worms, fireflies, and sticks of phosphorus should be able without any electrical stimulation to give out rays that could produce photographic action through substances that were opaque to every known kind of light was very suggestive, but such rays were not Röntgen rays, and obeyed different laws. It was clear, he concluded, that their little Society had an abundant field.

A small marine laboratory was opened at Cullercoats on the 21st ult. by Principal Gurney, of the Durham College of Science, Newcastle-on-Tyne. It will form a most useful adjunct to the biological department of the college, as well as a centre for the investigations which have been, and are still being carried on by the Northumberland Sea Fisheries Committee. The district owes the laboratory to the public-spirited generosity of John Dent, Esq., J.P., the Vice-Chairman of the Committee, who has already made excellent contributions to the knowledge of the local condition of the in-shore waters by the trawling excursions which have been carried on since 1892—the year after the three-mile restriction was adopted. The laboratory was formally handed over to the Sea Fisheries Committee, to be worked in conjunction with the Durham College of Science, Mr. Meek being placed in charge of the scientific operations. A large company assembled, representing the Sea Fisheries Committee, the College of Science, the Natural History Society, and the County Council.

The inaugural meeting of the seventeenth session of the Institution of Junior Engineers took place in London on Friday last, when Sir Alexander Binnie, the retiring president, presented the Institution premium to Mr. W. R. Beckton for his paper on "The Protection of Buildings from Fire," after which an address, on "Some Aspects of Railway Work," was delivered by Mr. J. A. F. Aspinall, the newly-elected president.

The twenty-fifth anniversary meeting of the American Public Health Association was held at Philadelphia, October 26-29, Dr. Henry B. Horlbeck, of Charleston, S.C., presiding. Dr. Irving A. Watson, of Concord, N.H., who has for many years acted as secretary, resigned, and was succeeded by Dr. C. O. Probst, of Columbus, O. Among the subjects to which special attention was given were tuberculosis, yellow fever, typhoid fever, and purification of water supply. A sanitary exhibition was held in connection with the meeting.

The *British Medical Journal* understands that Dr. Wright, the Professor of Pathology at Netley, has had an interview with the Commander-in-Chief on the subject of immunising our troops by vaccination against typhoid. Prof. Wright inoculated all the last batch of candidates for the Indian Medical Service, as well as himself and Surgeon-Major Semple. Lord Wolseley's views on the desirability of affording the protection by vaccination against typhoid to our troops are not yet announced. Any measure that gives a fair chance of mitigating the ravages of enteric among our young soldiers in India is worth a trial, provided no immediate danger or risk is incurred thereby, and no such danger attends the inoculations made in the manner devised by Prof. Wright.

At a recent meeting of the New York Zoological Society, it was reported by the executive committee that the plans for the zoological park are practically complete, and that it is imperative that the remainder of the first 20,000*l*. of the building fund should be subscribed at once in order that the plans may be submitted to the Park Board without delay.

Mr. E. E. Howell, of Washington, according to *Science*, has received from the U.S. Government Board of Control an order to construct a relief map of the Yellowstone National Park, for exhibition at the coming Exposition at Omaha. This model, which will be 6 by 6½ feet in dimensions, will be based upon the surveys made by the U.S. Geological Survey, and will represent the geology as well as the topography of the park. The scale will be one inch to the mile, and there will be no vertical exaggeration. The map will, it is said, be very accurate and complete, far surpassing the one made some years ago.

It is stated that there will shortly be placed on the streets of Paris a number of electric cabs, similar to those with which Londoners are now so familiar. One of the largest Paris cab companies is said to have ordered the construction of 100 of the vehicles.

The Guildford Natural History Society have decided to present a petition to the Commissioners of Woods and Forests, praying that Walmer Forest may be reserved as a sanctuary for wild birds, in which they, their nests, and eggs, may remain unmolested throughout the year; that it may not be let at any time for game preserving, or for any purpose inimical to bird life; and that it may remain in perpetuity as a national memorial to the great outdoor naturalist—Gilbert White of Selborne, whose observations were made in its neighbourhood.

The *Journal of the Society of Arts* for the current week publishes a list of the Society's lecture arrangements for the session which is to open on the 17th instant, and from this we extract the following information. Before Christmas a lecture will be delivered by Prof. James Douglas, on "Progress of Metallurgy and Metal Mining in America during the last Half-Century"; and there will be one by Dr. S. Rideal, on "The Purification of Sewage by Bacteria." Among the papers that will be given after Christmas we notice the following:—"The Projection of Luminous Objects in Space," by Eric Bruce; "Aeronautics," by Captain B. Baden-Powell; "The Recent History of Papermaking," by Clayton Beadle; "The Preparation of Meat Extracts," by C. R. Valentine; "Children's Sight," by R. Brudenell Carter. Courses of Cantor Lectures are announced as follows:—"Gutta-Percha," by Dr. E. F. A. Obach; "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley; "India-Rubber," by Dr. D. Morris; "Electric Traction," by Prof. Carus Wilson. Two lectures, suitable for a juvenile audience, will be delivered on January 5 and 12, by Prof. William Ramsay, on "Fire."

THE list of lectures to be delivered at the London Institution from November to February next has been issued, and comprises, among others, discourses on "Signalling across Space," by Prof. Silvanus P. Thompson; "On the Frontier of History in Britain," by Prof. Boyd Dawkins; "The Weather Office and its Work," by Charles Harding; "Microbes—Friendly and otherwise," by Prof. W. B. Bottomley; "My Scrambles amongst the Alps," by E. Whymper; "The Position of the Mammalia in the Animal Series," by Prof. G. B. Howes; "Haunts and Habits of British Birds," by R. Kearton; "Incandescent Gas Lighting," by Prof. Vivian Lewes; "Geological Changes beneath the Ocean," by Prof. John Milne; "The First Crossing of Spitsbergen," by Sir W. Martin Conway. The Christmas course for juveniles will be by Mr. F. Enock, who will speak on "Insects at Home, at Work, and at Meals."

PARTICULARS of lectures to working men, in connection with the Royal College of Science, London, have been published. The first course is to be given by Prof. G. B. Howes, and will consist of six lectures dealing with "The Kinship of the Vertebrata." The first lecture will be delivered on Monday, November 15. Subsequent courses will be given by Prof. Le Neve Foster, on mining, and by Prof. Tilden, on chemistry.

THE Sunday Lecture Society has arranged for the delivery, before Christmas, of the following science lectures on Sunday afternoons, at 4 o'clock, in St. George's Hall, Langham Place. On November 14, "Andrée and the North Pole: a Problem of to-day," by A. Montefiore Brice; November 21, "Wireless Telegraphy," by R. Kerr; November 28, "The Land of Dragon Trees," by Dr. D. Morris; December 12, "Colour," by Dr. C. W. Kimmins; December 19, "Some Animal Co-operative Societies," by Dr. Andrew Wilson.

IT will be remembered that in 1895 the original MS. of Gilbert White's "Natural History of Selborne" was sold by Messrs. Sotheby for £294. It is now announced that the same firm will, on November 25, offer for sale an even more interesting batch of writings by the same author. These MSS. are the original letters which were sent by post by Gilbert White to Thomas Pennant between August 10, 1767, and July 8, 1773. These letters were returned to Gilbert White when he first conceived the idea of writing his famous natural history, and from them was drawn up the autograph MS. sold in 1895. The letters are all holograph but four, which are in the handwriting of an amanuensis, signed by Gilbert White, and all but three occupy four pages folio. They are additionally interesting and valuable from the fact that many of the details recorded in them were altered, omitted, or augmented in the published work. The second lot of Gilbert White MSS. is "A Garden Kalendar," dating from 1751 to 1767. It is the author's holograph manuscript, and occupies 424 pages. This has never been published, excepting the portion May 1 to November 16, 1759; it is in the form of a consecutive diary, recording the writer's almost daily operations on his own land, and notes of the results of experiments tried by him in forcing and hothouse work. All the MSS. have been continuously in the possession of the White family.

THE twentieth annual meeting of the Indian Association for the Cultivation of Science was recently held at Calcutta, and a copy of the report adopted upon that occasion is before us. In the course of the year covered by the report, lectures were delivered before the Association upon various divisions of physical and natural science. The Association does not appear, however, to be in a very flourishing condition, and it needs more financial support to put it on a satisfactory basis. In an oration characteristically Indian, the Honorary Secretary urged the necessity of national support in order to make the Institution worthy of India, and pleaded for the endowment of a Science Institute in the metropolis of India. One passage from this aspiring address reads thus:—"Whether our Association will endure to continue to be the regenerating influence for our country may still be in the region of doubt; but if the relationship of cause and effect be eternal, then I can assure you, gentlemen, that circumstanced as our country is it will have to advance, unless otherwise doomed by an eternal decree—it will have to advance, I say with all the emphasis in my power, through the regenerating influence of science and of science alone, and that, therefore, other but similar institutions will have to take the place of ours." Surely such zeal for the cultivation of science, and faith in the social influence of scientific thought, will not go unrewarded.

THE Meteorological Commission of the Cape of Good Hope have published a valuable discussion of the rainfall of Cape Colony for the ten years 1885-94, based upon the monthly and yearly averages for 278 stations, and accompanied by sixteen explanatory maps. The work has been prepared by Dr. Buchan, and has, therefore, every guarantee of scientific accuracy. We extract a few brief notes from his remarks. The annual map shows that the distribution of rainfall over South Africa to the north of the latitude of Clanwilliam (32° 10′ S.) steadily increases from west to east, the amount on the Atlantic coast falling short of 5 inches; whereas on the east coast, for some distance to the north and south of Durban, it exceeds 40 inches. The smallest mean annual rainfall is 2·45 inches at Port Nolloth; it rises above 10 inches over the eastern and southern regions and above 20 inches in certain restricted regions, including Kimberley and the Cape. In the south-east some places have a mean range above 30 inches, the largest being 38·10 inches at Kologha (lat. 32° 31′ S., long. 27° 21′ E.). The heaviest rainfalls in any year are reported from the south-west of the Colony, and the least in the north-west; at Port Nolloth the fall in the driest year does not amount to an inch. Dr. Buchan traces the causes of the very variable rainfall to the geographical distribution of pressure with the resultant winds therefrom, and to the geographical distribution of temperature.

WE are sorry to notice the report that, owing to the present condition of the sugar industry, the publication of *Timehri*, the organ of the Royal Agricultural and Commercial Society of British Guiana, is to cease with the December number. We have on many occasions drawn attention to the magazine, in the contents of which is always to be found something of interest and scientific value.

UNDER the name *Capra mengesi*, Prof. Dr. Noack, of Brunswick, has recently described a new Arabian wild goat, of which he has obtained specimens from Herr J. Menges, the well-known German traveller and collector. The wild goat of Sinai (*Capra sinaitica*) was known to extend along the mountains down the eastern side of the Red Sea, but this new species is from the Hadramaut range on the coast of the Indian Ocean, which was recently visited by the late Mr. Bent, but apparently still requires further investigation. Prof. Noack also describes a new wolf (*Canis hadramauticus*), from the same district.

Petermann's Mittheilungen contains an able paper, by Dr. Gerhardt Schott, on the currents of the Great Banks of Newfoundland. The most interesting results, obtained from discussion of an immense number of observations, are (1) confirmation of the fact that the so-called "Gulf Stream" does not exist as a warm current east of 40° W., and has no rapid movement east of 60° W.; (2) the Labrador current does not anywhere touch the United States seaboard, and has nothing to do with the "cold wall"; (3) on the bank itself there is practically no current. It appears, unfortunately for navigation, that the positions of the warm and cold streams are not liable to definite changes with the seasons, but are irregular movements difficult to account for.

DR. OTTO NORDENSKJÖLD publishes a short preliminary account of the recent Swedish expedition to Tierra del Fuego, in *Petermann's Mittheilungen*. The expedition consisted of Dr. Nordenskjöld, Herr Dusén (botanist), Dr. Ohlin (zoologist), with two assistants and four porters, and its labours have extended over the summer seasons 1895–96 and 1896–97. From the brief notice published, we gather that contributions of considerable importance to various branches of science, especially, perhaps, geology have been made, the regions explored being of peculiar importance as a connecting-link with the great Antarctic continent.

IN our issue of September 30 (vol. lvi. pp. 520 and 521) we printed a short illustrated account of "The Progress of the Steam Turbine," and many of our readers may like to know that the current issue of the *Electrical Review* contains the first instalment of a lengthy paper on the same subject, which was read a few weeks ago by the Hon. C. W. Parsons before the Institute of Marine Engineers at Stratford.

PART 7 of "Among British Birds in their Nesting Haunts, illustrated by the Camera," by Mr. O. A. J. Lee, has just come to hand. It contains ten plates, and deals with the common guillemot, mallard, razorbill, puffin, crested tit, and red-breasted merganser. The work is published by Mr. David Douglas, of Edinburgh.

A NUMBER of new editions of scientific works have lately been received. First among these publications is the third revised edition of Prof. E. Strasburger's "Kleine botanische Practicum für Anfänger" (Jena: Gustav Fischer). In the four years which have passed since the appearance of the second edition, new knowledge has been obtained and is incorporated in the present issue. The work contains 121 figures reproduced from drawings made by Dr. Strasburger, and the text likewise represents the personal observations of the author. Students of structural botany therefore will find the book a trustworthy guide.—A second enlarged edition has been published of Dr. W. Ostwald's text-book of analytical chemistry, entitled, "Die wissenschaftlichen Grundlagen der analytischen Chemie" (Leipzig: Wilhelm Engelmann). The book was reviewed at length in NATURE (vol. li. p. 482) when it first appeared, and it has now been brought up to date. The chief addition refers to electrochemical analysis. The work is not intended for beginners, but to supply adequate theoretical support to the routine work of general analytical chemistry.—Messrs. J. and A. Churchill have published the third edition of "Elements of Human Physiology" by Dr. Ernest H. Starling. The first edition of the book was reviewed in NATURE in December 1892 (vol. xlvii. p. 146), and the chief changes which it has undergone are in the account of the coagulation of the blood, and in the section on the central nervous system.—The elementary stage of the examination in magnetism and electricity, held by the Department of Science and Art, is well covered by the "Elementary Manual of Magnetism and Electricity" by Prof. Andrew Jamieson. The fourth edition, which has just been published by Messrs. Charles Griffin and Co., provides teachers of the subject with a very helpful text-book.—Messrs. Cassell and Co. have sent us a copy of "Electricity in the Service of Man" by Dr. R. Wormell, revised and enlarged by Dr. R. Mullineux Walmsley. We notice that, though the title-page is dated 1897, the preface is dated November 1893, With one or two slight exceptions, the book appears to represent the state of knowledge at the latter epoch.—A revised and enlarged edition of "A Text-book of Physics," by Prof. Edwin H. Hall and Mr. Joseph Y. Bergen, has come to us from Messrs. Henry Holt and Co., New York. The book is an admirable text-book and laboratory manual for beginners in the systematic study of physics. The course covered is that required for admission to Harvard College, where Dr. Hall is professor of physics; and it comprises the leading elementary facts and principles of physics, and quantitative laboratory work referring to them. Teachers of elementary physics in this country would do well to provide themselves with a copy of the book, for it contains numerous ingenious and instructive experiments. —The second edition of "The Practice of Massage: its Physiological Effects and Therapeutic Uses," by Mr. A. Symons Eccles, has been sent to us by Messrs. Baillière, Tindall, and Cox. The first edition was reviewed at length in NATURE of September 3, 1896 (vol. liv. pp. 411 and 412), and we need now only say that the work has been revised and altered to make room for additional matter, especially with reference to the clinical uses of massage, without increasing the bulk of the volume.—The first part of the second edition of the serial issue of Mr. Howard Saunders's "An Illustrated Manual of British Birds" has reached us from Messrs. Gurney and Jackson. This well-known work, which has undergone revision, needs no recommendation from us.

THE additions to the Zoological Society's Gardens during the past week include two Sloth Bears (*Melursus ursinus*, ♂ ♀) from India, presented by Sir Henry D. Tichborne, Bart.; a Macaque Monkey (*Macacus cynomolgus*, ♂) from Tonquin, presented by Miss Rachel Hunt; two Palm Squirrels (*Sciurus palmarum*) from India, presented by Dr. G. H. Nowell; a Long-eared Owl (*Asio otus*), British, presented by Major-General Alex. A. A. Kinlock; a Salt-water Terrapin (*Malacoclemmys terrapin*) from North America, presented by Mr. H. Arthur Clifton; five Tesselated Snakes (*Tropidonotus tesselatus*) from South-east Europe, presented by Herr Carl Hagenbeck; a Mediterranean Peregrine Falcon (*Falco pincus*), captured in the Mediterranean, presented by Captain Watson; ten Paradise Whydah Birds (*Vidua paradisea*), three Pin-tailed Whydah Birds (*Vidua principalis*), four Crimson-eared Waxbills (*Estrelda phœnicotis*), two Red-bellied Waxbills (*Estrelda rubriventris*), two Yellow-rumped Seed-eaters (*Crithagra chrysopyga*), a Singing Seed-eater (*Crithagra musica*) from West Africa, a One-wattled Cassowary (*Casuarius uniappendiculatus*) from New Guinea, two Jackass Penguins (*Spheniscus magellanicus*) from the Falkland Islands, a Black Wood-hen (*Ocydromus fuscus*) from New Zealand, deposited; a Levaillant's Darter (*Plotus levaillanti*) from West Africa, purchased.

OUR ASTRONOMICAL COLUMN.

THE COMING TOTAL ECLIPSE OF THE SUN.—We must congratulate the British Astronomical Association on the energy they have displayed with regard to the coming eclipse in India. We hear that, in addition to the three official expeditions, a fourth, but unofficial, expedition under their auspices will be sent, and that no less than twenty-six observers have come forward to take part in it. It must not be forgotten that considerable expense is attached to such undertakings, and so large a number of observers shows that the general interest taken in such an event is very considerable.

Those who wish to combine an enjoyable winter's cruise in warm climes, with a view of the eclipse thrown in, may have noticed that the Orient Liner's steamer *Orotava* is timed to leave Colombo on January 20 next, and on her homeward voyage from Australia she will be navigated with a view to being on the line of central eclipse at the time of total obscuration. Passengers can thus proceed to Colombo, and after a short stay there, allowing sufficient time to see Ceylon, return by this vessel home, seeing the eclipse on the way. Particulars can be obtained from the Company's offices in Fenchurch Avenue, E.C.

THE BINARY β 395 = 82 CETI.—Dr. T. J. J. See has found a most interesting double system in the binary β 395, which Burnham was the first to detect (1875) and the last to measure (1891·8). The object was detected with Dr. See's usual sweeping power, namely 500, but before the components could be well divided he had to employ a power of 1500 At first the system was supposed to be new, owing to the great difficulty of observing it, but a search showed that it was none other than the system mentioned above, its cordinates being

$$\alpha = \text{oh. 32m. 9·9s.} \ \delta = -25° \ 18' \ 37''·3 \ (1900·0).$$

The most striking feature of this binary is that since its last measurement the orbital motion has been so great that the whole aspect of the system is changed. Nearly one and a half revolutions have been performed since 1875, and, curiously enough, as the companion returned to the same general position in 1886, the "observers of that and the following years failed to recognise that any sensible motion had intervened."

Dr. See has calculated from all the published observations the orbit of this binary (*Astr. Nachr.*, No. 3455), and he finds it of great eccentricity and revolving in the short period of 16·3 years.

Thus 82 Ceti becomes an important system, and should be carefully watched during the next eight years. Only three other systems revolve more rapidly, namely, β 883 in 5·5 years, κ Pegasi in 11·42, and δ Equulei in 11·45 years.

TELESCOPIC SEEING.—The Lowell Observatory is not of a fixed but of a migratory nature. Like a bird which at some period of the year changes its locality for warmer climes, so this observatory is moved to a region where the air is more suited at that time for better telescopic seeing. Oscillating between Flagstaff, Arizona, and Tacubaya, Mexico, Mr. Lowell is able to take advantage of the periods of good seeing at each of these stations. Both localities satisfy the now well-known geographical and meteorological conditions, and while Flagstaff is rather too far north, bordering on the great cyclonic movement in the north temperate zone in winter, the neighbourhood of the city of Mexico is not affected by this disturbance. The latter station is not, however, found to be ideal, owing to conditions of local topography. What these conditions are will be found stated by Mr. Lowell in his discussion on the capabilities of these two stations (*The Observatory* for November, No. 259).

The well-known observer, Dawes, always used to judge the "goodness" of the night by the size of aperture that could be satisfactorily used; thus he would speak of a one-inch night, three-inch night, up to an eight-inch night, his largest aperture being of eight inches. We are now finding out how accurate this system was, for, owing chiefly to the work of Mr. Douglass, the controversy between large and small apertures seems to be a question of the wave-lengths of the air-waves. An idea of the nature of these small air-waves will be gathered from Dr. See's interesting article in the *Astronomische Nachrichten* (No. 3455), and the diagrams shown illustrate the main conditions for good and bad seeing. These waves vary in different currents from half an inch to several feet. In cases where they move in the same direction and at a great rate the seeing is very bad. With moderate-sized waves moving slowly the definition is generally very fair. Often cross-currents occur, and when fine waves move in all directions the definition is never good, but for cases of very fine seeing only very slight traces of gently moving waves can be discerned. Theoretically for the best seeing there should be no trace of movement at all. Dr. See points out, in another article in the same journal, that the scintillation of the fixed stars can be very easily explained on this wave theory, and the experiments which he has carried out tend to corroborate this view.

THE NOVEMBER METEORS.—At the latter end of this week the earth passes through that stream of meteors which gives us a yearly display on or about the 14th of this month. Mr. Denning, who is our chief authority on this subject, and whose admirable memoir on this special swarm should be carefully absorbed, tells us that the morning hours of the 14th should be more especially devoted to their observation, although watches should be commenced a day beforehand and prolonged until the 16th. It is not, however, until the year 1898 that we expect to meet the most dense parts of the swarm, but on former occasions striking displays have been witnessed a year or two previous to the chief one, and this year we hope will be no exception. Let us trust that the weather will not be so unfavourable as it was last November.

THE CONNECTION BETWEEN THE CHARACTERS OF ISOMORPHOUS SALTS AND THE ATOMIC WEIGHT OF THE METALS CONTAINED.

IN order to assist in elucidating the question of the relationship between the chemical composition of solid substances and the nature of the crystals which they are observed to form, both as regards the exterior geometrical configuration and the interior physical character of such crystals, a series of researches were commenced by the author six years ago, having for their immediate object the exact determination of the differences presented by certain well-defined series of isomorphous salts. The differences in question, due to the different nature of the interchangeable chemical elements, belonging to the same family group, which by their mutual replacement give rise to the series, are so small in the case of the morphological constants, that extremely refined methods of investigation are requisite in order to detect and determine them. A large amount of detached data had previously been accumulated in crystallographic literature, but a very small proportion was characterised by the requisite degree of accuracy, and no organised attempt had hitherto been made to investigate any definitely related series of crystallised compounds in a sufficiently detailed and accurate manner. The care and precision demanded will be at once apparent when it is pointed out that the use of slightly impure or imperfect crystals, or the occurrence of slight errors of orientation in grinding out of the crystals the section-plates or prisms requisite for the optical portion of the work, would be sufficient to render the results valueless for the purpose in view. In fact such sources of error have in certain cases been shown by the author during the progress of the work to have led previous observers to conclusions diametrically opposed to the truth.

It was decided to choose, as most suitable for such a study, certain series containing in their different members the three alkali metals potassium, rubidium, and cæsium, on account of the very definite relationship and considerable intervals between their atomic weights, and the extreme electro-positive nature of the group, which latter fact rendered it likely that the differences in question would be here at a maximum. These three metals belong in the strictest sense to the same family group, and their atomic weights are respectively 39, 85·2, and 132·8, the atomic weight of rubidium being thus almost exactly the mean of the values for potassium and cæsium. The particular salts chosen, on account of the general excellence of their crystals, were the normal sulphates and selenates, and the double sulphates and double selenates which these salts form with the sulphates and selenates of magnesium, zinc, iron, manganese, nickel, cobalt, copper, and cadmium. The work on the sulphates, double sulphates, and selenates has at length been completed and presented to the Chemical Society (*Journ. Chem. Soc.*, 1893, 337; 1894, 628; 1896, 344; 1897, 846), and the investigation of the double selenates is now in hand. The choice of the double salts has proved equally as fortunate as that of the simple salts, inasmuch as the influence of the alkali metal is found to be of a vastly preponderating character compared with that of the dyad metal, and hence the eight groups of these salts have furnished so many independent examples of the influence of the atomic weight of the alkali metal. No effort or expense has been spared to render the work absolutely trustworthy and of a final character. The goniometers and other optical instruments employed have been without exception the most accurate that could be constructed, and the observations have been more numerously repeated upon different crystals than has ever before been attempted. Moreover, great care has been bestowed upon the preparation of perfectly pure specimens of the salts, no material being accepted which did not yield absolutely satisfactory results upon both spectroscopic and ordinary gravimetric analysis. Besides goniometrical and optical investigation, the work has included exceptionally careful determinations of the relative density of the salts in the crystallised condition, in order to afford data for the calculation of the volume relationships and of the molecular optical constants. Moreover, the observations have been extended to other than the ordinary temperatures, in order that the deductions shall not be subject to the objection that they may be simply fortuitous for a particular temperature.

Before commencing the optical part of the work attention was concentrated upon devising an instrument which should enable a section-plate (slice), or a 60° prism, to be ground out of a crystal with precisely such an orientation as might be desired, with respect to the natural faces, and therefore to the morphological axes. For the whole of the optical investigation is carried out by means of such plates and prisms of known orientation, the former being requisite for the establishment of the positions of the principal optical planes, the measurement of the optic axial angle, and the study of the interference phenomena, while the latter are essential for the determination of the three refractive indices. Manifestly, therefore, the accuracy of the optical results depends primarily upon the precision with which the desired orientation of these plates and prisms is attained. Hitherto crystallographers who have investigated the optical properties of the crystals of laboratory preparations, which are so much softer and more friable than mineral crystals, have been content either to employ plates or prisms formed by suitably disposed natural faces of the crystals themselves; or, failing such, to prepare them by grinding the crystals in oil upon a

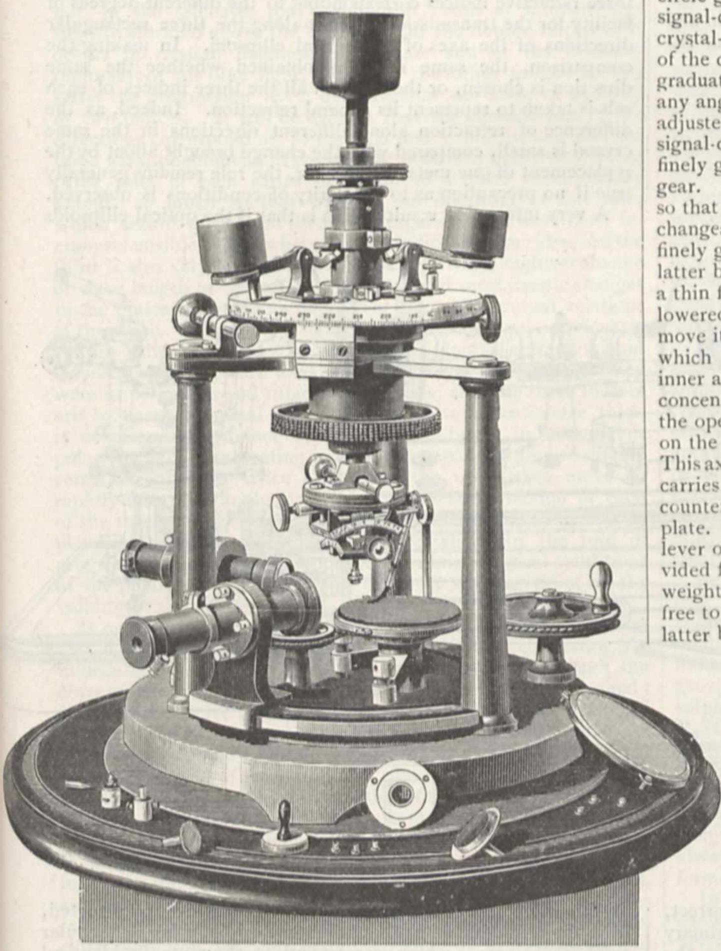


FIG. 1.

ground-glass plate, the crystal being held between the finger and thumb during the process. The difficulty of thus obtaining a plane surface having the desired orientation must be at once apparent, to say nothing of the imminent risk of breaking the crystal. At the best such a method can only be approximate, and it is attended with so much that is troublesome and vexatious that the investigation of a large series of compounds, in the detailed and accurate manner which the author desired, would be impossible.

After much consideration an instrument was eventually devised, and constructed for the author by Messrs. Troughton and Simms, which achieves the desired object in a most satisfactory manner. The author has no hesitation in ascribing the success which has attended the investigation to the admirable manner in which this instrument performs its functions. More than five hundred plates and prisms have already been prepared by its aid and employed in the work; and never once, for instance, has a plate which was desired to be perpendicular to the acute bisectrix of the optic axes failed to exhibit the interference figure by convergent polarised light precisely symmetrical to the centre of the field, as it should be. Moreover, not more than half a dozen crystals have been broken during grinding, and absolutely no plates or prisms have required to be rejected on account of want of accuracy of orientation. Further, what was by the old method a most tedious and disagreeable part of crystallographical work, now becomes one of the most delightful and interesting.

The instrument will be found fully described in the *Transactions* of the Royal Society (1894, A, 887), but a few words here as to the principles of its construction may not be without interest. It is represented, by the kind permission of the Royal Society, in Fig. 1. It may be succinctly termed a grinding goniometer, for it combines an accurate, suspended, horizontal-circle goniometer with a grinding apparatus. The telescope and signal-collimator, together with the circle and the suspended crystal-adjusting apparatus, form the goniometer. The segments of the circular movements of the adjusting apparatus carry finely graduated silver arcs, in order to enable the crystal to be set at any angular position, with respect to any zone of faces previously adjusted parallel to the axis with the aid of the telescope and signal-collimator. The grinding apparatus consists of a small finely ground glass disc, capable of being rotated by hand driving gear. By a simple device the latter is made almost frictionless, so that the disc is rotated almost without effort. Three interchangeable discs are provided, the second being of extremely finely ground glass, and the third of polished glass, these two latter being employed for polishing; all are used lubricated with a thin film of oil. The axis of the instrument is capable of being lowered or raised, so as to bring the crystal to the grinder or remove it, by means of a large milled-headed nut near the summit, which engages with a screw thread on the upper part of the inner axis. In addition to this, however, there is another outer concentric axis capable of vertical movement, intended to enable the operator to regulate the pressure with which the crystal bears on the grinding surface, in order to avoid breaking the crystal. This axis slides in the cylindrical bore of the rotatable cone which carries the circle, and it is capable of being fully or partially counterpoised by two weighted levers carried above the circle plate. It is usually found most convenient to throw the back lever out of gear during the grinding, by raising a screw provided for the purpose on the circle plate, thus leaving half the weight of the axis to bear downwards when the front lever is free to act, and then to more or less curtail the freedom of the latter by gentle manipulation with the left hand, while the right hand is used to rotate the driving pulley of the grinding gear. After a little practice the pressure is nicely regulated almost involuntarily by the left hand in accordance with the "feel" of the grinding, rendering it most unusual to crush the crystal operated upon.

Continuous use of this instrument has proved it to be all that can be desired for use with the crystals of chemical preparations. A somewhat larger instrument has since been constructed for the author, and was described in the *Proceedings* of the Royal Society (57, 324), for use either with chemical preparations or with the harder crystals of minerals; this instrument includes an independent diamond-fed cutting apparatus, and a large selection of metallic and other grinding and polishing laps, so that plates or prisms of even the hardest natural gems can be cut and subsequently ground and polished in an equally satisfactory manner. A duplicate of this instrument is included in the National Collection in the South Kensington Museum.

A further original piece of apparatus, which the author has also found invaluable in the optical part of the work, is a spectroscopic monochromatic illuminator, a description of which will be found in the *Transactions* of the Royal Society (1894, A, 913). It has enabled the author to make observations in every case for six wave-lengths at suitable intervals in the spectrum, and has proved particularly useful inasmuch as each of the series of salts investigated has included at least one member which exhibited exceptional optical properties, generally involving crossed axial plane dispersion of the optic axes, in which instances the command of an illuminator which could be made to yield light of any desired wave-length enabled the phenomena to be studied with a completeness hitherto unattainable. In brief, the apparatus is a spectroscope with two collimators, the slit of the first being as usual for the entrance of the rays from the source of light, in the author's case the electric arc, while the slit of the second is employed as a selecting slit as in Captain Abney's well-known apparatus. The two optical tubes, however, remain fixed, while the dispersing apparatus, a single large prism of high dispersion, is made to rotate so as to bring the various parts of the spectrum across the selecting slit in turn. The selected ray issuing from the second slit is slightly diffused by a screen of finely ground glass carried in a short sliding tube in front of the slit, which is all that is required in order to flood the whole field of any of the author's observing instruments, such as goniometers, polariscopes, and microscopes, with evenly distributed monochromatic light. The accompanying illustration, Fig. 2, shows, by the kind permission of the Chemical Society, the arrangement as actually used with the gonio-spectrometer in the determination of the refractive indices.

Having thus described the difficulties of the investigation and the measures taken to overcome them, a brief outline of the results attained up to the present will now be given.

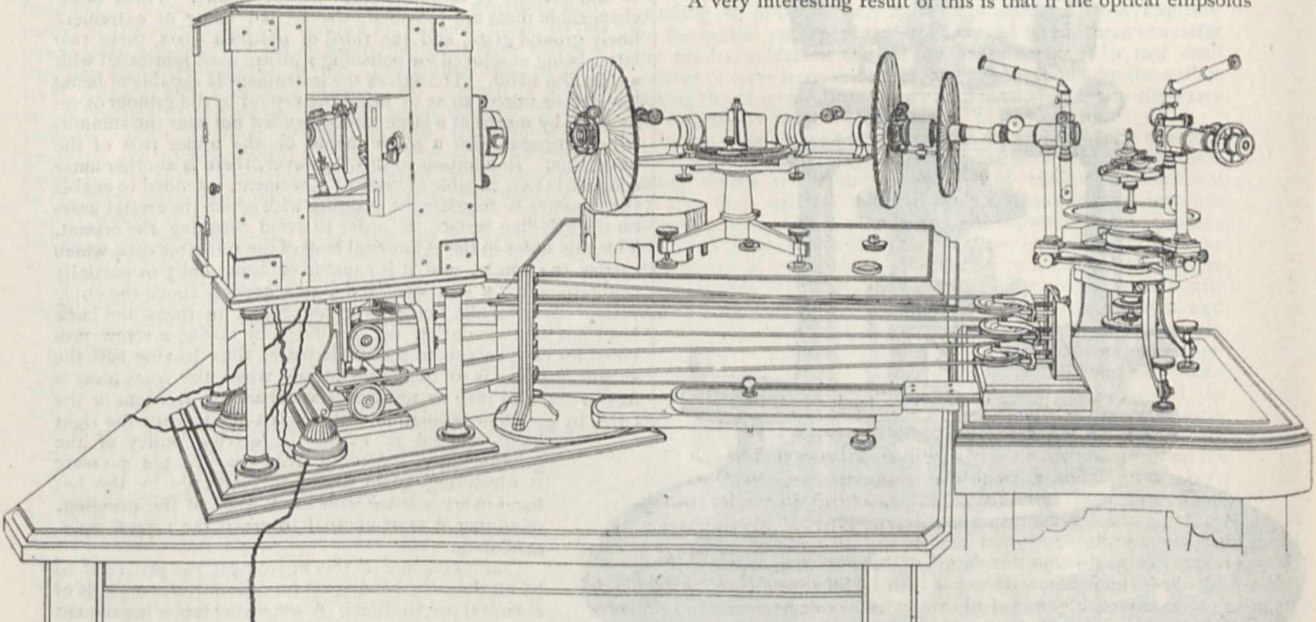


FIG. 2.

The use of the term "isomorphous" is not strictly correct, except in the cases of such series as crystallise in the primary forms of the cubic system, in which, for geometrical reasons, the interfacial angles are always identical. The normal sulphates and selenates of the three alkali metals under consideration crystallise, anhydrous, in the rhombic system, and the double salts of the series $R_2M(SO_4)_2.6H_2O$ in the monoclinic. The same planes are common to all the six simple salts, the replacement of sulphur by its family analogue selenium not effecting any change in this respect; likewise the double sulphates are characterised by planes common to their series. But corresponding interfacial angles on the different members of the same series are not identical, but differ by amounts varying from a few minutes to a couple of degrees. They are much smaller in the simple salt series than in the double salts. The result of elaborate measurements has revealed the fact that, without a single exception, the values of the angles of any rubidium salt are intermediate between those for the corresponding potassium and cæsium salts. There is consequently a progression in the angles of inclination of the crystal faces following the order of progression of the atomic weights of the alkali metals. Moreover, as a natural corollary, there is a corresponding progression in the morphological constants, the axial ratios. Still further, the influence of the nature of the metallic atoms is observed to exercise a curious effect upon the prevailing habits of the crystals. For example, the sulphates and selenates of potassium exhibit preponderating development of the brachypinacoid, the crystals usually being tabular in this direction; on the other hand the cæsium salts are characterised by the prominence of the basal plane, while the rubidium salts are distinguished by a prismatic habit due to the predominance of a brachydomal form intermediate between the two planes just mentioned.

Turning now to the optical properties, it has been found to be a rule without exception that the refractive indices of any rubidium salt are intermediate between those of the corresponding potassium and cæsium salts, and nearer to the former than to the latter, the differences being as one to three. In accordance with the biaxial character of the crystals, each salt has three refractive indices corresponding to the different degrees of facility for the transmission of light along the three rectangular directions of the axes of the optical ellipsoid. In making the comparison, the same result is obtained whether the same direction is chosen, or the mean of all the three indices of each salt is taken to represent its general refraction. Indeed, as the difference of refraction along different directions in the same crystal is small, compared with the change brought about by the replacement of one metal by another, the rule remains generally true if no precaution as to similarity of conditions is observed.

A very interesting result of this is that if the optical ellipsoids of the three rhombic sulphates or selenates are constructed, from the refraction data, about the same origin, using rectangular axial coordinates, which correspond to the mutually identical axes of morphological and optical symmetry, they are found to envelop each other; supposing the ellipsoid to be the optical indicatrix of Fletcher (the optical reference surface now universally employed), the indicatrix for the cæsium salt is the outer one, and that for the potassium salt the innermost, while that corresponding to the rubidium salt lies between the two, without touching either, but nearer to the innermost. In the double sulphate series the indicatrix likewise expands as the atomic weight of the alkali metal rises, but monoclinic symmetry only demands that one of the axes of the indicatrix shall be identical with the single symmetry axis of the system, the other two rectangular axes of the indicatrix being free to move together in the symmetry plane. The expansion of the indicatrix when potassium is replaced by rubidium or the latter by cæsium, is actually found to be accompanied by a rotation for several degrees about the symmetry axis, and the amount of this interesting rotation is more than twice as much for the latter chemical change as it is for the former.

The double refraction is also progressively affected by the replacement of potassium by rubidium and the latter by cæsium, the amount varying inversely as the atomic weight of the metal. Some very remarkable phenomena follow from this rule, owing to the fact that the initial amount of the double refraction in the potassium salt of any series or group is already very small. For a comparatively slight diminution is sufficient to bring it to zero, and even to go further and reverse its sign. As the three refractive indices of any salt are not equidistant from each other in value, and are affected to different extents by the same chemical change, they never in either the rubidium or cæsium salts become reduced to absolute identity at the same time, but become equal in pairs for specific wave-lengths of light and degrees of temperature. When this occurs the crystal becomes for that wave-length and temperature temporarily uniaxial in its optical comportment. The particular salt in which this occurs varies in the different series. In the sulphates it is the rubidium salt, in the selenates the cæsium salt, both at temperatures slightly elevated above the ordinary; in the double sulphates it occurs in cæsium magnesium sulphate and at the ordinary temperature for blue light, while in the other groups of this series the progression never quite reaches the state of equality of two indices. It will be evident that the distribution of the directions corresponding to the α, β and γ indices, and also the optic axial phenomena in convergent polarised light, vary in the three salts of each series or group to a quite extraordinary extent; so much so that without the discovery of this rule, which affords the key to them, the vagaries must have been incomprehensible. For whenever two indices become identical the third is also very nearly so, and consequently the slightest change of wave-length or temperature brings about most drastic changes in the optical phenomena dependent upon the mutual relations of the three. The most striking case is that of cæsium selenate. At the ordinary temperature the sign of double refraction and disposition of the optic axes are already reversed from what they were in potassium and rubidium selenates, and the three indices are so nearly identical that a section plate a centimetre thick is necessary to produce an interference figure in convergent polarised light. On heating gradually to 250°, the sign of double refraction changes twice over, and the optic axes move so rapidly that their acute bisectrix occupies the direction of each of the three morphological axes in turn. That these remarkable phenomena are precisely what are demanded by the rule of progression above enunciated, given the initial optical conditions of the potassium salt, is perhaps the most striking proof of the validity of the rule.

It may be here mentioned that double sulphates of potassium and manganese, and potassium and cadmium, containing six molecules of water, have not yet been obtained, although the corresponding rubidium and cæsium salts are readily formed; yet from the above rule, and others which have been indicated for the other properties, the author has been able to predict the morphological and optical constants which these salts will probably exhibit if ever they are obtained.

The determination of the densities of the crystallised salts has enabled the molecular optical constants to be calculated, with the aid of the formulæ of Lorenz and of Gladstone and Dale. It has been found that they exhibit a similar progressive increase following the increase in the atomic weight of the alkali metal, and that the increase is always greater when cæsium replaces rubidium than when the latter replaces potassium. The molecular refraction for the crystallised state of the sulphates and selenates was also compared with that for the state of solution in water, specific determinations of the density and refraction of highly concentrated solutions of known strength being made for the purpose. It was found that while the values for the two states are approximately the same, there are slight differences, due to the change of state, which observe a distinct progression; for they vary directly as the specific refractive energy and inversely as the atomic weight of the alkali metal. In both series the refraction equivalent of the potassium salt rises by 2½ per cent. when the salt is dissolved in water, and that of the rubidium salt by 1 per cent., while that of the cæsium salt decreases by ½ per cent. This interesting order of the differences clearly demonstrates the quantitative influence of the nature of the alkali metal upon even the smallest details of the physical properties; and the fact that the sign of the differences passes during the progress from positive to negative, indicates the substantial accuracy of the principle enunciated by Dr. Gladstone in 1868 that "the refraction equivalent of a solution is the sum of the refraction equivalents of the solvent and the substance dissolved," by the application of which principle the calculations for the state of solution were made.

The molecular volumes of the members of each series likewise exhibit the order of the atomic weights of the alkali metals, but the progression again proceeds more rapidly than in simple arithmetical proportion to the latter. A point of particular interest was elicited with respect to the volumes of the double sulphates, which throws a strong light upon the nature of those salts. It was found that the volume of the alkali sulphate is the same in the double salt as it is for the simple salt itself, that is to say, the simple alkali sulphate enters into the structure of the double salt without suffering any contraction in volume. This fact, contrasted with the very large contraction which accompanies the chemical union of the elementary constituents of the simple sulphates, negatives the possibility of chemical combination of the molecular constituents of the double salts. This, together with other facts which the investigation has brought to light, has led to the important conclusion that the composition of these double salts is simply a result of the aggregation of the molecular constituents in a particular type of homogeneous structure, in which they find stablest equilibrium, the very nature of this structure ensuring that the component simple molecules are always present in the same, the observed, proportion. The elucidation and definition of all the possible types of homogeneous structures have recently been elaborately worked out by Federow on the continent, and Barlow in this country, and the precise correspondence between the possible types of homogeneous structures and the observed varieties of crystal symmetry is now established beyond all doubt. The author has been able to indicate, moreover, the particular member of Barlow's classification corresponding to both the simple and double salt series.

The conclusion just referred to, regarding the nature of the double sulphates, taken in connection with other facts which the author has established, leads to a further one of a still more far-reaching character, namely, that the units of a homogeneous crystal structure are the simple chemical molecules themselves, and that the current assumption that the crystal unit is a more or less complex aggregation of chemical molecules is quite unnecessary and in general erroneous. This conclusion is further strongly supported by some recent work of Fock, on the solubilities of mixed crystals, based upon the theory of solid solutions.

Before leaving this interesting subject it should be mentioned that a method has been found, by combining the molecular volume with the morphological axial ratios, of determining the relative distances apart of the centres of contiguous chemical molecules of the sulphates and selenates, and of contiguous groups of the eight component chemical molecules of the double sulphates, each such group corresponding to the generic formula $R_2SO_4.MSO_4.6H_2O$. A comparison of these "distance ratios" shows that the replacement of potassium by rubidium, and of the latter by cæsium, is accompanied by a progressive increase in the separation of the structural units or groups of units in every direction, corresponding to the progress of the atomic weight of the alkali metal, and that the latter replacement always gives rise to a greater extension of the structure than the former.

In conclusion, the net result of the investigation has been to show that the whole of the morphological and physical properties of the crystals of each of these isomorphous series exhibit progressive variations, which follow the order of progression of the atomic weights of the alkali metals which the salts contain. Hence it may be said that these variations are functions of the atomic weight of the alkali metal, and it has been shown that the function is usually one which involves higher powers than the first. Of course atomic weight is only one of the numerous properties of an element, but it is doubtless the most convenient reference constant that could be chosen to express fundamentally the difference in the essential nature of the atoms of different elements. It is this difference in essential nature which gives rise to the rules which have been brought to light by the investigation; and the author desires to make it quite clear that atomic weight is merely employed as the basis of reference because it is the aptest expression of such difference, and not because of any virtue in atomic weight *per se*. The fact that the rules are equally applicable to series so widely different as the rhombic sulphates and selenates and the monoclinic double salts, appears to indicate their application to isomorphous series in general. Hence the author concluded his last communication to the Chemical Society in the following words: "The difference in the nature of the elements of the same family group which is manifested in their regularly varying atomic weights, is also expressed in the similarly regular variation of the characters of the crystals of an isomorphous series of salts of which these elements are the interchangeable constituents."

A. E. TUTTON.

THE JACKSON-HARMSWORTH ARCTIC EXPEDITION.

THE first meeting of the present session of the Royal Geographical Society took place at the Queen's Hall, Langham Place, on Monday night last, when Mr. Frederick G. Jackson lectured on the expedition led by himself to the Arctic regions. For the following abridged account of the lecture we are indebted to the *Times*:—

It was in August 1873 that the land afterwards known as Franz Josef Land was first accidentally discovered by the Austro-Hungarian expedition, under the leadership of Weyprecht and Payer. The following spring Payer made three journeys up and in the neighbourhood of what he then named Austria Sound. Arctic authorities advocated the route to the north suggested by Payer's impression that there was land still further to the north in and beyond the eighty-third degree, and land to the north-west reaching almost as far, and it was on Payer's observations that Mr. Jackson formulated his plans in the latter end of 1892. Unfortunately his expectations were fated to disappointment by the non-extension of the land to the north. His plans embraced not only an advance in a northerly direction, but the mapping-in of the coast-lines of Franz Josef Land, a thorough examination of that country, in taking scientific observations, and making collections generally. Those plans they had been able to carry out; and scientific observations had been carried on uninterruptedly for three years. They had also practically completed the map of Franz Josef Land, and settled the Gillis Land question. For some time the sinews of war were conspicuous by their absence, and little encouragement was given, but eventually Mr. Alfred Harmsworth generously offered to provide the necessary funds for the proposed expedition. They left the Thames on July 12, 1894, in the steam yacht *Windward*, calling at Archangel. Then they proceeded east, skirting the northern shores of Kolguev Island to Kharborova, a Samoyed settlement on the Yugor Straits, to take on board their thirty dogs and some fresh reindeer meat. They then steamed north through the Barents Sea, making for Bell Island, Franz Josef Land. The mass of islands of which Franz Josef Land was comprised consisted of high glacier-land rising to 2000 feet, covered with an ice-cap some hundreds of feet in thickness, and fronted along the shore by high perpendicular glacier faces from 30 feet to 80 feet in height. At rare intervals high black basaltic rocks jutted out of the ice near the shore, forming the only conspicuous landmarks. In front of these rocks the broken-down débris from the cliffs had formed a plateau, or shore, upon which a certain amount of stunted Arctic vegetation existed. Here might be found a few poppies, saxifrages, mosses, lichens, &c. Everywhere else, with the exception of a few low islands, the ice-sheet overran everything. Thick mists generally overhung this land; violent gales were frequent, combined with heavily falling and driving snow. Finding no suitable site for their hut, they returned to Cape Flora, a high basaltic cape 1400 feet high, beneath which they pitched their camp, as being the most favourable spot they had yet seen, one of the strongest inducements being the presence of a large loomery there in the high rocks, and the known presence of bears and walruses throughout the year. This they reached on September 8. They at once set to work to shoot bears and walruses for the winter, and to put up their log hut, which was named "Elmwood," and to make themselves as comfortable as circumstances would allow. On the return of the sun, about the middle of February, they got ready to start, and on March 9 Mr. Armitage and he took a preliminary journey with the object of making a depôt of provisions to the north and of ascertaining the character of the travelling in that direction. In the beginning of April they got under way with three ponies and a number of sledges, being accompanied for the first week by Dr. Koettlitz and young Hayward with one pony and sledges. Soon after rounding Dundee Point they discovered that the existing maps were not quite in accordance with fact. To the northward lay floe ice where land had been mapped in; and it was not till they reached the latitude of Point Arthur that they could discern land to the westward. To the south-west appeared open ocean. The weather now became very bad, and they were frequently confined to their tent for days together. Constant gales and driving snow impeded their advance, and the floe ice itself became very unstable with water in the deeper layers of the snow, so that they were frequently wading about in slush above their knees. They, however, pushed on. Richthofen Peak could nowhere be discerned, and no hill worthy of the name of mountain could be seen in any direction, although they were within half a mile of its supposed site. On April 30 they rounded Cape Fisher, and to the north appeared a low island, which in the distance had rather a volcanic appearance, owing to a cup-shaped elevation upon it. On May 1 they rounded Cape M'Clintock, a low weathered cape of columnar basalt, projecting out of the ice-clad land behind. A striking feature of this rock was a pillar of columnar basalt standing up in front of it. Thus it was in April 1895 that they discovered the Queen Victoria Sea, which he named after her Majesty. They reached a point 81° 20′ N. They carefully mapped in the whole coast-line, although the weather was exceedingly unsuitable for taking bearings. On May 4 they started back in a strong wind, dense mist, and driving snow, returning by the same route as they had come up. The difficulties of the floes daily increased. They had constantly to haul the ponies out of the snow morasses with ropes round their necks. They would then go for a few yards further and would flounder in again. They frequently had to take the sledges on themselves, leading the ponies through especially bad places, and had to go over the same ground thirteen times to effect this. On their return journey they got a view of the land to the north-west, which appeared to consist of islands. They returned again round the cape that he had named Cape Richthofen, thus giving themselves an opportunity of discovering the whereabouts of Richthofen Peak, if such existed; but they again failed to see any sign of such a hill in any direction. On May 12 they reached their hut at Cape Flora, getting the ponies back in the nick of time. After their return they were busy with botanical, geological, and other examinations, and in fitting up their whaleboat, the *Mary Harmsworth*, for a journey round the south-west coast as soon as the *Windward* should break loose from her winter quarters and depart for home. This she did on July 3, after being cut out of the ice. To the southward there appeared to be little ice, and from an altitude of over 1400 feet little more than open sea could be discerned. The other expeditions made by Mr. Jackson during his stay were described, and the lecturer concluded by saying that, so far from viewing Franz Josef Land as a favourable route to the Pole, his experiences now led him to believe it to be one of the worst; and although he had, in common with other Arctic explorers, the greatest desire to stand upon that mathematical point, still he had no sympathy with an attempt to reach the Pole as a mere athletic feat alone, but considered that geographical and other scientific work should always be included in the plan.

REPORT ON TECHNOLOGICAL EXAMINATIONS.

THE report on the work of the Examinations Department of the City and Guilds of London Institute for the session 1896-97 has just reached us, and is as usual a very business-like and interesting publication. We make a few extracts from it.

There has been a marked development in the work of the Examinations Department of the Institute during the past Session, as shown not only in the larger number of classes in Technology registered by the Institute, but also in the increase in the number of students in attendance at such classes, and of candidates for examination. This development is due to the further provision of facilities for technical instruction, and also to the fuller recognition of its value and importance.

The report before us shows that the Institute has endeavoured in various ways to assist this forward movement

Since the Technological Examinations were first undertaken by the Institute, the organisation of technical instruction has been greatly promoted by the Educational Committees of County Councils, with which the Institute has established close relations; and many of the improvements, which have been introduced into its schemes of instruction and examination, have been due to the suggestions of the organising secretaries of those committees.

In London, through its representation on the Technical Education Board of the London County Council and on the London Polytechnic Council, the Institute has taken a large share in the direction and organisation of the educational work of the Polytechnic Institutions; and in accordance with the original scheme of the Charity Commissioners for the administration of those bodies, the examinations of the Institute have been generally adopted, and the instruction given in those Institutions, although in no way unduly subordinated to examination influences, has been legitimately, and, it is believed, usefully, directed by the Institute's requirements.

During the session under review the number of students in attendance at the classes registered by the Institute was 32,566, as against 29,494 in the previous year, and the number of candidates' papers examined was 12,868, as against 12,099.

To enable the Institute to adapt its schemes of instruction to local needs and to the changing requirements of different trades, and to make its examinations a true test of the technical knowledge and ability of the artisan students who have been trained in its registered classes, frequent changes are made in its syllabuses of instruction, and tests of workmanship, wherever practicable, are made a part of the examination. Several alterations have been made in the programme of instruction and examination for the session 1897–98, to some of which we draw attention. Thus, in the syllabuses of textile subjects, important changes have been introduced.

Reference was made in last year's report to a discussion by a committee of experts in Lancashire of the conditions of examination in cotton weaving. The report of that committee was received by the Institute early in the session, and subsequently a conference was held in London of representatives of the Institute, the Institute's examiners and inspector, and delegates from the Technical Instruction Committee of the Manchester County Council. As a result of that conference, it was proposed that a new syllabus should be prepared in several of the weaving subjects to cover a period of three years, and that the full certificate should be granted to those students only who complete the three years' course of study. It was also considered advisable that candidates, before entering upon their first year's course of technical instruction, should pass a preliminary examination in the subjects of arithmetic, drawing, and elementary physics, in their special application to the technology of spinning and weaving. The representatives of the Union of Lancashire and Cheshire Institutes, having undertaken to prepare and submit for approval to the Committee of the Institute a syllabus of instruction for this preliminary examination, the Institute decided, after carefully considering the syllabus, to accept the certificate of the Union in lieu of the certificates of the Science and Art Department, previously required to qualify for a full technological certificate. New syllabuses were accordingly prepared in cotton spinning and weaving, in wool and worsted spinning and weaving, and also in jute spinning and weaving; and these syllabuses, after being modified by different experts to whom they were submitted, were finally adopted by the Institute, and have been inserted in the Programme. To obtain a certificate in the ordinary grade of either branch of calico or cloth manufacture, it will now be necessary that the student, unless specially exempted, should go through a two years' course of study and pass an examination at the end of each year's work.

In the subject of iron and steel manufacture, a new syllabus has been written; and with the view of adapting the examination to the requirements of students working in different parts of the country, a large number of questions will be given, covering the different sections into which the syllabus has been divided, and candidates will be at liberty to select those questions bearing upon the practice of the trade in the district in which they work.

It has been thought desirable to limit the scope of the examination in the electro-metallurgy to the principles underlying the electro-deposition of metals, and in order to bring the instruction into closer touch with the requirements of students engaged in the manufacture of electro-plated goods, the syllabus of examination has been modified, and the title of the subject has been changed into that of "Electro-Plating and Deposition."

The syllabus in mine surveying has been re-written with the view of making the instruction and examination more distinctly technical than hitherto. Questions will be set involving a knowledge of logarithms and trigonometry, and of the application of trigonometry to problems in mine surveying; but the questions in pure mathematics, which previously formed a part of the examination, will be omitted.

The report, in addition to giving particulars as to the various examinations which took place in connection with the session, contains extracts from statements made by the examiners concerning the general character of the work examined, which should prove useful to both teachers and students.

EXPERIMENTAL MORPHOLOGY.[1]

IN looking at the progress which has been made in the study of plant morphology, I have been as much impressed with the different attitudes of mind toward the subject during the past 150 years as by the advance which has taken place in methods of study, as well as the important acquisitions to botanical science. These different view points have coincided to some extent with distinct periods of time. What Sachs in his "History of Botany" calls the "new morphology" was ushered in near the middle of the present century by von Mohl's researches in anatomy, by Naegeli's investigations of the cell, and Schleiden's history of the development of the flower. The leading idea in the study of morphology during this period was the inductive method for the purpose of discerning fundamental principles and laws, not simply the establishment of individual facts, which was especially characteristic of the earlier period when the dogma of the constancy of species prevailed.

The work of the "herbalists" had paved the way for the more logical study of plant members by increasing a knowledge of species, though their work speedily degenerated into mere collections of material and tabulations of species with inadequate descriptions. Later the advocates of metamorphosis and spiral growth had given an impetus more to the study of nature, though diluted with much poetry and too largely subservient to the imagination, and to preconceived or idealistic notions.

But it was reserved for Hoffmeister (1859), whose work followed within three decades of the beginnings of this period, to add to the inductive method of research, as now laid down, the comparative method; and extending his researches down into the Pteridophyta and Bryophyta, he not only established for these groups facts in sexuality which Camerarius and Robert Brown had done for the Spermatophyta, but he did it in a far superior manner. He thus laid the foundation for our present conceptions of the comparative morphology of plants. Naegeli's investigations of the cell had emphasised the importance of its study in development, and now the relation of cell growth to the form of plant members was carried to a high degree, and it was shown how dependent the form of the plant was on the growth of the apical cell in the Pteridophyta and Bryophyta, though later researches have modified this view; and how necessary a knowledge of the sequence of cell division was to an understanding of homologies and relationships. Thus in developmental and comparative studies, morphology has been placed on a broader and more natural basis, and the homologies and relationships of organs between the lower and higher plants are better understood.

But the growth of comparative morphology has been accompanied by the interpretation of structures usually from a teleological standpoint, and in many cases with the innate propensity of the mind to look at nature in the light of the old idealistic theories of metamorphosis.

I wish now to inquire if we have not recently entered upon a new period in our study of comparatlve morphology. There are many important questions which comparative studies of development under natural or normal conditions alone, cannot afford a sufficient number of data. We are constantly confronted with the problems of the interpretation of structure and form, not only as to how it stands in relation to structures in other plants, which we deal with in comparative morphology, but the meaning of the structure or form itself, and in relation to the other structures of the organism, in relation to the environment, and in relation to the past. This must be met by an inquiry on our part as to why the structure or form is what it is, and what are the conditions which influence it. This we are

[1] Address delivered before Section G (Botany) of the American Association f. r the Advancement of Science, at Detroit, by Prof. G. F. Atkinson. (Numerous bibliographical references were given in the course of the address, but these have been omitted.)

accustomed to do by *experiment*, and it begins to appear that our final judgments upon many questions of morphology, especially those which relate to variation, homology, &c., must be formed after the evidence is obtained in this higher trial court, that of *experimental morphology*. While experimental morphology as a designation of one branch of research in plants, or as a distinct and important field of study, is not yet fully taken cognisance of by botanists, we have only to consult our recent literature to find evidence that this great and little explored field has already been entered upon.

Experimental methods of research in the study of plants have been in vogue for some time, but chiefly by plant physiologists and largely from the standpoint of the physical and chemical activities of the plant, as well as those phases of nutrition and irritability, and of histologic structure, which relate largely to the life processes of the plant, and in which the physiologist is therefore mainly interested. In recent years there has been a tendency in physiological research to limit the special scope of these investigations to those subjects of a physical and chemical nature. At the same time the study of the structure and behaviour of protoplasm is coming to be regarded as a morphological one, and while experimental methods of research applied to the morphology of protoplasm and the cell is comparatively new, there is already a considerable literature on the subject even upon the side of plant organisms. While certain of the phenomena of irritability and growth are closely related to the physics of plant life, they are essentially morphologic; and it is here especially that we have a voluminous literature based strictly on the inductions gained by experimentation, and for which we have chiefly to thank the physiologist.

If we were to write the full history of experimental morphology in its broadest aspect, we could not omit these important experimental researches on the lower plants in determining the ontogeny of polymorphic species of algæ and fungi which were so ably begun by De Bary, Tulasne, Pringsheim, and others, and carried on by a host of European and American botanists. The tone which these investigations gave to taxonomic botany has been felt in the study of the higher plants, by using to some extent the opportunities at botanic gardens where plants of a group may be grown under similar conditions for comparison, and in the establishment of alpine, subalpine and tropical stations for the purpose of studying the influence of climate on the form and variations of plants, and in studying the effect of varying external conditions.

While experimental morphology in its broadest sense also includes in its domain cellular morphology, and the changes resulting from the directive or taxic forces accompanying growth, it is not these phases of morphology with which I wish to deal here.

The question is rather that of experimental morphology as applied to the interpretation of the modes of progress followed by members and organs in attaining their morphologic individuality, in the tracing of homologies, in the relation of members associated by antagonistic or correlative forces, the dependence of diversity of function in homologous members on external and internal forces, as well as the causes which determine the character of certain paternal or maternal structures. I shall deal more especially with the experimental evidence touching the relation of the members of the plant which has been represented under the concept of the leaf, as expressed in the metamorphosis theory of the idealistic morphology. The poetry and mystery of the plant world, which was so beautifully set forth in the writings of Goethe and A. Braun, are interesting and entrancing, and poetic communication with nature is elevating to our ethical and spiritual natures. But fancy or poetry cannot guide us safely to the court of inquiry. We must sometimes lay these instincts aside and deal with nature in a cold, experimental, calculating spirit.

The beginnings of experimental morphology were made about one century ago, when Knight, celebrated also for the impulse which he gave to experimental physiology, performed some very simple experiments on the potato plant. The underground shoots and tubers had been called roots until Hunter pointed out the fact that they were similar to stems. Knight tested the matter by experiment, and demonstrated that the tubers and underground stems could be made to grow into aerial leafy shoots. This he regarded as indicating a compensation of growth, and he thought, further, that a compensation of growth could be shown to exist between the production of tubers and flowers on the potato plant. He reasoned that by the prevention of the development of the tubers the plant might be made to bloom. An early sort of potato was selected, one which rarely or never set flowers, and the shoots were potted with the earth well heaped up into a mound around the end of the shoot. When growth was well started, the soil was washed away from the shoot and the upper part of the roots, so that the plant was only connected with the soil by the roots. The tubers were prevented from growing, and numbers of flowers were formed. This result he also looked upon as indicating a compensation of growth between the flowers and tubers.

While we recognise Knight's experiments as of great importance, yet he erred in his interpretation of the results of this supposed correlation between the tubers and flowers, as Vöchting (1887, 1895) has shown. By repeating Knight's experiment, and also by growing shoots so that tubers would be prevented from developing, while at the same time the roots would be protected, flowers were obtained in the first case, while they were not in the second; so that the compensation of growth, or correlation of growth, here exists between the vegetative portion of the plant and the flowers, instead of between the production of tubers and flowers, as Knight supposed.

The theory of metamorphosis as expressed by Goethe and A. Braun, and applied to to the leaf, regarded the leaf as a *concept* or *idea*. As Goebel points out, Braun did not look upon any one form as the typical one, which through transformation had developed the various leaf forms; but each one represented a wave in the march of the successive billows of a metamorphosis, the shoot manifesting successive repetitions or renewals of growth each season, presenting in order the "niederblätter, laubblätter, hochblätter, kelchblätter, blumenblätter, staubblätter, fruchtblätter." Though it had been since suggested from time to time, as Goebel remarks, that the foliage leaf must be regarded as the original one from which all the other forms had arisen (at that time Goebel did not think this the correct view). No research, he says, had been carried on, not even in a single case, to determine this point. Goebel plainly showed, in the case of *Prunus padus*, that axillary buds, which under normal conditions were formed one year with several bud scales, could be made by artificial treatment to develop during the first year. This he accomplished by removing all the leaves from small trees in April, and in some cases also cutting away the terminal shoot. In these cases the axillary shoots, instead of developing buds which remained dormant for one year, as in normal cases, at once began to grow and developed well-formed shoots. Instead of the usual number of bud scales, there were first two stipule-like outgrowths, and then fully expanded leaves were formed; so that in this case, he says, the metamorphosis of the leaf to bud scales was prevented. For this relation of bud scales to foliage leaves, Goebel proposed the term "correlation of growth." In the case of *Vicia faba*, removal of the lamina of the leaf of seedlings, when it was very young, caused the stipules to attain a large size, and to perform the function of the assimilating leaf. He points out that experimentation aids us in interpreting certain morphological phenomena which otherwise might remain obscure. He cites the occasional occurrence ("Moquin-Tandon") in the open of enlarged stipules of this plant, which his experiment aids in interpreting. In the case of *Lathyrus aphaca*, the stipules are large and leaf-like, while the part which corresponds to the lamina of the leaf is in the form of a tendril, the correlation processes here having brought about the enlargement of the stipules as the lamina of the leaf became adapted to another function. Kronfeld repeated some of Goebel's experiments, obtaining the same results, and extended them to other plants (*Pirus malus* and *Pisum sativum*), while negative results attended some other experiments. Hildebrand, in some experiments on seedlings and cuttings, found that external influences affected the leaves, and in some cases, where the cotyledons were cut, foliage leaves appeared in place of the usual bud scales. In *Oxalis rubella*, removal of the foliage leaf, which appears after the cotyledons, caused the first of the bulb scales, which normally appear following the foliage leaf, to expand into a foliage leaf.

In some experiments on the influence of light on the form of the leaves, Goebel has obtained some interesting results. Plants of *Campanula rotundifolia* were used. In this species the lower leaves are petioled and possess broadly-expanded, heart-shaped laminæ, while the upper leaves are narrow and sessile, with intergrading forms. Plants in different stages of growth were placed in a poorly lighted room. Young plants which had only the round leaves, under these conditions continued to develop only this form of leaf, while older plants which had both kinds of leaves when the experiment was started, now developed on the new growth of the shoot the round-leaved form. In the case of plants on which the flower shoot had already developed, side shoots with the round leaves were formed.

Excluding the possibility of other conditions having an influence here, the changes in the form of the leaves have been shown to be due to a varying intensity of light. The situation of the plants in the open favour this view, since the leaves near the ground in these places are not so well lighted as the leaves higher up on the stem. In this case the effect of dampness is not taken into account by the experimenter, and since dampness does have an influence on the size of the leaf, it would seem that it might be at least one of the factors here. An attempt was now made to prevent the development of the round leaves on the young seedlings. For this purpose the plants were kept under the influence of strong and continuous lighting. The round leaves were nevertheless developed in the early stage, an indication that this form of the leaf on the seedling has become fixed and is hereditary.

Hering found that enclosing the larger cotyledon of streptocarpus in a plaster cast so as to check the growth, the smaller and usually fugacious one grew to the size of the large one, provided the experiment was started before the small one was too old. Amputation of the large cotyledon gave the same results.

Other experimenters have directed their attention to the effect of light and gravity on the arrangement of the leaves on the stem, as well as to the effect of light on the length of the petiole and breadth of the lamina. Among these may be mentioned the work of Weisse, Rosenvinge, and others.

Goebel has shown experimentally that dampness is also one of the external influences which can change the character of xerophyllous leaves. A New Zealand species of Veronica of xerophyllous habit and scaly appressed leaves, in the seedling stage has spreading leaves with a broad lamina. Older plants can be forced into this condition in which the leaves are expanded, by growing them in a moist vessel. Gain, Askehasy, and others have shown that dampness or dryness has an important influence in determining the character of the leaves.

The results of the experiments in showing the relation of the leaf to the bud scales, Goebel regards as evidence that the foliage leaf is the original form of the two, and that the bud scale is a modification of it.

Treub conducted some interesting experiments for the purpose of determining the homology of the pappus of the Compositæ.

Gall-insects were employed to stimulate the pappus of *Hieracium umbellatum*, and it was made to grow into a normal calyx with five lobes. A recent letter from Prof. Treub states that he later repeated these experiments with other species of Compositæ with like results, but the work was not published. Kny found, in seedlings and cuttings which he experimented with, that while there was still stored food available for the roots and shoots, there was little if any dependence of one upon the other. Hering comes to somewhat different conclusions as a result of his experiments, finding that in some cases there was a slight increase of growth, while in others growth of the one was reciprocally retarded when either the other was checked in development. Numerous cases of horticultural practice in pollination of fruits shows that the form and size of the fruit, and of the adjacent parts, as well as the longer or shorter period of existence of the floral envelopes, can be influenced by pollination.

The investigations carried on by Klebs in the conjugation of Spirogyra suggest how experimentation of this kind may be utilised to determine questions which in special cases cannot be arrived at easily by direct investigation. If threads of *Spirogyra varians* which are ready for conjugation are brought into a 0·5 per cent. solution of agar-agar, in such a way that nearly parallel threads lie at a varying distance in their windings, where they are within certain limits, the conjugation tubes are developed and the zygospores are formed. But where the threads lie at too great a distance for the influences to be exerted, the cells remain sterile, and no conjugation tubes are developed. If now these threads be brought into a nutrient solution, the cells which were compelled to remain sterile grow and develop into new threads, *i.e.* they take on the vegetative, though they are fully prepared for the sexual function. Strasburger has pointed out that this may be taken as excluding the possibility of there being a reducing division of the chromosomes during the maturing of the sexual cells, a process which takes place in animals, and that the behaviour of Spirogyra in this respect agrees with what is known to take place in the higher plants, viz. that the reduction process is not one which is concerned in the maturity of the gametes. The same could be said of Polyphagus, in which Nowakowski found that before the zygospore was completely formed the protoplasm moved out and formed a new sporangium.

In *Protosiphon botryoides* Klebs was also able to compel the parthenogenetic development of the motile gametes, and the same thing was observed in the case of the gametes of Ulothrix. If we are justified in interpreting this phenomenon as Strasburger suggests, the evidence which Raciborski gives as a result of his experiments with *Basidiobolus ranarum* would support the idea that there is no reducing division in the chromosomes before the formation of the nuclei of the gametes. Raciborski found that the young zygospores of this species, in old nutrient medium where the fusion of the plasma contents had taken place, but before the nuclei had fused, if they were placed in a fresh nutrient medium the fusion of the nuclei was prevented, and vegetative growth took place, forming a hypha which possessed two nuclei—the paternal one and the maternal one. Raciborski interprets Eidam's study of the nuclear division prior to the copulation of the gametes as showing that the reducing division takes place here as in the maturation of the sexual cells of animals, and looks upon the premature germination of the zygospore as showing that a paternal and maternal nucleus possesses the full peculiarities of a normal vegetative one. However, we are not justified in claiming a reducing division for the nuclei preceding the formation of the gametes in Basidiobolus from the work of Eidam, since he was not able to obtain sufficiently clear figures of the division to determine definitely how many divisions took place, to say nothing of the lack of definite information as to the number of chromosomes. Fairchild has recently studied more carefully the nuclear division, but, on account of the large number of the chromosomes, was not able to determine whether a reduction takes place. He points out, as others have done, the similarity in the process of the formation of the conjugating cells of Basidiobolus and Mougeotia among the Mesocarpeæ, and to these there might be added the case of Sirogonium, in which the paternal cell just prior to copulation undergoes division. The division of the copulation cells in Basidiobolus, Mougeotia, Sirogonium, &c., suggest at least some sort of preparatory act; but whether this is for the purpose of a quantitative reduction of the kinoplasm, as Strasburger thinks sometimes takes place, or is a real reduction in the number of the chromosomes, must be determined by further study, so that the bearings of these experiments on the question of a reducing division must for the time be held in reserve.

One of the very interesting fields for experimental investigation is that upon the correlation processes which govern morphology of the sporophylls (stamens and pistils) of the Spermatophyta. One of the controlling influences seems to be that of nutrition, and in this respect there is some comparison to be made with the correlative processes which govern the determination of sex in plants. Among the ferns and some others of the Pteridophyta a number of experiments have been carried on by Prantl, Bauke, Heim, Buchtien and others to determine the conditions which influence the development of antheridia and archegonia. Prantl found that on the prothallia of the ferns grown in solutions lacking nitrogen there was no meristem, and consequently no archegonia, while antheridia were developed; but if the prothallia were changed to solutions containing nitrogen, meristem and archegonia were developed. All the experiments agree in respect to nutrition; with scanty nutrition antheridia only were developed, while with abundant nutriment archegonia were also developed. Heim studied the influence of light, and found that fern prothallia grow best with light of 20 to 25 per cent. Exclusion of the ultra-violet rays does not affect the development of the sexual organs. He argues from this that the ultra-violet rays are not concerned in the elaboration of the material for flower production, as Sachs as suggested. In yellow light the prothallia grew little in breadth; they also grew upward, so that few of the rhizoids could reach the substratum. Antheridia were here very numerous. After seven months these prothallia were changed to normal light, and in four months afterwards archegonia were developed.

Among the algæ Klebs has experimented especially with

Vaucheria, such species as *V. repens* and *V. ornithocephala*, where the antheridia and oogonia are developed near each other on the same thread. With weak light, especially artificial light, the oogonium begins first to degenerate. He never succeeded in suppressing the antheridia and at the same time to produce oogonia.

High temperature, low air pressure or weak light, tend to suppress the oogonia, and at the same time the antheridia may increase so that the number in a group is quite large, while the oogonium degenerates or develops vegetatively. Klebs concludes from his experiments that the causes which lie at the bottom of the origin of sex in *Vaucheria*, as in other organisms, are shrouded in the deepest mystery.

In the higher plants a number of experiments have been carried on for the purpose of learning the conditions which govern the production of staminate and pistillate flowers, or in other words the two kinds of sporophylls. From numerous empirical observations on diœcious Spermatophyta, the inference has generally been drawn that nutrition bears an important relation to the development of the staminate and pistillate flowers; that scanty nutrition produces a preponderance of staminate plants, while an abundance of nutrition produces a preponderance of pistillate plants. For a period covering three decades several investigators have dealt with this question experimentally, notably K. Müller, Haberlandt, and Hoffmann. These experiments in general give some support to the inferences from observation, yet the results indicate that other influences are also at work, for the ratios of preponderance either way are not large enough to argue for this influence alone. In a majority of cases thick sowings, which in reality correspond to scanty nutrition, tend to produce staminate plants; while thin sowings tend to produce pistillate plants. In the case of the hemp (*Cannabis sativa*), Hoffmann found that these conditions had practically no influence. He suggests that the character of each may have been fixed during the development of the seed, or even that it may be due to late or early fecundation.

In monœcious plants it has often been observed that pistillate flowers change to staminate ones and *vice versâ*, and in diœcious plants pistillate ones sometimes are observed to change to staminate ones (the hemp for example, see Nagel, 1879). K. Müller states that by scanty nutrition the pistillate flowers of Zeamays can be reduced to staminate ones.

Among the pines what are called androgynous cones have in some instances been observed. In *Pinus rigida* and *P. thunbergii*, for example, they occur (Masters). Natsuda has described in the case of *Pinus densiflora* of Japan, pistillate and androgynous flowers which developed in place of the staminate flowers, and conversely staminate and androgynous flowers in place of pistillate ones. Fujii has observed that where the pistillate or androgynous flowers of *Pinus densiflora* occur in place of the staminate ones, they are usually limited to the long shoots which are developed from the short ones of the previous year. The proximity of those transformed short shoots (Kurztrieb) to injuries of the long ones, suggested that the cutting away of the long ones might induce the short ones to develop into long ones, and the flowers which were in the position for staminate ones to become pistillate.

Fujii says, "In fact, the injuries producing such effect are frequently given by Japanese gardeners to the shoots of the year of *Pinus densiflora* in their operations of annual pollarding. But the 'Langtrieb' which is transformed from a 'Kurztrieb' of the last year does not necessarily bear female of hermaphrodite flowers in the positions of male flowers." To determine the influence of pollarding of the shoots he carried on experiments on this pine in the spring of 1895. He pollarded the shoots, so that, as he terms it, to induce the nourishment to be employed in the development of the flowers and short shoots near the seat of injury. In other cases one or two shoots were preserved while all the adjacent shoots of last year's growth at the top of the branch were removed, and, further, both of these processes were combined. Out of the forty-five branches experimented on, and on which there were no signs of previous injury, there were nine pistillate or androgynous flowers in place of staminate ones; in twenty-one branches with signs of previous injury, five were transformed, while in 2283 not experimented on, and with no signs of previous injury, only seven were transformed. Such abnormal flowers, then, are due largely to the injuries upon the adjacent shoots, and, Fujii thinks, largely to the increased amount of nourishment which is conveyed to them as a result of this.

From the experiments thus far conducted upon the determination of sex in plants or upon the determination of staminate or pistillate members of the flower, nutrition has at least some influence in building up the nourishing tissue for the two different organs or members. This can in part be explained on the ground that antheridia and staminate members of the plant are more or less short-lived in comparison with the archegonia and pistillate members, the latter requiring more bulk of tissue to serve the purpose of protection and nourisnment to the egg and embryo. It is thus evident that while some progress has been made in the study of this question, we are far from a solution of it. Experiment has proceeded largely from a single standpoint, viz. that of the influence of nutrition. Other factors should be taken into consideration, for there are evidently other external influences and internal forces which play an important *rôle*, as well as certain correlation processes perhaps connected with the osmotic activities of the cell sap.

The relation of the parts of the flower to the foliage leaves is a subject which has from time to time called forth discussion. That they are but modifications of the foliage leaf, or constituents of the leaf concept, is the contention of the metamorphosis theory, and that the so-called sporophylls are modified foliage leaves is accepted with little hesitation by nearly all botanists, though it would be very difficult, it seems to me, for any one to present any very strong argument from a phylogenetic standpoint in favour of the foliage leaf being the primary form in its evolution on the sporophyte, and that the sporophyll is a modern adaptation of the foliage leaf. Numerous cases are known of intermediate forms between sporophylls and foliage leaves both in the Spermatophyta and Pteridophyta. These are sometimes regarded as showing reversion, or indicating atavism, or in the case of some of the ferns as being contracted and partially fertile conditions of the foliage leaf. There has been a great deal of speculation regarding these interesting abnormal forms, but very little experimentation to determine the causes or conditions which govern the processes.

In 1894 I succeeded in producing a large series of these intermediate forms in the sensitive fern (*Onoclea sensibilis*). The experiments were carried on at the time for the especial purpose of determining whether in this species the partially developed sporophyll could be made to change to a foliage leaf, and yet possess characters which would identify it as a transformed sporophyll. The experiments were carried on where there were a large number of the fern plants. When the first foliage leaves were about 25 cm. high, they were cut away (about the middle of May). The second crop of foliage leaves was also cut away when they were about the same height during the month of June. During July, at the time that the uninjured ferns were developing the normal sporophylls, those which were experimented upon presented a large series of gradations between the normal sporophyll and fully expanded foliage leaves. Among these examples there are all intermediate stages from sporophylls which show very slight expansions of the distal portion of the sporophyll, and the distal portions of the pinnæ, until we reach forms which it is very difficult to distinguish from the normal foliage leaf. Accompanying these changes are all stages in the sterilisation of the sporangia (and the formation of prothalloid growths), on the more broadly expanded sporophylls there being only faint evidences of the indusia.

The following year (1895) similar experiments were carried on with the ostrich fern (*Onoclea struthiopteris*), and similar results were obtained. At the time that these experiments were conducted, I was unaware of the experiments performed by Goebel on the ostrich fern. The results he reached were the same; the sporophyll was more or less completely transformed to a foliage leaf. Goebel regards this as the result of the correlation process, and looks upon it as indicating that the sporophyll is a transformed foliage leaf, and that the experiment proves the reality here of the modification which was suggested in the theory of metamorphosis, and thus the foliage leaf is looked upon by him as the primary form. Another interpretation has been given to those results, viz. that they strengthen the view that the sporophyll, from a phylogenetic standpoint, is primary, while the foliage leaf is secondary. What one interprets as a reversion, another regards as indicating a mode of progress in the sterilisation of potentiality, sporogenous tissue, and its conversion into assimilatory tissue. It is perhaps rather to be explained by the adaptive equipoise of the correlative processes existing between the vegetative and fruiting portions of the plant which is inherited from earlier times. Rather when spore-production appears on the sporophyte could this process be looked upon as a reversion to the primary office of the sporophyte, so that in spore-production of the higher plants we may have a constantly recurring reversion to a process which in the remote past was the sole function of this phase of the plant. In this way might be explained those cases where sporangia occur on the normal foliage leaf of Botrychium, and some peculiar cases which I have observed in *Osmunda cinnamomea.* In some of the examples of this species it would appear that growth of the leaf was marked by three different periods even after the fundament was outlined ; the first, a vegetative ; second, a spore-producing ; and third, a vegetative again ; for the basal portions of the leaf are expanded, the middle portions spore-bearing, the passage into the middle portions being gradual, so that many sporangia are on the margins of quite well-developed pinnæ. These gradations of the basal part of the leaf, and their relation to the expanded vegetative basal portion, showing that the transition here has been from partially formed foliage leaf to sporophyll after the fundament was established, and later the increments of the vegetative part from the middle towards the terminal portion, shown by the more and more expanded condition of the lamina and decreasing sporangia, indicate that vegetative forces are again in the ascendency. This suggests how unstable is the poise between the vegetative leaf and sporophyll in structure and function in the case of this species.

For two successive years I have endeavoured by experiment to produce this transformation in *Osmunda cinnamomea*, but thus far without sufficiently marked results. The stem of the plant is stout, and this, together with the bases of the leaves closely overlapping, contain considerable amounts of stored nutriment which make it difficult to produce the results by simply cutting off the foliage leaves. The fact that these transformations are known to occur where fire has overspread the ground, and, as I have observed, where the logging in the woods seriously injured the stools of the plant, it would seem that deeper-seated injuries than the mere removal of foliage leaves would be required to produce the transformation in this species. It may be that such injury as results from fire or the severe crushing of the stools of the plant would be sufficient to disturb the equilibrium which existed at the time, that the action of the correlative forces is changed thereby, and there would be a tendency for the partially developed foliage leaves to form sporangia, then when growth has proceeded for a time this balance is again changed.

The theory that the foliage leaves of the sporophyte have been derived by a process of sterilisation, and that the transformation of sporophylls to foliage leaves, in an individual, indicates the mode of progress in this sterilisation, does not necessarily involve the idea that the sporophyll of any of the ferns, as they now exist, was the primary form of the leaf in that species ; and that by sterilisation of some of the sporophylls, the present dimorphic form of the leaves was brought about. The process of the evolution of the leaf has probably been a gradual one, and extends back to some ancestral form now totally unknown. One might differ from Prof. Bower ; the examples selected by him to illustrate the course of progress from a simple and slightly differentiated sporophyte to that exhibited in the various groups of the Pteridophyta. But it seems to me that he is right in so far as his contention for the evolution of vegetative and assimilatory members of the sporophyte, can be illustrated by a comparison of the different degrees of complexity represented by it in different groups, and that this illustrates the mode of progress, as he terms it, in the sterilisation of potential sporogenous tissue.

On this point it appears that Prof. Bower has been unjustly criticised. The forms selected to illustrate his theory were chosen not to represent ancestral forms, or direct phylogenetic lines, but solely for the purpose of illustrating the gradual transference of spore-bearing tissue from a central to a peripheral position, and the gradual eruption and separation of spore-bearing areas, with the final sterilisation of some of these outgrowths.

To maintain that in phylogeny the sporophyll is a transformed foliage leaf, would necessitate the predication of ancestral plants with only foliage leaves, and that in the case of these plants the vegetative condition of the sporophyte was the primary one, spore production being a later developed function. Of the forms below the Pteridophyta, so far as our present evidence goes, the sporophyte originated through what Bower calls the gradual elaboration of the zygote. All through the Bryophyta wherever a sporophyte is developed, spore production constantly recurs in each cycle of the development, and yet there is no indication of any foliar organs on the sporophyte. The simplest forms of the sporophyte contain no assimilatory tissue, but in the more complex forms assimilatory tissue is developed to some extent, showing that the correlative forces which formerly were so balanced as to confine the vegetative growth to the gametophyte and fruiting to the sporophyte, are later changing so that vegetative growth and assimilation are being transferred to the sporophyte, while the latter still retains the function of spore production, though postponed in the ontogeny of the plant.

If we cannot accept some such theory for the origin of sporophylls and foliage leaves, by gradual changes in potential sporogenous tissue, somewhat on the lines indicated by Bower, it seems to me it would be necessary, as already suggested, to predicate an ancestral form for the Pteridophyta in which spore production was absent. That is, spore production in the sporophyte of ancestral forms of the Pteridophyta may never have existed in the early period of its evolution, and spore production may have been a later development. But this, judging from the evidence which we have, is improbable, since the gametophyte alone would then be concerned in transmitting hereditary characters, unless the sporophyte through a long period developed the gametophyte stage through apospory. Bower says, in taking issue with Goebel's statement that the experiments on *Onoclea* prove the sporophyll to be a transformed foliage leaf: "I assert, on the other hand, that this is not proved, and that a good case could be made out for priority of the sporophyte ; in which event the conclusion would need to be inverted, the foliage leaf would be looked upon as a sterilised sporophyll. This would be perfectly consistent with the correlation demonstrated by Prof. Goebel's experiments, as also with the intercalation of a vegetative phase between the zygote and the production of spores." In another place he says : "To me, whether we take such simple cases as the Lycopods or the more complex case of the Filicineæ, the sporangium is not a gift showered by a bountiful Providence upon pre-existent foliage leaves : the sporangium, like other parts, must be looked upon from the point of view of descent ; its production in the individual or in the race may be deferred, owing to the intercalation of a vegetative phase, as above explained ; while, in certain cases at least, we probably see in the foliage leaf the result of the sterilisation of sporophylls. If this be so, much may be then said in favour of the view that the appearance of sporangia upon the later formed leaves of the individual is a reversion to a more ancient type rather than a metamorphosis of a progressive order."

As I have endeavoured to point out in another place, if a disturbance of these correlative processes results in the transference of sporophyllary organs to vegetative ones on the sporophyte, "why should there not be a similar influence brought to bear on the sporophyte, when the same function resides solely in the gametophyte, and a disturbing element of this kind is introduced? To me there are convincing grounds for believing that this influence was a very potent—though not the only—one in the early evolution of sporophytic assimilatory organs. By this I do not mean that in the Bryophyta, for example, injury to the gametophyte would now produce distinct vegetative organs on the sporophyte, which would tend to make it independent of the gametophyte. But that in the bryophyte-like ancestors of the pteridophytes an influence of this kind did actually take place, appears to me reasonable.

"In the gradual passage from an aquatic life, for which the gametophyte was better suited, to a terrestrial existence for which it was unadapted, a disturbance of the correlative processes was introduced. This would not only assist in the sterilisation of some of the sporogenous tissue, which was taking place, but there would also be a tendency to force this function on some of the sterilised portions of the sporophyte, and to expand them into organs better adapted to this office. As eruptions in the mass of sporogenous tissue took place, and sporophylls were evolved, this would be accompanied by the transference of the assimilatory function of the gametophyte to some of these sporophylls."

Because sporophytic vegetation is more suited to dry land conditions than the gametophytic vegetation, it has come to be the dominating feature of land areas. Because the sporophyte in the Pteridophyta and Spermatophyta leads an independent existence from the gametophyte, it must possess assimilatory tissue of its own, and this is necessarily developed first in the ontogeny; but it does not necessarily follow, therefore, that the foliage leaf was the primary organ in the phylogeny of the sporophyte. The provision for the development of a large number of spores in the thallophytes, so that many may perish and still some remain to perpetuate the race, is laid hold on by the bryophytes, where the mass of spore-bearing cells increases and becomes more stable, for purposes of the greatest importance. Instead of perishing, some of the sporogenous tissue forms protecting envelopes, then supporting and conducting tissue, and finally in the pteridophytes and spermatophytes nutritive and assimilatory structures are developed. Nature is prodigal in the production of initial elementary structures and organs. But while making abundant provision for the life of the organism through the favoured few, she has learned to turn an increasing number of the unfavoured ones to good account. Acted upon by external agents and by internal forces, and a changing environment, advance is made, step by step, to higher, more stable, and prolonged periods.

While we have not yet solved any one of these problems, the results of experimental morphology are sufficient to indicate the great importance of the subject and the need of fuller data from a much larger number of plants. If thus far the results of experiments have not been in all cases sufficient to overthrow the previous notions entertained touching the subjects involved, they at least show that there are good grounds for new thoughts and new interpretations, or for the amendment of the existing theories. While there is not time for detailing even briefly another line of experiment, viz. that upon leaf arrangement, I might simply call attention to the importance of the experiments conducted by Schumann and Weisse from the standpoint of Schwendener's mechanical theory of leaf arrangement. Weisse shows that the validity of the so-called theory of the spiral arrangement of the leaves on the axis may be questioned, and that there are good grounds for the opening of the discussion again. It seems to me, therefore, that the final judgment upon either side of all these questions cannot now be given. It is for the purpose of bringing fresh to the minds of the working botanists the importance of the experimental method in dealing with these problems of nature, that this discussion is presented as a short contribution to the subject of experimental morphology of plants.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Sir Archibald Geikie has been appointed the Romanes Lecturer for 1898.

The Delegates of the Common University Fund have appointed Mr. William John Smith Jerome Lecturer in Medical Pharmacology and Materia Medica for the years 1898–99.

CAMBRIDGE.—Mr. J. H. Grace, bracketed second wrangler 1895, has been elected to a fellowship at Peterhouse.

Mr. S. F. Harmer, Superintendent of the Museum of Zoology, has been approved for the degree of Doctor of Science.

Mr. H. K. Anderson, Demonstrator of Physiology, has been elected to a Drosier Fellowship at Gonville and Caius College.

Dr. A. A. Kanthack, of St. John's College, has been elected to the Professorship of Pathology, in the place of the late Prof. C. S. Roy.

The University Lectureship in Midwifery is vacant by the resignation of Mr. E. H. Douty. Applications for appointment are to be sent to the Vice-Chancellor by November 15.

The General Board of Studies have issued a report in which they propose that the time-honoured examination in Paley's "Evidences" shall be discontinued, and that candidates for honours shall in the previous Examination be required to pass in English, French, or German, and also in Mechanics, Physics, or Logic. The report is likely to be keenly discussed.

The State Medicine Syndicate report that in the present year seventy candidates have offered themselves for examination in Sanitary Science, and that thirty-four were approved and received the University diploma in Public Health.

The degree of M.A. *honoris causa* is to be conferred on Mr. C. R. Marshall, Assistant in Pharmacology to the Downing Professor of Medicine.

Among the new Fellows elected at St. John's College on November 9, are Mr. W. McDougall, First Class Natural Sciences Tripos, 1892-94. and Mr. T. J. I'A. Bromwich, Senior Wrangler 1895, First Class Division I. Mathematical Tripos Part II., 1896.

IT is announced that Mr. Jonathan Hutchinson, F.R.S., has signified his desire to found an educational museum at Selby, his native town.

IN connection with North Dakota Agricultural College and Station a new chemical laboratory is in course of construction. Its estimated cost will be about 5000*l*.

DR. MOLLIER, of Göttingen, has been appointed professor of mechanical engineering in the Technological Institute at Dresden.

Science states that the U.S. Geological Survey has practically completed the distribution of the Educational Series of Rocks, 175 sets of 156 specimens each having been sent out during the past summer to universities, colleges and technical institutions in the United States. There remains a small number of incomplete sets, which will be placed in certain smaller colleges. The Educational Series were prepared by the Survey with much care, for the purpose of aiding students in acquiring a general and special knowledge of rocks, and promoting the study of geology.

THE Clerk to the Drapers' Company has informed the Registrar of the University College of North Wales, Bangor, that the Company will modify, in the sense suggested by the College, the conditions attached to their grant of 1000*l*. towards stocking and equipping the College farm. The grant is therefore now made conditionally upon a further sum of 3000*l*. being raised towards the same purpose before the end of the present session. It has been arranged that students pursuing the ordinary agricultural course at the College shall in future reside for a part of that course in the immediate neighbourhood of the farm, and thus get the benefit of practical training, side by side with the theoretical instruction. The College enters upon its tenancy of Lledwigan this week.

SCIENTIFIC SERIALS.

THE current number (July) of the *Monthly Weather Review* (Washington) contains a paper on the observation of halo phenomena. This is a translation of a reprint of an article by the Rev. K. Schips in the Year-book of the Natural History Association, a copy of which we have received. A committee has been formed in Germany for the study of halos, and a request is made for the regular observation of these phenomena, as it appears that the subject of meteorological optics receives no great attention, except in Japan. The paper will be found instructive to both observers and students.—The equations of hydrodynamics in a form suitable for application to problems connected with the movements of the earth's atmosphere, by J. Cottier. This contribution is of much importance to those who are studying the fundamental problem of meteorology. Mr. Cottier, who was a student of brilliant promise, unfortunately died on August 17.—Rain gushes in thunderstorms, by the editor (Prof. Cleveland Abbe). Several plausible explanations of this phenomenon have been put forward from time to time, but have been rejected as erroneous. It is at present an open question whether the gushes of rain bring about the formation of lightning, or *vice versâ*. Several suggestions are made by the editor, which require to be tested by further experiment.—Among various other notes there is an interesting one, entitled "Kites at the Chicago Conference, August 1893." This method of obtaining information relating to the upper air is daily becoming more popular, and seems likely to lead to useful results.

Bollettino della Società Sismologica Italiana, vol. iii. N. 2, 1897.—On an old mercurial seismometer designed by A. Cavalli, by G. Agamennone.—Geological observations on the Florentine earthquake of May 18, 1895, by C. De Stefani. An abstract of a memoir published in the *Annali* of the Central Meteorological Office.—Notes of earthquakes recorded in Italy (February 4–18, 1897), by G. Agamennone, the most important being the earthquake of Sicily and Calabria of February 11–12, and five earthquakes of unknown but distant origin, one on February 7, two on February 13, and two on February 15.

SOCIETIES AND ACADEMIES.

CAMBRIDGE.

Philosophical Society, October 25.—Mr. F. Darwin, President, in the chair.—The following elections were made: President—Mr. F. Darwin. Vice-Presidents—Prof. Newton, Prof. J. J. Thomson, Mr. Larmor. Treasurer—Mr. Glazebrook. Secretaries—Mr. Newall, Mr. Bateson, Mr. Baker. New Members of Council—Mr. Harker, Mr. Hutchinson, Prof. Liveing, Mr. Skinner.—The following communications were made: Electrical oscillations in wires, by Mr. H. C. Pocklington. In this paper are discussed some problems relating to electrical oscillations about wires made of perfectly conducting material and of circular cross-section. The first step is to find an expression for the electrical forces which satisfies the space differential equations, and gives infinite values for the forces near the wires. It is then shown that the arbitrary function contained in that expression can be so chosen as to make the value of the component of the electric force tangetial to the surface of the wire vanish if small quantities of the first order be neglected. The value of this arbitrary function is found in the case of a circular wire, and equations are found for the period of oscillation and the decrement of the oscillation. These equations are solved in the case when the wire is so thin that it is permissible to neglect not only its radius in comparison with the circle, but even the square of the reciprocal of the logarithm of its radius in comparison with unity. In this case the alteration in period and the damping depend on the logarithm of the ratio of the radii of the wire and the circle. As a corollary, the problem of the resonance of a complete circular resonator is discussed. It is found that when accurately tuned, the magnitude of the current induced is independent of the thickness of the wire, and that the thinner the wire the more sensitive it is to accuracy of tuning. The case of waves propagated along a helical wire is next considered, a general equation being found in which small quantities are neglected. The case when the reciprocal of the radius of the wire can be neglected is discussed in detail. For this case it is found that when the period is not great, there are two velocities of propagation possible, one with a velocity (v) measured along the wire, equal to that of light, the other with a greater velocity. If, however, the period is greater than a certain finite value, the former mode of propagation only is possible. If, however, the period is very great, the velocity of propagation may be greater than v, and if the period is so great that the product of the wave-length in free space into the diameter of the wire is very great compared with the square of the diameter of the helix, the velocity attains a limiting value equal to v when measured along the axis of the helix.—On circles, spheres, and linear complexes, by Mr. J. H. Grace. Clifford in his paper on Miquel's theorem gave an infinite series of theorems commencing with the fact that, given four lines, the circumcircles of the triangles formed by them meet in a point. The present paper contains a more general series of theorems in two dimensions, and a somewhat analogous series in three dimensions. Also the first theorem of the set for four dimensions is proved. Then the method of Klein ("Linien-Geometrie und metrische Geometrie," *Math. Ann*, v.) is used to transform these results into theorems regarding linear complexes and straight lines; and the transformation of Lie (*Math. Ann.*, v.) is used to obtain, from properties of straight lines and linear complexes, results concerning spheres and their angles of intersection.—Theorems relating to the product of two hypergeometric series, by Mr. W. McF. Orr. This paper deals with such theorems as that stated by Cayley, *Phil. Mag.*, November 1858 (Collected Papers, vol. iii. p. 268).—Reduction of a certain multiple integral, by Mr. Arthur Black. The integral dealt with is one in n variables; the subject of integration is one involving an exponential of which the index is a general quadratic function of $n + 1$ variables.—On the gamma function, by Mr. H. F. Baker. This note deals with the uniform convergence of a certain limiting process.—On the lines of striction of a hyperboloid, by Mr. H. F. Baker. This note remarks on the known fact that the line of striction belonging to either system of generators is a unicursal quartic curve, and considers the parametric expression of more general forms of octavic curves with six double points.—On the action of the radiation from uranium salts on the formation of clouds, by Mr. C. T. R. Wilson. It has been shown in previous papers (*Proc. Roy. Soc.*, vol. lix. p. 338, 1896; *Phil. Trans.*, vol. clxxxix. A, p. 265, 1897) that under the action of Röntgen rays, nuclei are produced in moist dust-free air, capable of acting as centres of condensation, when the air, initially saturated, suffers a sudden expansion such that v_2/v_1, the ratio of the final to the initial volume, exceeds 1·25. Nuclei requiring exactly the same degree of supersaturation are present in very small numbers in moist dust-free air under ordinary conditions. Recent experiments show that the radiation from uranium salts introduces nuclei, again requiring exactly the same degree of supersaturation, in order that condensation may take place upon them. The nuclei are many times more numerous than in the absence of the rays.

PARIS.

Academy of Sciences, November 2.—M. A. Chatin in the chair.—Actinometry in balloons, by M. J. Violle. Actinometric observations from balloons should possess many advantages over those taken on the earth, as the complete absence of dust is assured, and the air layer is also reduced. A trial ascent in the *Balaschoff*, by MM. Hermite and Besançon, showed that the radiation from the balloon itself was a negligable quantity; but from the results obtained, it would appear that there was still above the balloon such a quantity of water as in the liquid state would form a column of several centimetres in thickness.—On the preparation and properties of the borides of calcium, strontium, and barium, by MM. H. Moissan and P. Williams. The boride of calcium is formed by heating a mixture of dry calcium borate, aluminium, and sugar charcoal in a carbon crucible in the electric furnace for seven minutes (900 ampères and 45 volts). The duration and regularity of heating has a great influence upon the yield. The boride is obtained as a black crystalline powder, so hard that it readily scratches rock crystal. Chemically it is not easily decomposed, dry hydrogen at a red heat, nitrogen at 1000°, and water at ordinary temperatures being without action upon it. Fluorine attacks it in the cold with incandescence, but the other halogens only destroy the boride at a red heat. The borides of strontium and barium are prepared in the same way, and possess analogous properties. The formula of these compounds, RB_6, is identical with that of the hydrozoates of Curtius, RN_6.—Occultation of the group of the Pleiades by the moon on October 13, 1897, at Lyons, by M. Ch. André.—Observations on the Perrine comet (November 2, 1896) made at the observatory of Rio de Janeiro, by M. Cruls.—New demonstration of the fundamental theorem of projective geometry, by M. H. G. Zeuthen.—On the determination of the integrals of a partial differential equation by certain initial conditions, by M. E. Goursat.—On the problem of M. Bonnet, by M. C. Guichard.—Compressibility of gases at different temperatures at pressures near that of the atmosphere, by M. A. Leduc.—On the atomic weights of argon and helium, by M. H. Wilde.—On the stannic acids, by M. R. Engel. A *résumé* of the work on the stannic acids, with an explanation of some of the apparent contradictions.—Use of fluorescine for the detection of traces of bromine in a saline mixture, by M. H. Baubigny. The bromine is set free by a mixture of potassium permanganate and copper sulphate, and the vapours evolved allowed to impinge upon fluorescine paper. The presence of as little as ·001 gr. of bromine in 10 gr. of common salt is shown by a reddish coloration of the paper due to the formation of eosin.—On the crystallographic identity of the dextrorotatory and lævorotatory asparagines, by M. P. Freundler. The accuracy of Pasteur's law having been called in question by M. Walden from certain experimental determinations of M. Grattarola on the two asparagines, these angular measurements have been redetermined, with the result that the deviations found are well within the limits of experimental error.—Study of the transformation of sugars occurring in olive oil, by M. C. Gerber.—Mixed grafting, by M. L. Daniel. A description of a new mode of grafting which gives better results when the two plants present marked physiological differences.—On the evolution of the black rot, by M. A. Prunet. Injection may take place through the leaves of the vine at a certain stage of development, after which the leaves lose their susceptibility to black rot. It is just before this critical period that remedial measures should be applied to the leaves.—On the age of the grits containing *Sabalites andegavensis* in the west of France, by M. Jules Welsch.—New researches on the Ostioles, by M. J. J. Andeer.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 11.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein.

MATHEMATICAL SOCIETY, at 8.—On the Poncelet Polygons of a Limaçon: Prof. F. Morley.—On an Extension of the Exponential Theorem: J. E. Campbell.—The Integral $\int P_n^2\, dx$ and Allied Forms in Legendre's Functions, between Arbitrary Limits: R. Hargreaves.—The Character of the General Integral of Partial Differential Equations: Prof. Forsyth, F.R.S.—The Calculus of Equivalent Statements (No. 7): H. MacColl.

FRIDAY, NOVEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 8.—On the Nature of the Orbit of γ Lupi: T. J. J. See.—List No. 4 of Nebulæ discovered at the Lowe Observatory: Lewis Swift.—Equatorial comparisons of Uranus with 41 Libræ, and a probable Occultation of the Star by the Planet: John Tebbutt.—On the Effect of Chromatic Dispersion of the Atmosphere on the Parallaxes of α Centauri and β Orionis; and on a Method of Determining its Effect on the Value of the Solar Parallax derived from Heliometer Observations of the Minor Planets: David Gill.—The Great Equatorial Current of Jupiter: A. Stanley Williams.—Approximate Ephemeris of the Leonids from 1897 December 24 to 1898 April 8: G. Johnstone Stoney.—On the Effect upon the Moon's Motion of a Hypothetical Change in the Law of Gravitation: Robert Bryant.—A Spectroscopic Method for Determining the Second and Third Contacts during a Total Eclipse of the Sun: Wm. Shackleton.—Note on a Result used by Prof. Wadsworth in several recently published Papers: H. F. Newall.

MALACOLOGICAL SOCIETY (in the apartments of the Linnean Society), at 8.—Malacological Notes made during a Journey through Russia; with some Account of Dredgings in the Black Sea: G. F. Harris.—Description of a New Species of *Mülleria* from India: Edgar A. Smith.—Note on a Variety of *Rhaphaulus Lorraini*, with a List of the known Species: Edgar A. Smith.—On *Streptaxis gracilis*, a New Species from Ceylon: Oliver Collett.—Revision of the New Zealand Rissoiidæ: H. Suter.

PHYSICAL SOCIETY (in the rooms of the Chemical Society), at 4.—Council Meeting.——At 5.—On the Isothermals of Ether: J. Rose-Innes.—On the Variation with Temperature of the Electromotive Force of the H-Form of Clark Cells: F. S. Spiers and F. Twyman.

TUESDAY, NOVEMBER 16.

ZOOLOGICAL SOCIETY, at 8.30.—On British Medusæ: E. T. Browne.—On Three Consignments of Butterflies collected in Natal in 1896 and 1897 by Guy A. K. Marshall: Dr. A. G. Butler.—On the Sydney Bush-Rat (*Mus arboricola*): Edgar B. Waite.

MINERALOGICAL SOCIETY, at 8.—Anniversary Meeting.—Election of Officers and Council.—On Augelite from Bolivia: L. J. Spencer.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Manchester Ship Canal; Sir E. Leader Williams.—The Eastham Division; Whately Eliot. The Runcorn Division: Sir E. Leader Williams. The Irlam Division: W. O. E. Meade-King.

ROYAL STATISTICAL SOCIETY, at 5.30—Notes on the Subjects discussed at the Meeting of the International Statistical Institute at St. Petersburg, 1897: Major P. G. Craigie.

ROYAL PHOTOGRAPHIC SOCIETY, 12 Hanover Square, W., at 8.—A Review of Triple Printing Methods: E. Sanger Shepherd.

WEDNESDAY, NOVEMBER 17.

SOCIETY OF ARTS, at 8.—The Colonies: their Arts, Manufactures, and Commerce: Sir Owen Tudor Burne.

GEOLOGICAL SOCIETY, at 8.—The Geology of Rotuma: J. S. Gardiner.—A Geological Survey of the Witwatersrand and other Districts in the Southern Transvaal: Dr. F. H. Hatch.—Observations on the Genus *Aclisina* de Koninck, with Descriptions of British Species and some other Carboniferous Gasteropoda: Jane Donald.

ENTOMOLOGICAL SOCIETY, at 8.—Some Results obtained from the Hybridisation of Allied Species: J. W. Tutt.

ROYAL METEOROLOGICAL SOCIETY (at the Institution of Civil Engineers), at 7.30.—Results of a Comparison between the Sunshine Records obtained simultaneously from a Campbell Stokes Burning Recorder and from a Jordan Photographic Recorder: Richard H. Curtis.

ROYAL MICROSCOPICAL SOCIETY, at 8.

SANITARY INSTITUTE, at 8.—A Discussion on the Pollution of Water Supplies by Encampments of Hop-Pickers, Casual Workers, Tramps, &c.: to be opened by Prof. W. H. Corfield, in reference to the Dangers of Pollution of Municipal Water Supplies; and by Miss M. A. Chreiman, in reference to the Sanitary Control of Hop-Pickers, &c.

THURSDAY, NOVEMBER 18.

ROYAL SOCIETY, at 4.30.—Account of a Comparison of Magnetic Instruments at Kew Observatory: C. Chree, F.R.S.—Note on the Influence of very Low Temperatures on the Germinative Power of Seeds: H. T. Brown, F.R.S., and F. Escombe.—On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks. II. On *Spencerites*, a New Genus of Lycopodiaceous Cones from the Coal Measures, founded on the *Lepidodendron Spenceri* of Williamson: D. H. Scott, F.R.S.—The Histology of the Cell-wall, with special reference to the Mode of Connection of Cells: W. Gardiner, F.R.S.—Mathematical Contributions to the Theory of Evolution. IV. On the Probable Errors of Frequency Constants, and on the Influence of Random Selection on Variation and Correlation: Prof. K. Pearson, F.R.S., and L. N. G. Filon.—On the Geometrical Treatment of the "Normal Curve" of Statistics, with especial reference to Correlation, and to the Theory of Error: W. F. Sheppard.

LINNEAN SOCIETY, at 8.—On *Pontobolbos manaarensis*: Prof. A. Dendy.—On Haddonia, a New Genus of Foraminifera: F. Chapman.

CHEMICAL SOCIETY, at 8.—On the Decomposition of Camphoric Acid by Fusion with Potash or Soda: Dr. A. W. Crossley and W. H. Perkin, jun., F.R.S.—Experiments on the Synthesis of Camphoric Acid: W. H. Bentley and W. H. Perkin, jun., F.R.S.—The Action of Magnesium on Cupric Sulphate Solution: Dr. Frank Clowes and R. M. Caven.—Properties and Relationships of Di-hydroxytartaric Acid: H. J. Horstman Fenton.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Memorials Journal and Botanical Correspondence of C. C. Babington, F.R.S. (Cambridge, Macmillan and Bowes).—North America. Vol. 1. Canada and Newfoundland: S. E. Dawson (Stanford).—Resultate der Wissenschaftlichen Reforschung des Balatonsees, Zweiter Band, Erster Theil (Wien. Hölzel).—Bau und Leben unserer Waldbäume: Dr. M. Büsgen (Jena, Fischer).—The Practice of Massage: A. S. Eccles, 2nd edition (Baillière).—Air, Food, and Exercises: Dr. A. Rabagliati (Baillière).—Gases: their Constitution and Functions: S. J. Corrigan, Part 3 (St. Paul, Minn.).—Die Zigeuner: Prof. G. Cora (Turin).—The Meteorology of Edinburgh: R. C. Mossman, 2 parts (Edinburgh, Grant).—A System of Medicine: edited by Dr. Clifford Allbutt, Vol. iv. (Macmillan).—Les Constantes Physico-Chimiques: D. Sidersky (Paris, Gauthier-Villars).—Bibliography of X-Ray Literature and Research (1896–97): edited by C. E. S. Phillips (*Electrician* Company).—William Harvey: D'Arcy Power (Unwin).—A History of Fowling: Rev. H. A. Macpherson (Edinburgh, Douglas).—Botanisches Bilderbuch für Jung und Ult: F. Bley (Berlin, Schmidt).—University College, Nottingham, Calendar, 1897–98 (Nottingham, Sands).

PAMPHLETS.—Random Shots at Birds and Men: "Jim Crow" (Roxburghe Press).—Notions Générales sur L'Écorce Terrestre: Prof. A. de Lapparent (Paris, Masson).

SERIALS.—Century Magazine, November (Macmillan).—Journal of the Sanitary Institute, October (Stanford).—Reale Istituto Lombardo di Scienze e Letture, Rendiconti, serie ii. Vol. xxx. Fasc. xvi. (Milano).—American Naturalist, October (Philadelphia).—Astrophysical Journal, October (Chicago).—The Atoll of Funafuti, Part 4 (Sydney).—Zeitschrift für Physikalische Chemie, xxiv. Band, 2 Heft (Leipzig).—Anales del Museo Nacional de Buenos Aires, Tome v. (Buenos Aires).—Geological Magazine, November (Dulau).—Scribner's Magazine, November (Low).—Journal of Botany, November (West).—History of Mankind: F. Ratzel, translated, Part 21 (Macmillan).—Fortnightly Review, November (Chapman).—Knowledge, November (Holborn).—Gazzetta Chimica Italiana, 1897, Parte ii. Fasc. iv. (Roma).—Geographical Journal, November (Stanford).—Transactions of the Rochdale Literary and Scientific Society, 1896–97 (Rochdale).—North American Fauna, No. 13 (Washington).—Strand Magazine, November (Newnes).—Nansen's Farthest North, Part 1 (Newnes).—Mémoires de la Société de Physique et d'Histoire Naturelle de Genève, Tome xxxii. seconde Partie (Genève).—American Journal of Science, November (New Haven).

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