THURSDAY, SEPTEMBER 21, 1911.

THE PROGRESS OF PHYSICS.

The Progress of Physics during Thirty-three Years (1875–1908). Four lectures delivered to the University of Calcutta during March, 1908. By Arthur Schuster, F.R.S. Pp. x+164. (Cambridge: University Press, 1911.) Price 3*s*. 6*d*. net.

IN the year 1908 Prof. Schuster during his visit to India gave to the University of Calcutta four lectures, which he has now incorporated into a book, dealing with the progress which had been made in his subject during his own active lifetime, namely from the year 1875 onward.

The scope of the book he thus explains:—

"It is my aim to trace the changes in our point of view, rather than to give an historical account of the sequence of the discoveries which make this period memorable. . . . I prefer to be frankly subjective, and warn you beforehand that my account will be fragmentary, and to a great extent reminiscent of those aspects which have come under my own personal view."

In his preliminary survey of the state of the science before 1875 he contrasts the endeavour at that time prevalent to get a clear idea of the mechanism underlying the various processes, with the "blinkers" which are in some quarters willingly accepted now, not only as inevitable but as praiseworthy instruments conducive to a rational philosophy. The one idea of Energy is now sometimes upheld as dominating the field, and rendering unnecessary all more picturesque inquiry into forces and motions and coordinates in detail.

It is true that ignorance of detail may often be a dominant feature in both methods of dealing with phenomena; but the modern treatment, as he says—"glorifies our ignorance, while the other accepted it as a regrettable necessity." . . . The "vagueness which used to be recognised as our great enemy is now being enshrined as an idol to be worshipped."

At the beginning of the period dealt with by the author this tendency hardly existed:—

"The tendency to hide ignorance under the cover of a mathematical formula had already appeared, but was not openly advocted; hence students were still taught to form definite ideas of the processes of nature."

So far an advantage seems to him to lie with the past; but then, on the other hand, he recollects a less excellent tendency which then existed to regard the scope of physics as already fairly complete, with all the main avenues explored, and only side tracks and subsidiary paths awaiting the would-be discoverer—whose aim sometimes was to get hold of some neglected residual effect, by employing extremely sensitive instruments and applying power enough to bring it within the compass of observation; and whose other and highly estimable aim was to measure with careful accuracy effects already known.

This condition of things Prof. Schuster thus describes:—

"In many cases the student was led to believe that the main facts of nature were all known, that the chances of any great discovery being made by experiment were vanishingly small, and that therefore the experimentalist's work consisted in deciding between rival theories, or in finding some small residual effect which might add a more or less important detail to the theory."

It is perhaps singular that such an outlook should have so closely preceded an outburst of novelties such as have of late years aroused the enthusiasm of the worker, as well as the occasional derision of the sceptical critic.

"Looking back now on this period, when Röntgen rays and radio-activity were undreamt of, we may well learn to be cautious in our own predictions of the future."

Nevertheless, some of the discoveries were made in what may be called the old-fashioned way, one example being of the first magnitude:—

"A typical example of a great discovery brought about by the method indicated by Maxwell is furnished by Rayleigh's measurements which culminated in the discovery of argon, through a research undertaken to determine with accuracy the density of gases. . . . It is nevertheless indisputable that the greatest discoveries, both formerly and in recent years, have not originated in the hunt of residuals."

No; they have sometimes been begun accidentally, but they have been followed up by those who have been guided by a clue of theory; and some of the most splendid have been made by mathematical physicists who were clearly conscious all the time of what their aim was and what was the meaning of the phenomena they observed.

"Altogether I am doubtful," says Prof. Schuster, "whether any great discovery has ever been made by anyone who has only aimed at recording a number of facts."

Those who contemn theory, and who affect to disbelieve the explanation which physicists give of recently observed phenomena, would do well perhaps to realise that ultra-scepticism has often been a drag on scientific progress, as well as occasionally a safeguard and a help.

As an example tending in this cautionary direction we may quote from the author as follows:—

"The frame of mind with which the academic physicist [or, we might add, the academic chemist] looked upon investigations of the passage of electricity through gases, might be made the subject of instructive comment. The facts, so far as they had been ascertained, did not fit in with recognised views: hence they were ignored, and students were warned off the subject. There was a feeling that perhaps in a century or so the question might be attacked, but that in the meantime it had better be left to be played with by cranks and visionaries. No criticism was more frequent, at that time, than that of characterising as premature any new idea or fresh line of investigation in this direction; as if any advance of science has ever been made which was not premature a fortnight before it was made."

The extreme usefulness of a working hypothesis or theoretical clue can scarcely be emphasised better than by the following:—

"If we look back upon these experiments now, they may be used to point the moral that experiments conducted in what is sometimes considered to be the true philosophic spirit, where the investigator without any preconceived theories or notions simply wishes to classify facts, seldom lead to any valuable results.

"Progress began when the subject was attacked with some definite object in view, either some theory however crude which had to be supported, or some numerical connection which had to be investigated."

It has been one of the features of Sir J. J. Thomson's work, for instance, that theory and experiment have gone hand in hand and have been published together. The reviewer has heard this feature objected to, but it is more than justified. The publication of the great discovery which is being here specially referred to is thus mentioned by Prof. Schuster:—

"The lecture in which the above experiments were described, was delivered to the British Association [at Dover] on the occasion of the visit of members of the French Association, which met concurrently at Boulogne.[1] It at once carried conviction, and, though to those who had followed the gradual development of the subject it only rendered more certain what previous experiments had already plainly indicated, the scientific world seemed suddenly to awake to the fact that their fundamental conceptions had been revolutionised. A new era of science begins at this point."

Prof. Schuster had himself made experiments which would have received their quantitative explanation had the idea of a separate atom of electricity detached from matter been at that time fairly conceivable. But, as he says—in full accordance with the attitude of most others at the time—

"The separate existence of a detached atom of electricity never occurred to me as possible, and if it had, and I had openly expressed such heterodox opinions, I should hardly have been considered a serious physicist, for the limits to allowable heterodoxy in science are soon reached."

There were not wanting critics to emphasise the heterodoxy of the idea, even when the discovery had been made; and chemical scepticism concerning *ions* exerted a retarding effect in Britain:—

"This ionic theory of gas discharges, while ignored in England, made good progress abroad; Arrhenius adopted it, as well as Elster and Geitel."

But it is in connection with the subject of terrestrial magnetism and its explanation that the author makes the most biting comment:—

"There can only be one solution of the problem, and if we can explain any magnetic effect on the earth's surface by outside forces, it follows that it cannot at the same time be explained by internal forces. This remark disposes of a good deal of the criticism lavished on pioneer attempts to open out this region of science. Though this criticism is often confined to a judicious shrugging of the shoulders, it stops scientific progress more effectually than active opposition, and is apt to become a constitutional habit with those who give way to its undoubted temptations."

Of course, caution is necessary; but on the whole, says the author—

"The state of plasticity and flux—a healthy state, in my opinion—in which scientific thought of the present age adapts itself to almost any novelty, is illustrated by the complacency with which the most cherished tenets of our fathers are being abandoned."

For instance,

"Nowadays the student finds little to disturb him, perhaps too little, in the idea that mass changes with velocity; and he does not always realise the full meaning of the consequences which are involved."

This part of the treatise is so important, and the usefulness of theory as a guide to discovery is so vital, that we must dwell on the author's treatment of the more philosophical aspect of physics with special interest.

First of all he admits that we must allow something for intuition:—

"When we consider two rival theories in any branch of human knowledge, we are sometimes drawn towards one or towards the other, not by any process of reasoning, but by an instinctive feeling which may be so strong that we unhesitatingly reject one of the alternatives. . . . The strongest of our scientific 'instincts' is our ultimate belief in the simplicity of nature. If both light and electrical attractions are transmitted through a medium, it would revolt our feelings—that is to say, our non-reasoning faculties—to assume, without strong evidence to the contrary, that two different media exist for the two manifestations."

But it is not to be supposed that the intuition is always right. The example which the author takes—in order to illustrate the useful consequences of even an erroneous theory—is not one with which the reviewer sympathises, for he is one of those who desire dogmatically to deny the possibility of physical action except through a medium; whereas Prof. Schuster says:—

"To me it seems that the dogmatical denial of action at a distance is a survival of the ancient anthropomorphic explanation of natural phenomena."

He admits, however, with cordiality that the search for the medium has resulted in many discoveries, and, like many other theoretical clues—whether correct or not—has been justified by results. From this, he says:—

"Two lessons may here be learned. One is, that the temporary success of a doctrine does not necessarily justify the grounds of its foundation; and the other, that progress in science is more often achieved by a definite hypothesis, which may be followed up and tested, than by a wider and perhaps more philosophic doctrine, which cannot be disproved because it does not endeavour to go deeper than the mere descriptive classification of phenomena."

In the same spirit as that in which he maintains the possibility or conceivability of physical action at a distance, the author is not frightened away from any hypothesis because of its excessive strain upon ordinary common sense. For instance, he is able to contemplate the view that an atom or an electron may be a source or a sink of fluid, continually appearing out of nothing at some points and continually going out of existence at others.

"The universe must have begun by a process which lies outside physical laws, and it seems to me no

[1] The title originally was "On the Existence of Masses Smaller than the Atoms," but was changed when the paper was published in the *Philosophical Magazine*, xlviii., p. 565 (1899), to "On the Masses of Ions in Gases at Low Pressure."

easier to grasp the conception of a creation which took place at one single time than a creation which continues throughout all ages. Indeed, if we come to think of it, the continuance of a physical law like that of gravitation is as much a miracle as the continuous uniform creation of matter would be."

In this, as in a few other matters, the reviewer is unable to follow him completely.

Coming to another subject, the lecturer has some wise things to say regarding laboratory teaching in physics; some of which—like much else of school teaching—is calculated rather to promote dislike and dulness than to arouse any enthusiasm for science; and whatever may be the merit of college courses in physics, he cannot refrain from noticing how little of that sort of training was available for, or was needed by, the great discoverers.

"The cardinal fact to bear in mind is that previous to 1870, when laboratory instruction, if given at all, was sporadic, the experimental skill of investigators was as great as it is now. We need only mention the names of Faraday, Joule, Helmholtz, and Regnault, in support of that contention. The conclusion is irresistible that an intelligent student, possessing a sufficient theoretical knowledge, is capable of starting research work in physics without previous special training. It is not for him that complicated laboratory courses have been designed, but for the ordinary student."

It is very desirable in all cases that the stimulation of interest shall not be subordinate to the acquisition of mere technical skill. Without enthusiasm, the mere ability to measure all sorts of uninteresting quantities is of comparatively little use.

"The future investigator will no doubt ultimately save time if at an early stage he acquires a certain technical skill and becomes acquainted with physical methods, but otherwise the efforts of the teacher should be directed to stimulating his scientific activity rather than sending him through all manipulations which he might possibly have to perform."

That the author is a great authority in the subjects of terrestrial magnetism and atmospheric electricity is well known, and in his last lecture he enters into these rather fully, compared with his rapid survey of other subjects. Hence these portions have a value of their own, and a few *obiter dicta* may be extracted.

Concerning the view which has been held about the annual and diurnal variations in terrestrial magnetism, he says:—

"A better agreement may be obtained by making the plausible hypothesis that the electric conductivity of the higher regions of the atmosphere is due to solar radiation, and is therefore greater in summer than in winter, and also greater in daytime than at night."

On the subject of atmospheric electricity:—

"The earth as a whole is charged negatively, and on the average we find that there must be nearly a million electrons on every centimetre of its surface. . . . Lenard, in an important research, has shown that a drop of water as it falls never reaches a velocity greater than 8 metres per second, however large the drop, while drops having a diameter of 1·5 millimetres fall with a velocity of about half that amount. . . . The larger drops break up in the air, and doing so become positively electrified, according to Dr. Simpson. If the ascending current spreads out laterally near the top of the cloud, the vertical velocity is diminished, the drops will grow and fall, but only to break up and be carried upwards again. A quantity of electricity large enough to account for the lightning discharge can thus accumulate in a cloud."

We have thus taken a rapid survey of this interesting book and given a sample of its contents.

The only fault we have to find with it is a minor one, that ought not however to pass unnoticed,—the punctuation is of a systematically irritating kind. In the extracts here made it has in most places been corrected, so that the defect will not be noticed in them, but before concluding we must quote without correcting. There is evidently some one among the printers or readers for the press who has a theory about commas; one rule apparently being that a comma must always precede a relative pronoun.

To illustrate the nonsense which is often thus made, it will suffice to quote a few sentences at random:—

P. 158: "To put the result in a form, which is readily appreciated, I will compare different molecules," &c.

P. 98: "Energy cannot be expressed entirely by quantities, which merely depend on change of position (kinematical factors), but must involve," &c.

P. 139: "Nothing has been said as yet on the explanation of the secular variation of terrestrial magnetism, and in our ignorance of the causes, which make the earth behave like a magnet, it is perhaps wisest to put the question aside for the present."

P. 130: "The discussion of the problem [of diurnal variation of terrestrial magnetism] . . . shewed that there is a substantial remnant which comes to us from the inside of the earth, and this is, as it should be, because the earth being a conductor, any change of the magnetic forces must give rise to induced internal currents."

The main part of the cause of diurnal variation, however, lies above the surface of the earth, and is due to electric currents in the upper atmosphere,—says the author; who thereby seems to contravene a more general pronouncement, quoted above, as to the uniqueness of a given explanation. It is probably the more general pronouncement that he would wish to modify.

The immediately preceding extract is of interest for its own sake, and not merely as an illustration of seriocomic punctuation. So is the following:—

P. 156: "It is always satisfactory when we find that different lines of reasoning lead to the same result, and at present there is hardly one, in the domain of Geo-Physics which stands on so firm a basis as that giving to the earth an extremely high rigidity."

In the selected quotations we have done less than justice to the author's treatment of the many problems which have coincided with his active life, and to the solution of which he has so often contributed; but the book is accessible and very readable. We may be grateful to the University of Calcutta for having stimulated the production of these lectures, and to the author for writing them out and publishing them. They constitute another link in the chain which is binding together East and West.

OLIVER LODGE.

CHEMICAL STRUCTURE AND PHYSIOLOGICAL ACTION.

The Chemistry of Synthetic Drugs. By P. May. Pp. xiii+229. (London: Longmans, Green and Co., 1911.) Price 7*s.* 6*d.* net.

IT is the expressed aim of the author of this volume to bring to the notice of chemists a branch of their subject affording scope for commercial application, and at the same time to interest medical men who may desire information concerning the chemical nature of the synthetic remedies presented to them. It is obvious that but little can safely be assumed as common ground of previous knowledge, in appealing to so wide a constituency of readers, and it was a good thought to begin with a glossary of technical terms: although it seems a little difficult to believe in the existence of the chemist who needs "antipyretic" or "narcotic" defined for him.

The author is to be congratulated on having presented a readable account of a difficult subject in 220 pages of text, not a few of which, moreover, are of necessity occupied by structural formulæ.

A selection of the more interesting and instructive classes of synthetic drugs for discussion probably afforded the only possibility of dealing, within such limits, with a subject in which recorded observations are overwhelmingly abundant and sound generalisations but few. The gain in interest for the non-specialist is well worth the loss in comprehensiveness. It is no disparagement of such a volume to say that it owes much to Fränkel's "Arzneimittelsynthese," as the author duly acknowledges. It could be wished, however, that he had leaned a little less heavily on that authority, particularly in some matters of pharmacological detail. For example, he follows Fränkel in stating that "pilocarpine closely resembles nicotine in many of its pharmacological effects" (p. 31), and accordingly regards as significant the possession by both of a five-membered ring. Of a writer on this subject for English readers one might expect such slight acquaintance with the work of the Cambridge school of physiology as would have sufficed to save him from accepting this statement. That the real pharmacological affinities of pilocarpine are with muscarine, with which it has no obvious community of structure, is one of the anomalies with which the subject bristles. The statement that "atropine and cocaine are closely related . . . in their physiological action, both of them causing dilatation of the pupil" (p. 86), is another instance of a tendency to attach importance to superficial resemblances, in the interests of a preconceived correspondence between structure and action. Mr. May's direct contact with the subject is obviously on the chemical side, but the description of the action of apomorphine as "quite opposite to that of morphine," is again a little crude, even for pharmacology at second hand.

The introductory chapter, dealing with the general theories of the physiological action of drugs, follows Fränkel closely, and would have gained by more attention to the development of theories since 1906. It is rather for its chapters dealing with special groups than as a general theoretical survey that the book should prove of value. Atropine and the tropeïnes, cocaine and the local anæsthetics, the morphine and isoquinoline groups of alkaloids, are all dealt with in a manner which should enable even the medical practitioner, with mere remnants of his student chemistry as a basis, to follow intelligently the aims of those engaged in producing new synthetic compounds in the different series. The citation of trade names provides a useful link with practical therapeutics. In treating of the isoquinoline alkaloids and the adrenaline series of bases, much space is devoted to recent, and particularly to English, publications: and if some of these seem thus to acquire more prominence in the general scheme than their intrinsic importance warrants, the fault is in the right direction; for, as the author points out, much of this work, as well as that on the organic arsenic and antimony compounds, has not before been collected into one volume.

On the whole, by what it omits as well as by the presentation of what it includes, the book succeeds in giving a more readable, if a slighter, account of the subject than its predecessors in the same field. A high degree of originality is excluded by the nature of the subject. The book would gain much by comparatively slight revision at the hands of someone directly acquainted with the physiological side of the subject, and the author may be recommended to seek such aid before publishing a new edition.

MECHANISM IN CRUCIFEROUS FLOWERS.

Prinzipien der Physikalisch-Kausalen Blütenbiologie. In ihrer Anwendung auf Bau und Entstehung des Blütenapparates der Cruciferen. Von Dr. A. Günthart. Pp. ix+172. (Jena: Gustav Fischer, 1910.) Price 4.50 marks.

THE floral construction of the Crucifer, repeated in so many familiar wild and cultivated plants, is at first sight so remarkably simple that the type is utilised possibly more than any other for the purposes of elementary botany, as presenting a handy symmetrical blossom with few parts and apparently little complication in relation to pollination. More careful observation, however, shows that this is by no means the case; the biological construction is definitely transversely zygomorphic, involving a duplicate mechanism; while morphological considerations show that the apparent simplicity has been attained by extreme reduction-specialisation from anthostrobiloid forms of which phylogenetic suggestions can only be traced in the allied families of the Capparidaceæ and Resedaceæ.

Dr. Günthart's volume constitues an extremely valuable and interesting contribution to the detailed investigation of the floral biology of these flowers. Representative types of twenty-five genera, arranged in thirteen groups, have been worked out by sectional methods, and are copiously illustrated by 136 schematic figures and diagrams. As the title indicates, the special point at issue is the determination of the extent to which any definite purpose or intention can be traced in the elaboration of complex floral mechanism devoted to cross-pollination by insect agency. The reading in of ideas involving purpose or forethought on the part of the plant has been so extremely general in œcological description of flowers, is so pleasing to the imagination, and proves so popular and difficult to escape from in elementary teaching, that a detailed analysis of such well-known Crucifer types as Matthiola, Raphanus, Alyssum, Aubrietia, &c., is particularly welcome.

Thus, among Crucifers generally, (1) the claws of the petals bend away from the lateral stamens as if to leave definite "entrance-slits" to the assumed nectar-containing pouches of the lateral sepals; (2) the anthers of the longer stamens are commonly twisted on their filaments so as to face round towards the adjacent lateral ones, as if with the intention of rubbing the entering proboscis of an insect; (3) the edges of the filaments are frequently extended into elaborate appendage-growths which are apparently intended to guide the proboscis of the insect-visitor exactly to the secreting surface. Such details are so obviously included under the heading of special adaptations to secure insect-pollination that the question of their actual origin demands most careful investigation.

The object of Dr. Günthart's work is to show that practically all subsidiary details of special mechanism and final adjustment may be traced back to a few fundamental tendencies in the floral construction, which, being given by phylogeny, work out on simple mechanical lines the construction details which are at first sight so purposeful. Such "active-factors" in the case of the Cruciferous flower are distinguished as:—

1. The tendency of the floral receptacle to extend in the transverse plane of the floral diagram, this factor controlling the dorsiventral insertion of the petals, the lateral apertures of the flower-tube, &c.

2. A tendency for the median sepals and adjacent parts to be "elevated" by a peculiar growth-extension in the median plane of the receptacle, which is responsible for "true" (primary) calyx-pouches and the increasing restriction of the secreting surface to lateral hollows.

3. The transverse and longitudinal extension of the ovuliferous region: the former phenomenon (Siliculoseæ) still further exaggerating characters induced by the original transverse construction.

4. The mutual pressures between a closed calyx and central ovary exerted on "passive" petals and stamens leading to the production of rotated anthers and marginal extensions of the filaments.

In tracing the elaborate mechanical connections of these phenomena, however, the problem of their meaning is admittedly only removed one step further back. We still remain ignorant of the reasons for the initiation of these "active" characters. Nor is there any reason to believe that continued research will ever satisfactorily solve all problems which stretch back into the distant phylogeny of the group. Still, every step cleared up is one gained, and the vague conception of intention is gradually replaced by the view that from an initial tendency, itself probably induced by some physical cause, certain mechanical results will necessarily follow, which will in turn determine the subsequent possibilities of the evolution of the race. Further, the fundamental factors thus deduced should give the key to the systematic arrangement of the family.

FACT AND FANCY IN DIETETICS.

"*What Shall I Eat?*": *a Manual of Rational Feeding*. By Dr. F. X. Gouraud. With a Preface by Prof. A. Gautier. Authorised English translation by F. J. Rebman. Pp. xvi+379. (London: Rebman, Ltd.; New York: Rebman Co., n.d.) Price 6*s*. net.

THERE appears to be a plethora of books on diet just now, but the present volume does not reach the same standard of excellence which is noticeable in several other books on the subject recently reviewed in these columns.

Dr. Gouraud's work contains a certain amount of useful information, it is true, but it is so interwoven with speculations and contradictions that it is not likely to prove useful either to specialists or to the public at large.

The preface tells us it is intended for the business man and the educated housewife among others, but we wonder what the average man of business would make out of the following sentences:—

"Endogenetic purin is produced by the rejection of nuclein by the organism; its percentage, though variable in each individual, is a fixed quantity in each individual. Exogenetic purin of alimentary origin varies considerably according to diet, and may be reduced to zero by a regimen entirely free of all xanthic bodies."

"Beef is a powerful factor in membral hyperacidity. Its alimentary value, which depends almost wholly on the percentage of fats present in it, is rather slight. It takes only second place to butter, sugar, and rice. Its sole merit from the alimentary standpoint can only be that it supplies within a small compass a comparatively large amount of assimilable nitrogen."

"The third nutritive element in milk is the carbohydrates, *i.e.* lactose or milk sugar. This is a bihexose well known for its diuretic properties which makes the sugar in diabetics. Phosphorus is also abundant, and is present chiefly in the shape of physiological values well differentiated."

Quotations such as the preceding could be multiplied indefinitely. A physiologist will at once detect the gross misstatements of fact; but the man in the street, so far as he can make head or tail out of technical language, will at any rate detect the want of logic and of a knowledge of English composition. The glossary at the end of the book will not help him much, for we learn there that purins are unclean or poisonous substances, that xanthin is a yellow colouring matter, that steapsin is a diastasic ferment, that inosite is a saccharine substance, that casein is a derived albumin, that galactose is lactose, that ammonia contains hydrogen atones, &c., &c.

The translator does not in the greater number of instances know the English equivalents for French technical terms, or for the names of pathological conditions. We select only one gem for special mention; we are told that milk is curdled by the *pressure* of the stomach. This is a very free translation of *présure*, which really means rennet. Not having seen the book in the original French, it is a little difficult to apportion the blame between Dr. Gouraud and his translator. Internal evidence leads one, however, to conclude that both are at fault.

The book is a curious and muddled medley of fact and fancy; the translation has evidently been carried out by someone unfamiliar with physiology, and deficient in his knowledge of both French and English.

W. D. H.

OUR BOOK SHELF.

Lilies. By A. Grove. Pp. xi+116+8 coloured plates.
Apples and Pears. By G. Bunyard. Pp. xi+116+8 coloured plates.
(Present-day Gardening Series.) (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 1s. 6d. each.

MR. GROVE's book on lilies is one of the most welcome that have appeared in this series. Among popular flowers the genus is, perhaps, the most trying with which English gardeners have to deal, and the presence of many species in our gardens is due more to the efficiency and rapidity of ocean transit than to a proved capability of our cultivators to grow them in gardens. It is probably to the facility with which stocks can be renewed that the present unsatisfactory state of lily cultivation is largely due. The incentive to conquer the problems of keeping them alive and propagating them are, to a great extent, lacking when a new and vigorous stock can be easily obtained from the salerooms. Mr. Grove is, however, an enthusiast, and we have it on the authority of Mr. Elwes—himself the author of a classical work on the genus—that he knows more about their cultivation than anyone else living. There is no botany in the work; it is purely a gardening book cleverly and pleasantly written by a master of his subject. Mr. Elwes contributes an interesting preface.

Mr. Grove's study of lilies has been carried on unostentatiously in his garden on the Berkshire hills, and his name is comparatively unknown except to the *élite*. It is otherwise with Mr. Bunyard. As the head of one of the first fruit-tree nurseries, and an experienced author on hardy fruits, he has long filled a high place in the esteem of those occupied in the same pursuits. The present little volume is certainly one of the best that has ever appeared on the subject of apples and pears. Although concise it is comprehensive, and deals efficiently with every phase of their treatment. The author gives lists of the best sorts for various purposes and different districts, all the better because they are comparatively short. He deals with their cultivation from the propagation and planting of the trees, and the way to combat insect pests, to the storing of the fruit. The state of many orchards of this country impels one to hope that this book may be widely read.

Each of these volumes is illustrated by eight coloured plates, and makes a very creditable addition to the useful series to which it belongs.

The Animal World. By Prof. F. W. Gamble, F.R.S. With an Introduction by Sir Oliver Lodge, F.R.S. (Home University Library of Modern Knowledge.) Pp. 255. (London: Williams and Norgate; New York: Henry Holt and Co., n.d.) Price 1s. net.

PROF. GAMBLE's account of the animal world is written from the point of view of function. Its chief aim is to direct attention to the adaptations of structure to the performance of movement, breathing, and other vital functions. An introductory chapter, which contains a general survey of the structure and classification of animals, is rather condensed, and will probably be more useful to the reader who has already a little knowledge of animal life than to the beginner. The description of the movements, and of the succession and distribution of animals, provides opportunity for pointing out the great advantages possessed by birds and mammals in consequence of their warm blood. The quest for food, modes of breathing, the colours and senses of animals, societies and associations, symbiosis, the care of the young, and short accounts of the life-history of a few animals, form the subjects of successive chapters. The concluding chapter on heredity and variation might well have been a little more extended: the subject-matter is too briefly explained to be of full value to the reader for whom the book is intended.

Several of the figures are crude, especially that of Vorticella. The statement on p. 28 that the buds of cœlenterates may remain in connection with the parent tissues "by strings of mesenchyme" requires modification. On p. 37 the spaces between the mesenteries of a sea-anemone are designated the cœlom, and immediately below are referred to as increasing the capacity of the digestive cavity.

The book, which is written in a fresh clear style, is characterised throughout by breadth of view, and is also noteworthy for the aptness of the illustrative examples cited. The thoughtful reader, with an interest in biology, will find in this volume food for thought in abundant measure.

Orthochromatic Filters. Pp. 55. (Croydon: Wratten and Wainwright, Ltd., n.d.) Price 6d.

THE title of this little book does not include its contents, for there is a chapter on "contrast filters," with some very striking examples of their use. A photograph of an engineers' blue print taken through a strong red filter that needs the exposure to be increased twenty-four times with a Wratten's panchromatic plate, renders the blue as a full black, instead of the rather feeble grey given by an ordinary plate with no filter. The great improvement obtainable in the rendering of the grain of dark-coloured woods, as well as in other cases, is well illustrated. We learn that the sensitiveness to green and red of ordinary orthochromatic plates is generally from 2 to 5 per cent. of the total sensitiveness, while in a panchromatic plate this rises to as much as 18 per cent. From these and other figures of a like nature the necessary increase of exposure when using certain colour filters with various specially sensitised plates is calculated in a simple way. The chapter that will be of most interest to those who are fairly familiar with the use of colour filters and sensitised plates, deals with the optical properties of filters. It gives clear examples of the degradation of defining power of the lens by the use of a filter strained by being too tightly screwed up in its cell, and also of filters which introduce various degrees of astigmatism. Many other matters are dealt with which are of prime importance to those who use colour screens.

Studies of Trees and Flowers. By M. Wrigley. With descriptions by Annie L. Smith. Pp. 129+viii+129 plates. (London: Methuen and Co., Ltd., n.d.) Price 15s. net.

THE photographs that form the chief feature of this weighty volume reflect considerable credit on the skill of the author as a manipulator with the camera. Undoubtedly the most impressive are the photographs of plants *in situ*; the picture of the foxglove is good, except that it fails to show the lower portion of the plant; those of the birches, especially of the silver birch and of the Burnham beeches, are instructive, but the best are the illustrations of two groups of Scotch firs at Kincraig that betoken group as well as individual habit. Many of the sprays, notably of the blossoming myrtle and hawthorn, and of the fruiting broom, are attractive, but it is not apparent that any useful purpose is served by these or the general collection, since it is not difficult and more advisable to obtain natural specimens in season. Miss Lorrain Smith has carried out satisfactorily the task of supplying appropriate brief notes, and doubtless appreciated the Peziza and Usnea that appear at the end.

LETTERS TO THE EDITOR.

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

The Ooze of the Thames.

SOME time ago I directed attention to the part played by annelids in making the ooze of rivers, such as the Nile, fertile. Aided by a Government grant, research has been continued during the year, and in August a special visit was paid to Kew Gardens and the Thames. The river was very low, and I was able to collect specimens which are not always available, and bring away a sample of the ooze for careful examination. I found the mud teeming with *Helodrilus oculatus*, Hoffm., a new record for the south of England; *Paranais naidina*, Bretscher, new to Britain; *Monopylephorus elegans*, Friend, new to science; and other things, showing how much work still remains to be done by London naturalists. There were also many living nematodes, all apparently belonging to one species, half an inch or more in length. I have not yet been able to work out its history or discover its host, but the thing which seems to me to be of special interest relates to this parasitic creature. In examining the ooze from time to time the thing that struck one was the presence of numberless white threads of considerable length and great tenuity. These proved to be the integuments of vast numbers of dead nematodes. In the case of annelids, the process of decay is so rapid that dead worms are rarely found, and only by means of the most careful microscopic examination or chemical analysis can one discover how numerous they have been. But the evidence goes to show that the ooze of rivers is immensely enriched in nitrogenous matter year by year through the death of annelids, as well as oxygenated by their tireless movements.

While much has been done in the analysis of soils, little if anything seems to have been undertaken in relation to ooze. My own researches are at present largely restricted to the systematic study of the living species of annelids; but it would be of immense advantage to science, and especially to agriculture, if some expert like Dr. Russell could give us careful analyses of river oozes. I have appealed many times for samples of ooze from estuaries and rivers in order that something might be done, but hitherto the response has been very heartless, and there has been no alternative but to make special journeys to interesting localities, at great cost of time and money. The importance of the subject, however, is such that I venture again to bring it to the notice of students and investigators in the hope that it may receive the attention it deserves.

Swadlincote, September 16. HILDERIC FRIEND.

Ancient Forests in Scotland.

REFERRING to your correspondent's letters which appeared in NATURE of June 1 and August 24 last in regard to the contemplated cutting down of the fir trees at Auchnacarry, in south Inverness-shire, permit me to state that, though very old (say two to three hundred years), these cannot properly be said to have formed part of the ancient Caledonian Forest. The fir was very probably found in the latter, and in certain places it may have been the prevailing description; unquestionably it is the most prominent survivor, and during the last few centuries has been one of the most important economical products of the Highlands of Scotland.

The cause of the disappearance of the Caledonian Forest has hitherto seemed obscure, if not inexplicable. Some light, however, is perhaps afforded by the fact that over the entire area which it covered, say all the counties north of the Firths of Forth and Clyde, except perhaps the Isle of Bute, Fife, Caithness, and the Orkney and Shetland Islands, the surface is frequently bestrewn with iron slags. So numerous are these latter in some districts that a hundred heaps of slag may be found almost within the confines of a single parish. From an examination of the pieces of charcoal found amongst these slags it has been ascertained that when these were formed the principal trees in the neighbourhood were birch and oak, but in some instances traces have been found of beech, ash, elm, fir, and holly.

Evidently in the more ancient times, namely, before the use of water-power was introduced in Scotland for the extraction of iron from the ore, two processes were successively employed for the purpose. In the earliest, the natural wind was taken advantage of, and the seat of operations was determined by the favourable physical configuration of the land to guide and concentrate the blast on the materials of combustion. From one document, at least, we learn that this method seems to have been employed down to 900 years ago. The sites associated with the later or succeeding process, and at which, presumably, bellows were used, are all in sheltered positions where the remaining forests were located; a few of the very last of these in operation can be dated as belonging to the fourteenth and fifteenth centuries. There is reason to believe that the bellows were in use in this connection as early as, if not earlier than, the Roman occupation.

When water-power for iron-making was introduced into Scotland at the beginning of the seventeenth century, the sites chosen were not only in protected situations also, but on low ground, on the banks of rivers, and preferably with suitable wood for fuel in the vicinity; but some of the latter seems to have been rolled down from the heights above, or floated by water from considerable distances. This class of works continued in operation generally until about 1760, and in the case of those near Inverary and Bunawe until much more recent years. Charcoal made from pine wood was very largely used at all of this series of works.

From the foregoing it may be gathered that as the iron slag heaps of Scotland form the memorials of her ancient forests, our knowledge of the latter may be much restricted by a neglect of the study of the metallurgical industries there in former times. GEORGE TURNER.

300 Langside Road, Glasgow, September 4.

"The Polynesian Wanderings."

YOUR review of my book, "The Polynesian Wanderings" (August 10), is warmly appreciated as performing the service of an introduction to scholars interested in the philology of the Pacific. In order to prevent a misconception of the work, I ask leave to note an exception to one or two statements in the review which might produce a wrong impression.

Mr. Ray comments upon the incommensurability of the several languages of Polynesia and Melanesia. What he puts in a few lines I had discussed in pages, and had announced that it was impracticable, in our present knowledge of Melanesian speech, to essay a quantitative comparison. On pp. 142 and 143 of the volume I have been at pains to establish my method of comparison by computing a coefficient of recognisability of the Proto-Samoan borrowed element in some ninety Melanesian languages. This is a figure which may be reached independently of the quantity of the loan material; it rests upon each borrowed word by itself in comparison with the same word as found in the present speech of Nuclear Polynesia; it expresses the extent of the deviation from the norm. The determination of quantity lying beyond our reach at present, I have utilised the only element of comparison which in years of research I have been able to discover, that of quality. When Mr. Ray has read again my detailed statement of method he will be the first to thank me for having introduced some principle of comparison where none has hitherto existed. I am convinced that this coefficient of quality amounts to more than a make-shift; its value will exist in its applicability as a constant factor. Mr. Ray cites my determination of coefficient 93 for Nguna and 76 for Sesake, "the same language, Sesake being a colony from Nguna." The lower coefficient of Sesake is not a matter of mere opinion; it is the mathematical product of the presence in that language of several consonant mutations expressive of a wider divarication from the Proto-Samoan stem. If we were in possession of practically complete dictionaries of Nguna and Sesake, this coefficient of quality would, in my best judgment, still be applicable. Suppose that such dictionaries should exhibit Nguna as having Proto-Samoan loan material quantitatively to the extent of 100 words to the thousand, and Sesake 125; of course, it is understood that I am using figures symbolically. We should err in assigning to Nguna a 10 per cent. Proto-Samoan element and to Sesake 12½ per cent. We should have to regard quality as well as quantity; we should have to employ my quality coefficient (subject to such recomputation as a better supply of data would make possible) as an essential factor. Thus Nguna, as a result of the combination of the two elements, would be indicated by 9·3 per cent. and Sesake by 9·5 per cent. Then and thus only will it be possible to state positively that Nguna and Sesake have received the same influence from the Proto-Samoan, the question of whether *qua* Melanesian they are the same language being a matter wholly distinct.

It was of set purpose that I have omitted the discussion of the syntax of the grammar of Oceanic languages. Our present material is all stated most inaccurately; our authorities, without exception, have stated their considerations of grammar in terms of the grammatical categories of inflected speech. The grammar of these isolating languages must be newly written. It will form a large part of the Samoan dictionary of Polynesian philology upon which I am now engaged. In various publications I have made preliminary announcement of some of the principles of this grammar—*e.g.* in my monograph on the Beach-la-mar jargon, just published, I have dealt with the evolution of the verb in the diffuse attributive; but in the present incomplete stage of the study it did not seem advisable in the volume under review to seek to exceed the phonetic examination of the material there assembled.

WILLIAM CHURCHILL.

New York, August 28.

IN my review of Mr. Churchill's book, "The Polynesian Wanderings," I certainly intended my remark as to the liability of error arising from deficient and imperfect material to apply both to quantitative and qualitative comparisons. With regard to the former, there can be no dispute, and the impracticability of quantitative comparison was recognised by Mr. Churchill on p. 143 of his book. But a qualitative comparison as given by Mr. Churchill in his tables, and referred to in the letter, seems to be equally liable to error through inaccuracy in the material. Referring again to the tables for Nguna and Sesake, which I took as typical cases, Mr. Churchill finds that the lower coefficient of Sesake—*i.e.* 76 as opposed to Nguna 93 (implying that Sesake was less like Polynesian than Nguna)—was due to the presence in Sesake "of several consonant mutations expressive of a wider divarication from the Proto-Samoan stem." Mr. Churchill's Sesake words were taken from the lists of Codrington and Gabelentz. The source of his much shorter list in Nguna is not stated. Using a longer list by Bp. Patteson (from which those of Codrington and Gabelentz were derived) and a very long (MS.) vocabulary of Nguna, I find that all Mr. Churchill's examples in Sesake are identical with Nguna, and all the Nguna are identical with Sesake. The consonant mutations are the same. Thus the quality of the likeness to Polynesian is the same for both languages, and the great difference in Mr. Churchill's results is entirely due to the lists being defective and appearing under different names. For the *accurate* application of Mr. Churchill's comparisons the vocabularies used *must* be equal in extent and signification.

My desire in the note on Mr. Churchill's omission to discuss grammar was to direct attention to the fact that he had not shown that any distinctively Polynesian particles (as, *e.g.*, the article *te*, the verbal signs *kua*, *na*, the so-called possessive words *loku*, *toku*, &c.) were used in Melanesian languages.

SIDNEY H. RAY.

Habits of Dogs.

I HAVE read with interest the letter of Miss Everett in your issue of August 31 on dogs eating wasps, as I have a poodle which also eats them, with evident satisfaction. He generally catches them alive, but will also pick them up from the floor when recently killed; he evidently suffers somewhat from the sting, but only for ten or fifteen seconds.

I have always attributed this liking for wasps to some stimulating action of the poison similar to that produced by formic acid on man; this idea was suggested by the following plan, learned in Switzerland.

If a freshly peeled wand be plunged into an ants' nest, so as to be bitten by the infuriated ants, and is then passed between the lips, a sensation of refreshment is experienced which appears to be out of proportion to the effect which one would expect from the mere acidity.

I believe that I have read somewhere that formic acid is a stimulant.

ROBERT VENABLES.

8 rue du Sundgau, Mulhouse, Alsace, September 8.

ON p. 348 Dr. Kidd asks if it is known to be a common thing for dogs to carry hedgehogs in their mouths. I can only answer for my own dog, a fox-terrier. Last season a hedgehog strayed into our garden, and appeared anxious to stay; but the dog carried it in his mouth repeatedly, and so teased it in various ways, that we were not surprised when the hedgehog beat a permanent retreat by absconding. The curious circumstance in the affair was that the dog appeared to carry the hedgehog, rolled in a ball, without causing his lips to bleed; in this particular, Carlo seems to be cleverer than Dr. Kidd's dog!

Braewyn, Earlsfield Road, Wandsworth Common.

R. HOOPER PEARSON.

A Gilbert White Manuscript.

MENTION has been made in the Press of the recent sale of a hitherto unpublished manuscript by Gilbert White. It consists of a nature calendar which the author of "The Natural History of Selborne" carefully drew up before he wrote the first of the letters which are the basis of his famous book. To the latter, he tells us, he meant to add an "Annus Historico-Naturalis," and it seems that the MS. in question was intended to be used in this connection. I am pleased to say that the Selborne Society will shortly produce the calendar (which is particularly interesting) in facsimile, and print a limited edition on Italian hand-made paper.

I should be glad to give further particulars to any of the many admirers of Gilbert White who would care to have them.

WILFRED MARK WEBB.
(*Honorary Secretary*.)

The Selborne Society, 42 Bloomsbury Square,
London, W.C., September 19.

Miniature Rainbows.

THE recent letters on miniature rainbows recalled to my mind a rather interesting case which I observed some years ago at Inversnaid, on Loch Lomond. Here a small stream makes a pretty waterfall; and while standing beside the pool at the base of the fall, and directly opposite the fall itself, I noticed first a brilliant rainbow reflected in the pool. The actual bow was formed in the spray above the pool, and, unless my recollection is greatly at fault, it appeared less brilliant than its reflection. But the bow and its reflected image, viewed together across the pool, formed an almost complete circle, broken only where the extremities of the real bow in the spray appeared to come down towards the surface of the pool.

A. L. LEACH.

Giltar, Shrewsbury Lane, Shooters Hill,
September 16.

ARGENTINA AND THE ANDES.[1]

THE author has gathered his Argentine experience from two prolonged sojourns at the estancia of his brother, a settler dating back to 1868. He stayed in the country for more than a year, and since his notes were submitted to English estancieros of experience, the present book may reasonably be assumed to contain no errors of importance; it gives us a very fair idea of the actual life, and also of the conditions, which prevailed in earlier times.

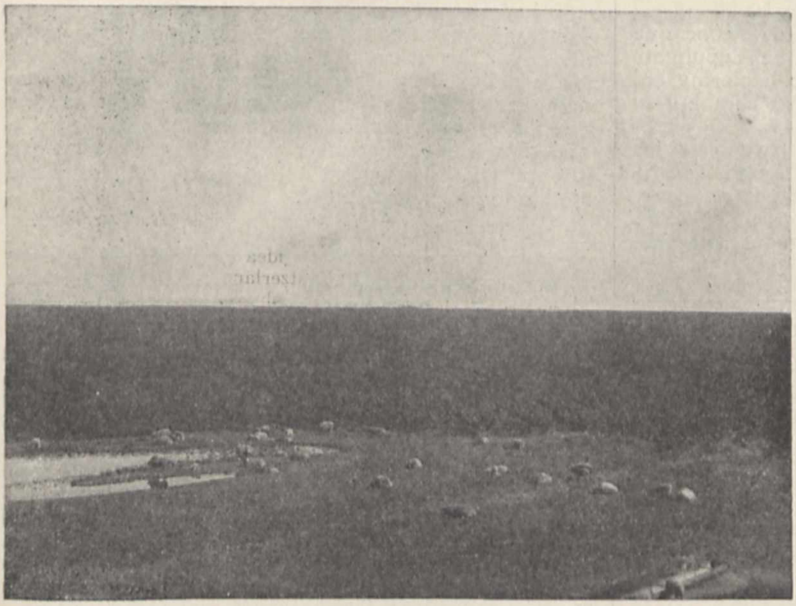

FIG. 1.—The Pampas sown with Alfalfa. From "Argentine Plains and Andine Glaciers."

The homesteads, built like forts, the boundless cattle runs, encounters with Indians, the hunting trips in the wilds, have all changed for a better and much duller state of things. The Indians have retreated or vanished before the rapidly advancing civilisation; the runs are all fenced in, and to visit some lagoon, where alone interesting bird life might be watched, is likely to mean trespass!

The influence of the industrious Italians is steadily transforming the Pampas into interminable agricultural fields, a change which is spreading further and further to the West. The process is as follows. The owner of undeveloped blocks of land of his domain of, say, fifty square miles, accepts a number of Italian time-squatters, who after having raised crops of Indian corn, wheat, or linseed for several years, are moved on to another block, whilst the former is then permanently sown with alfalfa, *i.e.* lucerne. These pioneering or preparatory cultivators are North Italians; the Southerners stick to the towns. A family takes up from 700 to 800 acres; they find themselves in everything, and pay a quarter of the produce as rent. This is a better plan than their taking land "on halves," the owner supplying them in this case with everything, an arrangement which necessitates capital and produces friction. The author has carefully gone into these and kindred economic questions.

However, the best description of such a land, with scenery none and the natives gone, cannot rise above the level of a stockfarm, in spite of accounts of ensilage, the lassoing, branding, and counting of stock, and the invasion by locusts. There are some interesting observations. The native-born cattle and sheep have learned to avoid eating the poisonous weed *romerilla* (unfortunately animals and plants are scarcely ever mentioned except by their vernacular names, and our author does not profess to be a naturalist), but the imported horses, bulls, and rams have to be taught not to eat this plant. They are tied up, and the collected weeds are burned to the windward of them, so that they are well smoked, after which they dislike the green plant.

The pampas grass is said to be dying out where it comes into contact with this dreary civilisation, and this shrinking seems to take place in a round-about way. Formerly, when all the pasture was native and coarse, the cattle did not touch the still coarser pampas grass; now, when the pasture consists nearly everywhere of lucerne, the cattle go for the grass as a change of diet, or tonic, and thus keep the tussocks stunted, which ultimately succumb to the repeated cropping. The pampas are a land of promise for the energetic young man; if he begins early, and is prepared to work hard, he may, without capital, force

FIG. 2.—Penitentes, with rubble concealing the connecting ice base. From "Argentine Plains and Andine Glaciers."

[1] "Argentine Plains and Andine Glaciers: Life on an Estancia, and an Expedition into the Andes." By Walter Larden. Pp. 320. (London: T. Fisher Unwin, 1911.) Price 14s. net.

his way up to a managership, and finally become a wealthy estanciero on his own account. But the author gives the emphatic warning that "Argentina is not a country suitable for the English of the usual emigrant class."

A relief from the monotonous ranch life was the crossing of the Andes into Chile by way of Mendoza, with excursions of several weeks towards Aconcagua and the glaciers of the headwaters of the Tupungato valley, in company of an enthusiastic exploring engineer, who finds his recreation in the climbing of difficult peaks.

The ninety-one original photographs (two of which are here reproduced by the courtesy of the publishers) are excellent representations of a multitude of scenes from lassoing gauchos, sheep-shearing, and locust-plagues, to shifting dunes amongst lagoons, glaciers, and *nieves penitentes*.

THE ERUPTION OF ETNA.

IN the last issue of NATURE (p. 368), a brief reference was made to what has proved to be a somewhat important eruption of Etna. Our knowledge of the successive phenomena is still scanty, the telegrams inserted in English newspapers being short; but, from the more lengthy accounts given in the *Corriere* of Catania, some further details may be gleaned.

The eruption was, as usual, preceded by a series of tremors interspersed with stronger shocks. At Mineo, which lies about 35 miles S.S.W. of Etna, the first movement was recorded on September 10, at 0.58 a.m., followed for more than fifteen hours by almost incessant tremors. After 4.28 p.m., however, a period of calm ensued, which for at least twenty-four hours was interrupted by only one disturbance; and, even at Linguaglossa (about ten miles north-east of the central crater), the shocks had become so infrequent and so slight that the inhabitants were no longer awakened by them.

Almost concurrently with the first tremors, black clouds of vapour and ashes were seen to rise from Etna. The first new vent was opened at 4.30 a.m. on September 10 on the northern flank of the mountain to the north-west of M. Frumento,[1] and at a height of about 9200 feet; the second, at 9.40 a.m., in the neighbourhood of M. Nero; in both cases an hour or more after pronounced shocks. From both openings there issued dense clouds, with lapilli, sand and ashes, but no lava. Later in the day, at 12.15, a third vent appeared, near M. Crozza, and a little later a fourth, near Castiglione Sicilia. After this, new vents opened in rapid succession. On September 11 there were sixteen in action, of which fourteen ejected vapour and dust, and the other two, lower down, lava. On September 13 Prof. Riccò reported that as many as 54 vents had opened in the region between M. Rosso and the craters formed in 1879. The central crater also ejected an immense quantity of ashes, which have covered the surrounding country to the depth of several inches.

During the first day there seems to have been no outflow of lava. At 1.30 a.m. on September 11, however, during a period of comparative seismic calm, a new vent opened between M. Rosso and M. Nero, at a height of about 5250 feet, with enormous emission of dust, &c., followed by a stream of lava. Five hours later another vent appeared in the same district, from which a copious stream of lava issued. The streams rapidly descended the steep slope, passed round M. Rosso and then between the lavas of 1646 and 1809, thus assuring the safety of Linguaglossa. The main stream presented a front from 12 to 15 yards high, and from 500 to 600 yards wide, and advanced rapidly, sometimes at the rate of a quarter of a mile an hour. During the next two or three days, its velocity was reduced. On September 13, it had crossed the carriage road and circum-Etnean railway; the next day it had approached to within two miles of the Alcantara River, which forms the northern boundary of the volcano. On the 15th the main stream split into four subsidiary streams, and the violence of the eruption perceptibly abated. At the time of writing (September 18) the lava stream, the flow of which appeared to be checked, had made another onward movement.

C. DAVISON.

[1] It should be remembered that some of the names given above are duplicated on Mount Etna. The height of the mountain in 1900 was 10,758 feet.

THE CENTENARY CELEBRATION OF THE UNIVERSITY OF CHRISTIANIA.

THE delegates of the foreign and national universities and of many academies of science met an enthusiastic reception at the centenary festival. The organisation was admirable throughout, and much useful assistance was given by a number of students, who acted as marshals, and by ladies who had been asked by the University authorities to help in the entertainment. The majority of the professors and students spoke English well, so that if any foreign delegate met with a difficulty—which is improbable—at least the way was made smooth for all who spoke English.

The Prime Minister, Mr. Konow, and many of the other high officials of the State associated themselves throughout with the University, so that the festival was regarded not merely as academic but also as national.

On the afternoon of Monday, September 4, a short reception was held at the University by the rector, Dr. Brögger, to welcome the delegates, who numbered about 130, and to explain the expediency of dividing us into twelve groups, according to the geographical positions of our several countries. Each group was requested to choose a spokesman, and I had the honour of being chosen to represent the British Empire.

On the evening of Monday the doctors and professors of the University invited their foreign and Norwegian guests, to the number of three or four hundred, to supper at the Grand Hotel. Before supper Prof. Morgenstjerne gave us a cordial welcome in a speech delivered in French, and afterwards we went to the dining-rooms, of which there were several, and supped in groups of skilfully chosen parties of congenial spirits.

The more formal part of the festival took place the following morning (Tuesday, September 5) at the National Theatre. Dr. Brögger presided on the stage, to which access was given by two gangways on each side of the orchestra. The King and Queen honoured the meeting with their presence; and the spectacle was brilliant with the dresses of the ladies, the academic robes, and bright uniforms.

The proceedings began with a cantata composed by Mr. Winter Hjelm, of which the words are by Björnson, entitled "Lyset" (the Light), sung by the students, both men and women, with a full orchestra. After two parts of the cantata had been given Dr. Brögger addressed the audience in German on the history of the University. The groups of delegates then presented their several addresses of congratulation, and each spokesman delivered a speech of a few minutes in length. The rest of the cantata was then given, and this brought the meeting to an end.

In the evening the King and Queen received all the delegates at the castle, and said a few gracious words to each guest.

On Wednesday (September 6) the second formal meeting took place in the handsome new Aula of the University. This hall is not so large as the National Theatre, where the meeting had taken place on the previous day, so that it was only possible to admit national and foreign delegates, but other entertainments were provided by the committee of ladies.

The proceedings on this occasion consisted of instrumental and vocal music, and of a short address by Prof. Stang on the work of the University. The rector then explained that in the honorary degrees which were to be conferred, the claims of mathematics and astronomy were purposely excluded, because degrees in these branches of science had been conferred only a few years ago, on the occasion of the Abel Festival, I myself having then received a degree.

The heads of faculties then presented the names of the several doctors in the various departments of learning to the rector. It may be interesting to note that of the five speeches two were in English, two in German, and one in French. The degrees were then conferred by the rector on the new doctors, of whom but few were actually present. It may here suffice to say that the new British doctors were Prof. Sanday, Prof. Alfred Marshall, Sir Frederick Pollock, Sir Thomas Barlow, Sir John Bradford, Sir William Osler, Prof. Sayce, Dr. Henry Sweet, Sir James Dewar, Principal Miers, Sir John Murray, Sir William Ramsay, Prof. Sollas, and Sir Joseph Thomson.

In the evening the Municipality of Christiania entertained the delegates at dinner in the municipal buildings.

On the following morning a number of parties were taken round the museums, and the two old Viking ships naturally attracted much attention. In the afternoon the Videnskabs Selskabet—the national academy of science—gave a party in the garden attached to their fine house. This home of science was presented to the society not long ago by two Norwegian ladies, whose names, unfortunately, I omitted to take down. As the weather was glorious, this was one of the pleasantest of our many entertainments.

In the afternoon Prof. Birkeland gave a lecture in French on the phenomena attending the discharge of electricity through rarefied gas, with the application of his ideas to cosmogony on the largest scale. The lecture was of great interest; but it contained so much that was new, at least to me, that I will not venture to give a detailed account of his results. I understand that he is now sending a paper on the subject to the *Comptes rendus*.

The festival at Christiania terminated with a brilliant gala performance at the theatre of three acts of Björnson's "Mary Stuart," in the presence of the King and Queen.

On the following morning (Friday, September 8) a large number of the delegates, accompanied by ladies and their Norwegian hosts, left Christiania for Bergen in a special train put at their disposal by the Government. The line affords scenery of great beauty, and is a monument of the triumph of the engineers over enormous difficulties, for we climbed to the height of 4000 feet, and reached the region of snow and glaciers. The weather had been magnificent on the eastern side of the mountains, but we were in heavy rain as we descended the wonderful gorges of the western side. It had been supposed by most of us that the arrival at Bergen would be the real end to the hospitality shown to us; but in this we were mistaken. Every house in Bergen was illuminated in our honour, so that we ran into a city of light, and, notwithstanding the heavy rain, the streets were densely crowded in the neighbourhood of the station. On Saturday and Sunday it was fine again, and thus we learned that Bergen is not a city of eternal rain.

On Saturday a visit to the museum and to the marine biological station had been organised, followed by a drive through the romantic hills which surround the town. In the late afternoon the municipality, as represented by the President and by the first Burgomaster (for in Norway there are two Mayors for each city), invited us to a dinner, at which there were many excellent speeches. Finally, we were invited to the theatre, where a comedy by Björnson was admirably acted. This play, entitled "Geography and Love," was perhaps chosen to teach men of science that they ought not to become intolerable nuisances to their wives.

On Sunday morning the special train returned to Christiania, somewhat emptied by the departure by sea of some delegates, who were bound for St. Andrews.

It is notoriously difficult to judge of places and institutions in their holiday dress, but I am sure that all the visitors must have carried away an impression of great activity in the study of literature and science on the part both of the professors and students; and what I have written will have shown how great was the hospitality extended to us during this crowded week.

G. H. DARWIN.

CELEBRATION OF THE FIVE-HUNDREDTH ANNIVERSARY OF THE FOUNDATION OF THE UNIVERSITY OF ST. ANDREWS.

CELEBRATIONS there have been in St. Andrews from very early times, more especially when its ancient chapels and monasteries were in full activity, and still more when its splendid cathedral, the largest and finest in Scotland (yet so ruthlessly destroyed by the Reformers) lent its countenance to the ceremonies. The present, however, surpasses them all save in the absence of the King, who so often favoured the city and the University up to the time of Charles II. Thus, to confine the remarks to academic life, great were the rejoicings on February 14, 1413, when Henry Ogilvie, M.A., the bearer of the papal Bull of the cultured Benedict III. endowing the young University with its important privileges, entered the city. Bells sounded from the steeples, a solemn convocation of the clergy was held in the refectory of the Priory, and a procession to the high altar of the cathedral was made by the whole assembly in rich canonicals, "whilst 400 clerks, besides novices and lay brothers and an immense number of spectators, bowed down before the high altar in gratitude and adoration."[1] After high mass the day was devoted to mirth and festivity. Such was a fitting baptism to a university which owed its beginning more to the impulse of learned men to teach than to public or private endowments. No special buildings at first existed, the masters opening pedagogies in various parts of the town, the larger meetings in churches or in the refectory of the Priory so recently and so judiciously restored by the late Lord Bute.

Now, after the lapse of five centuries of an almost unbroken continuity in academic life, the University again engages in festivity and rejoicing. During its long and chequered career it has surmounted numerous trials and difficulties—such as the turmoil of revo-

[1] Tytler, "Hist. Scot."

lutions, the asperities of reformations, and the paralysing spoliations—and to-day is not lacking in vitality, vigour, and eagerness to fit a university of the olden time to every modern improvement. Formerly it had seen the burning of martyrs in front of its gates or in its vicinity, had endorsed the law on the unfortunate witches, and rigidly excluded women even from its quadrangle, on one hand; and, on the other, it had reared or fostered many men of note who spread its fame throughout other lands, or sent its best and wisest to preside over the sister-universities or to teach within their walls. Science, literature, and divinity have been enriched by the labours of its staff throughout this long period, its students have increased in number, women have entered its gates on the same footing as men, and its interests have been widened by the union with the college of the enterprising and prosperous city of Dundee.

With its long, chequered, and honourable career behind it, and imbued with high purpose for the future, the University held the first function of the celebration on Tuesday afternoon, September 12, in the presentation of his portrait to Mr. Carnegie. This was a gift of the students, Senate, and University Court in recognition of their former rector's munificence to the University, for to him it owes, amongst other things, its fine Carnegie Park, pavilions, library, and gymnasium. The picture represents Dr. Carnegie in his robes as rector. Principal Sir James Donaldson made the presentation on behalf of the subscribers, and Dr. Carnegie made a notable acknowledgment.

In the evening there was a reception by the chancellor, Lord Balfour of Burleigh, who, with Lady Balfour, graciously received the great concourse of visitors and others in the North Hall at the United College of St. Salvator and St. Leonards. No more brilliant scene could have been imagined. Not even the great array of silver ornaments and statues, of gorgeously arrayed Churchmen of every rank at the celebration of the endowment of the young University in 1413 to grant degrees by the papal Bull, could have exceeded the varied and striking array of the representatives of science, of medicine, of arts, divinity, law, and other distinguished men and women from almost every civilised country in lines from New Zealand to Australia and radiating through the old world and through the new to the old grey city on the Scottish coast. The bright colours and ornamentation of the robes and hoods, the gold chains of office—academic and civil—the brilliant orders and medals, and the still more varied colours and graceful drapery of the ladies, mingled with the sheen of spurs and the full-dress uniforms of military men, both highland and lowland, of representatives of the navy and groups of civic dignitaries, made a scene never to be forgotten. One thing more only can be alluded to, and it is that the welcome given by Lord and Lady Balfour to every one of the 3500 was of such a kind that from first to last the proceedings were of a most pleasant and harmonious kind. The band of the Scots Guards at the eastern end of the hall enlivened the proceedings, which were further enhanced by the chaste decoration of the interior, from the platform to the opposite end.

Moreover, a torch-light procession of the students starting from the Carnegie Park, clad in the most varied and fantastic costumes, made a striking and most fascinating scene throughout the city, as the long, snake-like line of fire wound its way along crescent, street, and promenade. Whether man or woman held the torch it was sometimes difficult to say; so that if the women students were not present, their places were sympathetically filled. To add to the charm of the proceedings the old tower of the United College of St. Salvator and St. Leonards was outlined each evening at every angle by rows of electric lamps—white, blue, and red.

Finally, a symposium was held in the Volunteer Hall under the auspices of the Students' Representative Council, at which all graduates and students of the University met. Many old friends thus had an opportunity of seeing each other and of contrasting the old *régime* with the new, and there was no happier assembly during the celebration than this.

Under bright sunshine the morning of Wednesday, September 13, was occupied by marshalling in the United College quadrangle the assembled University Court, Senate, lecturers, graduates—both ordinary and honorary—students, including members of the Officers Training Corps, delegates and distinguished men from the colonies, India, from foreign universities and societies, Lords of Session, sheriffs, the Provost and Town Council, and others to form a procession to the town church (Holy Trinity), so recently and so finely restored under the auspices of Dr. P. M. Playfair. In the church an impressive commemoration service was performed, chapters were read by the chancellor and vice-chancellor, the "Te Deum Laudamus" was sung, and an appropriate and eloquent sermon was given by the Moderator of the General Assembly (Principal Stewart, of St. Mary's College). Prayers were said by Dr. Playfair and the Very Rev. Archibald Henderson, D.D., clerk of the United Free Church, and it is noteworthy that the first prayer was a translation by the late Marquis of Bute, a former rector of the University, of the prayer given in 1413 on the arrival of the papal Bulls establishing the University. The whole tone of the procession and its surroundings and of the service in the Church of the Holy Trinity was in keeping with old academic tradition, and the same feeling pervaded the great assemblage. In no other Scotch city could the combination of past and present render the scene more purely academic.

In the afternoon the presentation of congratulatory addresses took place in the North Hall, the chancellor, rector, and the staff occupying the platform. About 166 addresses were handed in by the distinguished delegates of universities, learned societies, university general councils, town councils, churches, and other important bodies; and as each was as a rule arrayed in official robes, with gold chains and orders, the scene was one of the most interesting in the celebration. As the representatives of each country were announced, the band played a brief but appropriate piece of music. The chancellor (Lord Balfour of Burleigh), after reading a letter from the King, then delivered an eloquent and masterly address, in which he welcomed the delegates from all parts of the world, alluded to the founders of the University, its continental character, its modern modifications, the effect of its training on the national life, and finally he sketched a picture of the future of the University. Principal Sir James Donaldson then welcomed the delegates and guests on behalf of the senate.

A delightful entertainment, consisting of historical tableaux connected with the University, was given by the students in the evening. Moreover, students of the 'eighties (1880–9) had a special symposium.

Equally favourable was the weather of Thursday morning, when the rector of the University, the chosen representative of the students, was installed. The popularity of the Earl of Rosebery, who now has held the rectorship in every Scottish university, was sufficient to have filled the vast hall several times over, and, as it was, every available space was packed, little short of 4000 people being present. Before the entrance of the procession of the chancellor, rector, principals, senate, and staff in general, the students beguiled the time with songs, and as the procession entered the band played "Gaudeamus Igitur." The president of the Students' Representative Council then intimated the result of the rectorial election; Lord Rosebery took the oath, was robed, amidst the cheers of the students and audience, and then delivered his address, which was marked throughout as the production of a finished orator and man of affairs, as the experience of a man of letters, and as the counsel of a statesman. He lightly touched on the early history of the University (much of which recent writers have necessarily borrowed from Lyon, biassed though he was, and others), the troubled times following its foundation, the tenacity of its hold on learning (science for the time being forgotten) amidst the vicissitudes of its centuries, and in a fascinating manner drew a picture of the first rector as a Struldbrug of Swift doomed to perpetual life, who, from a point of vantage, surveyed the progress of the University century after century, and, though shocked at and severely critical in regard to many of the changes, concluded by affirming that, after all, substantial advances had been made all along the line. In his final words the rector counselled the students to hold fast to the simple and temperate life, the dogged perseverance, and the pure and high aims of those who had gone before them. Especially did he warn them of the dangers of losing that self-reliance, that frugality, that resolute application to work, and that masterful surmounting of difficulties which have made their countrymen thrive even under neglect, and have won for them the respect of the world. Above all, should they avoid being a "spoon-fed" nation.

After the conclusion of the rectorial address, congratulations from the Senate were conveyed by Principal Stewart to Sir James Donaldson on the completion of his twenty-fifth year of office, and in recognition of the skill and ability with which he had guided the affairs of the University. The principal feelingly replied. Then the graduation ceremony proceeded. The first (about ninety) were those receiving the honorary degree of LL.D., and as each distinguished graduate stepped on the platform to be capped by the chancellor, he or she was cheered by the students and audience; and so with the fourteen men who received the D.D. degree. Amongst those on whom the degree of LL.D. was conferred were many eminent men of science, as mentioned in the last issue of NATURE (p. 374), some of whom had been students in the old university, or had carried out researches in its marine laboratory.

In the afternoon garden-parties on a large scale were given by the mistress and council of St. Leonards' School in their fine grounds, the band of the Scots Guards playing at intervals; whilst another large party was entertained at Mount-Melville, the seat of Mr. J. Younger. Both had endless beautiful and interesting pictures in scenery and landscape gardening, in fine trees and shrubs, to entertain them, especially at Mount-Melville, where arboriculture has long been prominent.

The banquet in the Bell-Pettigrew Museum in the evening was on a large scale, the chair being occupied by the chancellor, and he was supported by the rector and principals, by Lord Reay, Lord Elgin, Lord Stair, Lord Ailsa, Lord Pentland, Lord Kinnoull, Lord Tullibardine, Lord Haddo, Lord Southesk, Lord Kinnaird, Lord Glenconner, Lord Shaw, the principals of Edinburgh, Glasgow, and Aberdeen, Dr. Andrew Carnegie, Mr. Whitelaw Reid, Mr. A. J. Balfour, the Maharajah Gaekwar of Baroda, and a long list of distinguished men. After the loyal toast the chancellor declared the museum open, and alluded to the munificent gift of Mrs. Bell-Pettigrew. Speeches were given by the rector, principals, Mr. Balfour, Sir William Turner, Sir Donald Macalister, Lord Reay, Lord Elgin, Lord Pentland, Mr. Munro-Ferguson, President Butler (New York), and many others, and the dinner was throughout of the most agreeable and successful character.

In order to entertain those whom the limited capacities (550) of the hall had of necessity excluded, a ladies' "at home" was held in the large North Hall, under the auspices of the Ladies' Celebration Committee. Lady Balfour, Lady Leconfield, Lady Helen Munro-Ferguson, and the ladies of the executive committee received the guests, who spent a most enjoyable evening. Moreover, a similar reception was held in the Victoria Art Galleries, Dundee, where Lady Baxter of Invereighty and Mrs. Urquhart, the wife of the Lord Provost of Dundee, received the guests, and the evening was spent in the same happy and memorable way.

The close of the quincentenary celebrations occurred on Friday, September 15, which was chiefly spent in Dundee in connection with University College (formerly the Baxter College), which is now an integral part of the University of St. Andrews. A special train conveyed the Court, Senate, staff and guests from St. Andrews to Dundee at 10 a.m., and all the visitors assembled at University College Library, signed the visitors' book, and proceeded to the gymnasium, where, on behalf of the council of the college, Lord Camperdown gave them a cordial welcome. Remarks were then made by the chancellor and by the rector, who, in a humorous yet suggestive speech, held that universities of the future would always be founded in great centres of population. The buildings, especially the new Carnegie Physics Laboratory, the medical buildings, the engineering laboratory, the college museum of natural history, the various class-rooms, and the city museum, were then inspected, and a tribute paid to the wonderfully complete arrangements for the teaching of medicine, engineering, physics, and other departments.

A luncheon was given by the University in the drill-hall, where the guests were received by Lord Provost Urquhart and the magistrates. The chancellor occupied the chair, and many distinguished men supported him, viz. Lord Reay, Lord Rosebery, Lord Camperdown, Lord Stair, Lord Shaw, the principals, senate, and staff of the University, and others. Between 600 and 700 persons were present. The usual toasts were given, and the company broke up about half-past two to proceed to view various large mills in the city, to join the excursions to Glamis, Rossie Priory, and a sail by steamer to Perth—all under most favourable auspices.

Another function was a graduates' and students' dinner in the Bell-Pettigrew Museum at St. Andrews, presided over by the chancellor, at 7.20 p.m. More than 500 were present, and amongst the guests was Sir Dyce Duckworth, who has so frequently visited St. Andrews, and he, in his speech, took his hearers back to the days of Principal Tulloch, on whose grave that afternoon a procession of old graduates and alumni had placed a wreath. The same would have been done if the grave of Sir David Brewster, of world-wide renown, had been in St. Andrews, for the University cherishes the memory of her, and subsequently Edinburgh's, great scientific principal.

Lastly, a students' ball at 10 p.m. brought the proceedings to a termination. This was one of the brightest and gayest of the social gatherings, under the auspices of the Students' Representative Council and its president, Mr. Dickey. The uniforms of the officers of the warships at present in St. Andrews Bay, the bright robes of the foreign and British graduates, the varied hues of the ladies' attire, and the gowns of the students themselves lent a charming novelty to the picture.

Thus ended the stately celebration of the five-hundredth anniversary of the foundation of St. Andrews University, under the most cheerful of sunny skies, pure (but not "piercing" air), and amidst the unique academic surroundings of the place, which usually, and unfortunately, are wholly absent in those great populous centres where the universities spoken of by the rector will in future be. But the great stretches of pure sand, the expanse of the blue waters of the bay (on which the warships proudly ride), and the long lines of tidal rocks remind us that nowhere within the British dominions can the sciences of geology, botany, and zoology be studied under more inspiring or more favourable auspices than in the little city by "the cold North Sea." Be that as it may, one thing is certain, viz. that both guests and hosts vied with each other in making this celebration one of the most delightful and memorable gatherings it is possible to conceive. W. C. M.

EDWARD WHYMPER.

IN Edward Whymper, who died suddenly at Chamonix on Saturday last, September 16, we have lost one who was more than a most undaunted and successful climber of mountains. Born on April 27, 1840, the son of an artist and engraver on wood, he was brought up to the work and carried it to great perfection. He went to the Alps on a professional errand in 1860 and began his career as a climber. Next year he made the first ascent of the Pelvoux, and in 1864 vanquished its neighbour, the Ecrins, the highest summit of Dauphiné. Before that he had attacked the Matterhorn. How this was at last conquered, in 1865, and of the tragedy of the return, when four lives were lost, it is needless to tell. In 1867 he visited Greenland and attempted to penetrate the inland ice. It was a failure, though not from his fault. In 1872 he returned to do some surveying on the coast. In 1879–80 he undertook his notable journey to the Ecuadorian Andes, during which he successfully ascended ten volcanic mountains, ranging from 15,000 feet to above 20,000 feet, most of them hitherto unclimbed, spent a night on the summit of Cotopaxi, and twice reached that of Chimborazo.

In later years Whymper made four or five exploratory expeditions in the Canadian Rockies and Selkirks. But he was more than a successful mountaineer: he was a keen observer of all natural phenomena. His two great and beautifully illustrated books, "Scrambles amongst the Alps" and "Travels amongst the Great Andes of the Equator," contain much of scientific value. He was a student of glaciers, and a keen critic of those who claimed for them great powers of erosion; a close observer of volcanic and other geological phenomena, and a collector who knew what was worth bringing. While at Disco Bay he obtained a fine series of fossil plants and of Eskimo relics. From the Andes he brought many specimens of rocks and other material, descriptions of which have been published, and himself wrote a paper on the aneroid barometer, besides devising a modification of the mercurial instrument for use on high mountains.

Whymper's latest books, "Chamonix and Mont Blanc," published in 1896, and "Zermatt and the Matterhorn," which appeared in the following year, are admirable of their kind, and have met with great success. He was a fellow of the Royal Society of Edinburgh, had received the Patron's medal of the Royal Geographical Society, and been decorated with the Order of St. Maurice and St. Lazare, besides being an honorary member of foreign geographical societies and Alpine clubs. T. G. BONNEY.

NOTES.

THE Government of the Commonwealth of Australia has promised to contribute 5000*l.* towards the expenses of the Mawson Antarctic Expedition, and the Victorian Government 6000*l.* This amount brings the contributions of the various Australian Governments to the sum of 22,000*l.*

THE friends of the late Christian A. Herter have contributed to a memorial fund in recognition of his labours in promoting medical science. The fund, which amounts to 8000*l.*, has been confided to the directors of *The Journal of Biological Chemistry.* The chief aim of the trust is to further the interests of that journal, which was founded by Herter.

ACCORDING to the *Revue Pratique de l'Électricité*, a bronze statue has been erected at Poleymeux, in the Rhone Department, France, in memory of Ampère. The inventor is represented standing in an attitude of meditation, the right hand raised to the forehead, the left clenched. On the side is inscribed "La Science," suggestive of the subject of his meditation.

AN International Engineering Exhibition is to be held in April next at Baku, Russia, and will be open for six weeks. The exhibits will comprise internal-combustion engines, air-compressors, electrical apparatus, motor-cars, &c. Particulars of the prospective arrangements may be obtained from the sole honorary representative in this country—Dr. P. Dvorkovitz, 1 Broad Street Place, E.C.

DR. R. KARSTEN, lecturer in comparative religion in the University of Helsingfors, has started on an expedition to Gran Chaco and Bolivia for the purpose of making investigations on the sociology and religion of various tribes of natives, some of whom are little known, while others have never been visited. He will be accompanied by his cousin, O. Lindholm.

M. G. FAYET, of the Paris Observatory, has been appointed astronomer at the Nice Observatory, in succession to M. Simonin.

MR. MARCONI has been elected president of the Junior Institution of Engineers in succession to Sir J. J. Thomson, F.R.S.

MR. J. J. NOCK has been appointed by the Secretary of State for the Colonies, on the recommendation of the Kew authorities, curator of the Hakgala Gardens, Ceylon.

THE meeting of the International Sanitary Conference to revise the provisions of the convention of 1903 for the prevention of the invasion and propagation of plague and cholera, is to take place in Paris on October 10 next.

A CONFERENCE of members of the Museums Association and others interested is to take place in the Free Public Museums, Liverpool, on Wednesday, October 18, the object being to discuss subjects of interest to those concerned in the work of museums.

PROF. LUIGI CARNERA, hitherto the director of the International Latitude stations at Carloforte and Oncativo, has been appointed professor of astronomy and geodesy in the Istituto Idrografico della R. Marina at Genoa, to which address he desires all communications to him to be sent.

THE new session (the seventieth) of the Pharmaceutical Society's School of Pharmacy is to be opened on October 4, when the inaugural address will be delivered by Dr. J. Macdonald Brown. The Hanbury gold medal will be presented on the occasion to M. Eugène Léger, of the Hôpital St. Louis, Paris.

A REUTER message from Adelaide states that Mr. Brown, the South Australian Government geologist, reports that the uranium ores recently discovered in the northern portion of South Australia possess great importance, owing to the limited extent of the world's supply of radium-producing ore. He also reports the existence of extensive deposits of corundum in the same district, and recommends prospecting there for rare gems.

THE third exhibition of small power engineering appliances, models, and scientific apparatus will be held at the Royal Horticultural Hall, Vincent Square, Westminster, on October 13 to 21. It will comprise working and stationary engineering models of all kinds, small power steam, gas, and oil engines, lathes and light machine tools, electrical appliances, &c. There will also be a completely equipped model engineering workshop, in which demonstrations of metal-working processes and small engine building will be given daily.

AN agreement has been signed by the representatives of the United Kingdom and Germany, the carrying into effect of which will mean a thorough investigation into the extent of sleeping sickness in the Gold Coast Colony, the Ashanti and Northern Territory Protectorates, and Togoland. Each Government will keep the other informed of the incidence, extent, and possible spread of the disease in its territory, and will treat the other's native subjects free of charge; but each may impose restrictions on the frontier traffic and may prevent suspected sufferers from crossing its border. The agreement is for three years certain from December 1, 1911, and continues thereafter for yearly periods, unless denounced at least six months before the close of a year.

IT is reported in *The Lancet* that the chief medical officer of one of the Austrian army corps has recently ordered the use of Calmette's serum against serpent-bites, and a fairly large stock of it has now been issued to each regiment in the south of the Empire. The men and the medical officers are instructed in the use of it, and regular inspections of the stock, as well as lectures on the natural history of the poisonous kinds of serpents, are provided for. In addition to the serum, the various appliances necessary for its proper application have been supplied to the army hospitals. Hitherto much dependence has been placed on the treatment of such injuries by alcohol and the application of permanganate of potash.

IN May last great excitement was created in Turkey and throughout the Mohammedan world by the rumour that a party of English archæologists had profaned the Mosque of Omar at Jerusalem in search of the regalia of Solomon, the Ark of the Covenant, and the Tables of the Law. A full account of the results of this expedition appear in *The Field* of September 16, of which a summary is given by *The Times* of the previous day. The excavations were chiefly devoted to what is known as the Virgin's Well and the maze of tunnels and chambers connected with it. Many fragments of Jewish and Hellenistic pottery were found. While some of it may be attributed to Canaanitish potters, none can be safely dated so late as the ninth century B.C. One Israelitish lamp, in almost perfect condition, is certainly as old as the eleventh century B.C. The Hellenistic pottery betrays indubitable evidence of that school of pottery which was transformed in the eighth and ninth centuries B.C. by Cypriote or Rhodian influence.

THE mediæval belief that the neuro-hystero-psychic manifestations known as Tarantism, because they were attributed to the bite of the Tarantula spider (*Lycosa tarantula*), has again appeared in the Troad, according to an interesting account given by a correspondent of *The Times* in its issue of September 9. The ecstatic dances, now said to be due to the promptings of the spirit of St. George, are similar to those which prevailed in Europe from 1374 to the beginning of the sixteenth century, the only difference being that in the present case the excitement is shared by men as well as women. The correspondent quotes two instances, which may probably be attributed to automatic suggestion, in which spider bites were said to be the cause of similar phenomena in one of the Troad villages. Similar manifestations are said to have occurred recently in the small island of Marmora, and at Balouki, a suburb of Constantinople. It is suggested that the investigation of these phenomena should be undertaken by medical experts and by the societies devoted to psychical research.

DR. MAX OHNEFALSCH-RICHTER publishes in *The Times* of September 11 an interesting letter on the discoveries of the Prussian Academy's archæological expedition to Paphos, in Cyprus. We appear to allow the Germans to excavate as they please in one of our colonies. That is very good of us, and it is all to the good of science; but it is a pity that our archæologists cannot be digging in the kingdom of Cyprus too. That little island-realm, which owns the sway of George V. (in succession to Richard Lionheart, who was the first English King of Cyprus) is full of archæological treasures which only await the spade. Witness the fine collections of Minoan antiquities from Enkomi in the British Museum. Dr. Ohnefalsch-Richter describes antiquities of a later period, chiefly Greek inscriptions, written in the peculiar Cypriote syllabic script, from Paphos. A discovery of his own at Rantidi last year gave the impetus to the Prussian work which has resulted in so great an addition to our knowledge of Cypriote inscriptions. The site on which they have been found by Dr. Zahn is that of the ancient high-place of Aphrodite at Paphos.

INFORMATION has been received of the arrival of the magnetic survey vessel, the *Carnegie*, at Mauritius on August 6, having been thirty-one days out from Colombo, Ceylon. The exceptionally large chart errors (approximating in magnetic declination to four degrees for one extensively used chart and for another even to six degrees) which were shown on the portion of the cruise from Cape Town to Colombo, *via* St. Paul I., April–June, have been confirmed by the cruise from Colombo to Mauritius. The *Carnegie* also arranged her route so as to intersect the tracks of the *Gauss* (1901–3), and thus has been able to secure valuable secular variation data. A fuller account is published in the September issue of *Terrestrial Magnetism and Atmospheric Electricity*. Dr. Bauer, during his visit to Australian institutions, was able to set afoot a general magnetic survey of Australia, one of the largest land areas remaining to be explored in this respect. The survey is to be conducted under the joint auspices of local organisations and of the Carnegie Institution of Washington, the observer-in-charge for the latter being Mr. E. Kidson, formerly of the Christchurch Magnetic Observatory, and more recently observer on board the *Carnegie*. Cooperation has also been effected between the Mawson Antarctic expedition and Dr. Bauer's department.

IN the obituary notice of the Rev. F. J. Jervis-Smith, F.R.S., which appeared in NATURE of September 7, the writer, who was an old friend, remarked:—"Trained as a mechanical engineer, he gave up the calling of his choice, went to Oxford, and entered the Church for family reasons." Mr. E. J. Jervis-Smith writes to say that this is not correct, as his father's education was entirely classical. Also, he says, "My father intended from his earliest childhood to enter Holy Orders, as it was his father's greatest wish that he should do so." The Rev. F. J. Jervis-Smith certainly knew all the tricks of the engineer's workshop, and prided himself upon so doing; and this led the writer of the notice to believe that he had been trained in mechanical engineering, instead of receiving the usual classical education with the intention of entering Holy Orders. His interests were, however, scientific and engineering, whatever was his educational course, for his son says:—"As a child my father saw a great deal of Mr. William Ellis Metford, who imbued him with a love of mechanics and scientific apparatus. He had a small scientific and mechanical laboratory of his own at Taunton, where he carried on research work before going to Oxford as Millard lecturer."

WE learn from *The Lancet* that a society for the prevention of diseases and epidemics (Gesellschaft zur Bekämpfung von Volksseuchen) has been founded in Austria which will act in concert with the Public Board of Health and the Sanitary Department of the Ministry of the Interior. Its aims are to supplement the endeavours of the public authorities in combating diseases, to improve the general circumstances of patients and their families belonging to the poorer classes, to provide adequately trained attendants for the care and nursing of patients during epidemics, and to organise medical help and hospital accommodation in non-epidemic times. The society will also encourage investigations relative to the spread of diseases, as well as their prophylaxis and treatment, and will, so far as possible, make the general public acquainted with the results of these scientific researches. The society will endeavour to improve the knowledge, not only of the so-called epidemics, but also of all diseases which prevail extensively. The present intention is that the scientific part of the work shall be divided amongst all practitioners in the country through the instrumentality of the local medical unions and councils. It is thought possible that an international society for the study of epidemic diseases may in the course of time be called into existence.

Man for September contains an important report by Mr. C. L. Woolley on the great collection of pottery brought by Dr. M. A. Stein from Chinese Turkestan and western China, which dates from the first century B.C. onwards. Much of it consists of hand-made pots fired in an open hearth, as is still the custom in modern India, and showing in the section the uneven bands of colour usually resulting from this process. An important advance is illustrated by the moulded ware, in which the moulds employed show distinct Gandhara influence. The wheel-made pots are usually of finely levigated clay, kiln-fired, sometimes smothered, sometimes of a clear terra-cotta red. It is not necessary to suppose that the glazed specimens were imported, because similar glazes, though on a different body, were certainly locally produced.

RECENT reports announce numerous important prehistoric finds in this country. In a sepulchral barrow of the Bronze age at Eye, near Peterborough, a pot containing food offerings to the dead was unearthed in 1910. But it was only in the present year that the actual interment was discovered, the skeleton being that of a tall man, whose corpse had been laid on the right side with the head to the south-west, and the arms and legs flexed, a disposition typical of this period. The absence of articles accompanying the interment makes it difficult to fix the date more closely than in the second millennium B.C. During the visit of the Cambrian Association to Promontory Hill Fort, which overlooks the Vale of Clwyd, near which some fine bronze trappings were found some forty years ago, the accidental discovery by a member of the party of some fragments of pottery at the mouth of a rabbit burrow enabled Prof. Boyd Dawkins to conclude that this site had been occupied from the later Bronze and Iron age down to the end of the second or third century of the Roman occupation.

The Times of September 6, in its second article describing the excavations made by Commendatore Boni at the Roman Forum, throws some light on the problems connected with the famous Niger lapis, or black stone, which was unearthed in 1890, and has since supplied the material for a vigorous controversy. It is a slab of black marble covering remains which are certainly of great antiquity, including a broken rectangular stele bearing an inscription, which has hitherto remained undeciphered. These remains bear marks of intentional demolition; and close to the place were found a series of dedicatory gifts, such as small idols of clay, bone, or bronze, with some river sand, which was obviously brought here from a distance to serve some special religious purpose. It thus appears to mark the site of a ruined sanctuary, hitherto assumed to be an unlucky spot—the grave of Romulus, or of his foster-father Faustulus, or Hostus Hostilius. Commendatore Boni now believes that this was the site of the rostra destroyed by the patricians at the beginning of the civil war, about 124 B.C. The present remains, he supposes, mark an expiatory rite performed in obedience to an oracle procured from the shrine of Demeter at Enna, in Sicily, from which advice was sought how best to expiate the contamination of the Forum by the slaughter of so many Roman citizens. It thus represented a popular monument intended to be a lasting memorial of plebeian resentment against this outrage on the part of the aristocratic faction.

THE contents of Nos. 3 and 4 of the second volume of the Economic Proceedings of the Royal Dublin Society include an article by Prof. G. H. Carpenter on insects, &c., injurious to crops and trees observed in Ireland in 1910.

WE have received a copy of the report of the museum of the county borough of Warrington for the year ending June 30. It may be noticed that the museum accepts such miscellaneous objects as a Rhone beaver and a portion of tree-trunk gnawed by the Canadian representative of the same.

IN the September number of *British Birds* Miss E. L. Turner records the breeding of the bittern in Norfolk during the past summer. It appears that three adult birds were observed in the latter part of December, 1910; booming commenced at the end of the following January, and continued, with the exception of February, until June 4, when it ceased. A half-fledged young bird was taken on July 8 (and subsequently liberated) which appeared to be four or five weeks old; and it is suggested that this was the latest of the brood, the other members of which had dispersed. The empty nest was observed. If, as appears to be the case, the cock ceases to boom immediately after the young are hatched, it may be inferred that both parents share in the task of feeding their offspring. Although the bittern is doubtless a night-feeder, it appears to tend its young at intervals throughout the day, as one at least of the old birds was observed to visit the nest several times a day.

A FEW weeks ago reference was made in this journal (August 10, p. 200) to the discovery of a breeding colony of fulmar petrels at Berriedale Head, Caithness. In the September number of *The Irish Naturalist* Mr. R. J. Ussher announces the existence of a colony of these birds on a high, perpendicular cliff on the coast of Mayo, this being the first instance of the breeding of the species in Ireland. According to the local boatmen, these white "cawnoges" made their appearance on the cliff, which is about 700 feet high, four years ago, and have been steadily increasing in numbers since that date. On July 10 Mr. Ussher scaled the cliff, and, with the aid of binoculars, counted eighteen sitting fulmars on a ledge about 400 feet above the water, the specific identity of the bird being rendered certain by individuals which flew close overhead. It is also stated that a colony of about twenty fulmars was observed on a cliff in Ulster in May, the birds, according to local report, having made their appearance in 1910, and remained through the breeding season. Mr. Ussher does not believe that the fulmars have been attracted by the whaling stations on the west coast of Ireland, but that their appearance is part of the extension of the breeding area of the species now in progress. Of this extension Mr. R. M. Barrington gives a summary in a separate paper in the same serial.

IN an article on the purpose and some principles of systematic zoology, published in *The Popular Science Monthly* for September, Mr. Hubert Lyman enunciates the following five propositions, which he regards as of prime importance in regard to the present condition of the science and the lines on which it is studied:—(1) Naming and describing new species and correcting nomenclatural errors, while valuable, and indeed essential, is frankly the most elementary, and hence the lowest, form of zoology. (2) To be of real worth and permanent value, the systematic study of any group of animals must take into account, so far as they are known, the pre- and post-natal development, the geological history, and the geographical distribution of the species which compose it. (3) While genera and larger groups in our systems of classification ought to be based on relationship, their delimitation is often of necessity artificial, and is purely a matter of expediency and convenience. (4) The value of a character for distinguishing species or higher groups depends chiefly on its constancy, and for indicating relationships within a group on its significance; in neither case is its conspicuousness anything more than a matter of convenience. (5) In all systematic work, the line between facts of nature and opinions of the worker should be sharply drawn; the value of the work often depends on the clearness of this line. The article is certainly opportune, as there is a decided tendency at the present day to regard systematic work as the end and final aim of zoology instead of the foundation.

A NOTE by Prof. A. C. Seward in *The Geological Magazine* (July) describes a fossil bipinnate leaf, taken from the Molteno beds at the base of the Stormberg series in Cape Colony, that supplies the type of a new genus, Stormbergia. The stalked pinnules furnish the chief distinctive feature of what is regarded as a probable fern frond; in some respects it resembles *Bernoullia helvetica*, a fossil fern of Rhætic age.

IT is obvious that the task of exhibiting alpine plants on tables in April calls for considerable enterprise and previous calculation. A prize offered by the Royal Horticultural Society of Ireland has inspired an article on the subject, contributed by Mr. W. H. Paine to *Irish Gardening* (September). The cultural directions refer to species of Primula, Androsace, Viola, Aubrietia, Saxifraga, Shortia, and Anemone. With regard to methods, while the various plants have their special soil requirements, it is recommended that the plants should be panned in autumn to get established, then plunged in sand and covered with a depth of leaves, sand, or bracken through the winter. Preparations for bringing the plants into exhibiting condition must be started several weeks before the show takes place.

WITH the object of estimating the aperture of stomata, Dr. Francis Darwin, assisted by Miss D. F. M. Pertz, has devised an ingenious apparatus that he calls a porometer. It consists of a small campanulate glass vessel attached to an air chamber. The glass vessel is fixed to a leaf, and pressure in the chamber is reduced, whereby air is drawn through the stomata. The rate of flow of the air into the chamber is measured, and supplies a comparative indicator of changes in the apertures of the stomata. The porometer provides a continuous method; it indicates the movements of a group of living cells, and possesses a great advantage over the horn hygroscope and cobalt paper, inasmuch as the readings of the instrument are independent of transpiration. The experiments described in the Proceedings of the Royal Society (vol. lxxxiv.) are designed to show how illumination and water supply influences stomatal aperture.

THE main features of an address, delivered by Mr. R. R. Gates before the National Academy of Sciences at St. Louis, on the mode of chromosome reduction, is published in *The Botanical Gazette* (May). With regard to general facts, it is noted that there are two ordinary methods of chromosome reduction in organisms, the one involving an end-to-end arrangement, the other a side-by-side pairing; the difference is not of phylogenetic or hereditary value, but is a matter of cell mechanics. Consequent upon the important point first demonstrated by Strasburger, that the chromosomes are in homologous pairs throughout the tissues of the sporophyte, it is argued that the reduction process consists in a segregation of the paired somatic chromosomes in the heterotypic mitosis, and a split of these chromosomes in the homotypic, and that the supposed function of synapsis to bring about a pairing of the chromosomes is not justified.

A MEMORANDUM on the monsoon conditions prevailing during June and July, with a forecast for August and September, issued by the officiating director-general of Indian observatories on July 30, states that an almost complete break in the rains began between June 18 and 26. On July 5 a fresh advance of the Arabian Sea current occurred, and extended rapidly into the interior; but by July 15 the monsoon had again begun to weaken, and a second break set in, which lasted until about July 27. The total rainfall of this month fell short of the normal by about 34 per cent., the defect being almost general. From a consideration of the various extra-Indian conditions which usually influence the behaviour of the monsoon, the inference is drawn that although the latter may be expected to continue unsteady and weak, the drought is likely to become less general as the season progresses. The combined rainfall of August and September, however, will probably fall short of the normal, particularly in parts of central and north-west India. Reports subsequently received by telegraph seem to show that this forecast is, in the main, likely to be fulfilled.

The Scientific American of August 19 publishes a most interesting article entitled "The Head of the Official Meteorological World," accompanied by an excellent photograph of Dr. W. N. Shaw, taken by Mrs. Shaw (who, in addition to her skill as an amateur photographer, takes an active interest in educational matters). The presidency of the International Meteorological Committee, comprising the principal directors of the national weather services of the world, is by no means an easy position. Great tact is required at meetings in reconciling opinions which are sometimes quite opposed to each other, in introducing new subjects for discussion, and in referring difficult matters to the consideration of carefully selected subcommittees. The writer of the article (Mr. C. F. Talman) points out that the committee was singularly fortunate in having among its members a man ideally fitted to occupy this post, vacated by Prof. Mascart (head of the French Meteorological Service) shortly before his death in 1907. He reviews with much ability the varied and useful work of the present holder of the position, from the beginning of his academic career, the marks of his "directive genius" as shown in the operations of the Meteorological Office, and briefly sketches some of the evidences of the "advanced position that he has come to occupy in the general campaign of meteorological research." To mention one important matter only, the British meteorological year-books and their appendices now appear so punctually that they set the pace for similar publications throughout the world.

IN *The Cairo Scientific Journal* for August Dr. W. F. Hume gives an account of the finding of a meteorite which fell in the delta of the Nile on June 28, in the village lands of El Nakhla, some 44 kilometres E.S.E. of Alexandria. Fragments were reported as having fallen at five separate localities, and several pieces were secured for examination. The specific gravity was 3·4, and the interior of the specimen showed prismatic crystals, probably of enstatite, and yellow grains of olivine or peridot; the outer surface was covered with a black, glistening skin rich in iron. Specimens were exhibited in Section C at the British Association, where Dr. Hume gave further details.

IN the same number Mr. J. I. Craig describes a fragment of a sundial which was found at the temple of Basa in the Sudan, in lat. 16° 42′ and long. 33° 53′ E. It is constructed from a block of marble which is not of local origin, but must have been imported, probably from Europe. It contains portions of seven converging lines, and two curved lines on a conoidal surface, and much resembles two sundials which are now in the museum at Alexandria. Since the worked surface is not complete, and what is left is not a true geometrical surface, computation of the locality for which the dial was constructed is impossible; but it is suggested that the block was carved after an Alexandrian model, and the hour lines were adjusted for a place in the Sudan. Illustrations of the dial are given, but the article does not mention where it is preserved.

MR. H. GRINDELL MATTHEWS recently succeeded in establishing communication by means of his wireless telephone over a distance of five and a half miles by speaking from Beachley, near Chepstow, to New Passage, on the opposite bank of the Severn. The system will now be tried by the War Office at Aldershot, which will be given the option of purchasing Mr. Matthews's invention. Meanwhile further experiments are being carried out, and attempts to communicate from Chepstow to Cardiff, a distance of twenty-five miles, are being made. Cody man-lifting kites play a prominent part in the necessary arrangements, and apparently Mr. Matthews recently received a bad electric shock from the wire attached to the kite, although no power was being used at the time. Mr. Matthews was also able to obtain sparks when the kite wire was touched by another coil of wire. This apparently has convinced Mr. Matthews that, given a sufficient length of insulated wire, it is possible to collect energy from the atmosphere. We shall wait to see the results of further experiments in this direction, which doubtless Mr. Matthews will make shortly.

THE researches of Pictet have made it probable that most of the plant alkaloids are to be regarded as degradation products of vegetable proteins, since they are formed by the union of these simple substances with formaldehyde. The ring compounds synthesised in this manner are subjected to further minor changes in the plant, such as oxidation, reduction, replacement of hydroxyl, &c., and converted into the natural alkaloids. Pictet showed how in this way the majority of the alkaloids could be supposed to be formed, but specially excluded the isoquinoline alkaloids, which comprise such important representatives as morphine and the alkaloids of opium, berberine, &c., from his hypothesis. In the current number of the *Berichte* he shows how tyrosine or phenylalanine condense with formaldehyde to tetrahydroisoquinoline derivatives, and is able to effect the complete synthesis of hydroxyberberine starting from homopiperonylamine and formaldehyde. The conception that alkaloids are derived from proteins is therefore to be extended also to the isoquinoline alkaloids.

THE September issue of *The Central*, the magazine of the City and Guilds of London Central Technical College Old Students' Association, is of special interest. It opens with an appreciative account, by Mr. G. C. Turner, of the career and work of Prof. Henrici, F.R.S., who retired from his professorship at the college at the end of last term. A full report follows of the banquet to Prof. H. E. Armstrong, F.R.S., in May last, which was duly noted in NATURE at the time. Important articles by old students of the college deal with lifeboat launching slipways, the training of alluvial rivers by the guide-bank system, modern simple span truss-bridge construction, and the electro-technical commission.

OUR ASTRONOMICAL COLUMN.

THE EXPECTED RETURN OF COMET 1905 II. (BORRELLY).—From a number of observations made in 1905, M. Fayet has calculated a definite orbit for Borrelly's comet of that year, and finds that perihelion passage should take place on 1911 December 18·601 (Paris M.T.). Ephemerides based on these elements are published in No. 4523 of the *Astronomische Nachrichten*, and the complete discussion is to appear shortly in vol. xxx. of the Annals of the Paris Observatory.

Until the end of November the southern declination of the comet will make observations impossible in our northern observatories, although the general conditions of this apparition are more favourable than those of 1905.

THE DISCOVERY OF ECLIPSING VARIABLES; β AURIGÆ A VARIABLE STAR.—In an interesting paper appearing in

No. 2, vol. xxxiv., of *The Astrophysical Journal*, Dr. Joel Stebbins discusses the probability of there being a number of readily detectable eclipsing variables among those stars known to be short-period spectroscopic binaries. Such stars must offer the phenomena of mutual eclipse to some parts of the universe, and Dr. Stebbins establishes the probability that a very fair proportion will present more or less partial eclipses to the earth; as a class, that is, they offer greater probability of the discovery of eclipsing variables than do the bulk of the stars. Not only that, but their periods can be more or less determined from their spectroscopic elements, and so the times of maximum light-variations suggested. Such periods would be the most favourable for observation, and with the selenium photometer Dr. Stebbins considers that for stars of magnitude 2·0 and brighter a 0·10 magnitude variation may be considered conspicuous, so that very small eclipses might become evident in properly timed observations.

To test his proposition, Dr. Stebbins made observations of β Aurigæ and δ Orionis, and found that both were eclipsing variables. The work on the latter is not yet complete, but its extreme light-range is not far from 0·10 magnitude.

In the case of β Aurigæ, a number of consecutive observations indicated no change, but on October 23, 1910, the selenium photometer showed the magnitude to be 0·07 fainter than before. From a number of observations, fully discussed in the same number of the journal, Dr. Stebbins finds that the total range is 0·087 magnitude, of which 0·076 is due to eclipses and 0·011 is due to ellipticity of figure of the two components. The times of light-minimum are apparently in exact accordance with the times predicted from Baker's spectroscopic elements. It would also appear that the surface-intensities of the components are many times greater than that of the sun.

COMETARY PHENOMENA.—From Dr. K. Bohlin we have received an abstract from the *Naturwissenschaftlichen Rundschau* in which he reviews our present knowledge of cometary phenomena. In the first part systems of comets are dealt with, and in the last of five well-defined systems, we find comet 1910*a* classed with 1890 IV. and 1907 I. In dealing with the light, extent, and structure of comets, there is little that is new to record; and in the chapter on spectra the latest results are not mentioned, although they replace much that preceded them. The section discussing the tails of comets, and the strange fluctuations in the streams of matter forming them, is interesting, and is illustrated by some reproductions from photographs.

OBSERVATIONS AND CATALOGUES OF NEBULÆ.—Now that the subject of the classification and distribution of nebulæ is to the fore, Dr. Bauschinger's publication in vol. iv., part i., of the *Annalen der Kaiserlichen Universitäts-Sternwarte in Strassburg*, of the Strassburg observations and catalogue, will prove a welcome addition to the literature dealing with the subject.

The publication consists of three parts, in the first of which Dr. Wirtz discusses his observations of nebulæ made with the 49-cm. refractor during the period April, 1902, to March, 1910. The general methods of observation are described, and then the results tabulated; special micrometer measures of the stars in the Omega and Dumbell nebulæ were made, and the results are shown on two charts.

The second part of the present publication contains a general catalogue of the nebulæ observed at Strassburg from 1881 until 1910, and gives the various designations, the positions (1900·0), and brief descriptions of the physical features of 1257 nebulæ; the catalogue has been compiled by Dr. Wirtz, who writes the introduction, wherein he points out that it is the outcome of the work initiated by Winnecke in 1872. The final part of the publication consists of a most interesting comparison, by Dr. Wirtz, of the Strassburg results with those of other nebulæ observers.

A NEW OBSERVATORY IN AFRICA.—From No. 4519 of the *Astronomische Nachrichten* we learn that the French Geographical Society charged M. Jarry Desloges with the erection of a more or less temporary observatory on the "Hautes Plateaux" of northern Africa. Extensive and arduous researches as to the "seeing" at various places over a wide region at an altitude of 1100 metres or more have been made, and now an observatory is in course of erection.

RECENT SOIL INVESTIGATIONS.

IT is well known that the United States Bureau of Soils does not attach the same importance to a chemical analysis of the soil as is usual elsewhere. The argument adopted is that all soils contain the same rock minerals, and therefore the soil solution from which plants derive their nourishment must be identical in composition, so far as mineral plant food is concerned, in all cases. But inasmuch as the aqueous extracts of different soils show the same kind of differences towards plants as the soils themselves, it follows, if the original hypothesis is true, that the infertility of the poor soils must be due to some toxic organic substance. Search is therefore being made for substances of this nature, and during the progress of the experiments numerous interesting fields are opening up. Evidence has, for example, been obtained which is considered to prove that the roots of growing plants, and particularly the root hairs, possess an extracellular oxidising power; this power is greatest in fertile soils, and is diminished in certain infertile soils. The oxidation is attributed mainly, if not entirely, to the activity of a peroxidase produced by the roots. Messrs. Schreiner and Reed, the authors of this paper, also consider that soil itself can effect oxidations closely analogous to those of an oxidase, although, in their view, the process is mainly non-enzymotic.

Another publication, also from the Bureau of Soils, gives the results of Messrs. Robinson and McCaughey's investigations on the colours of soils, which they trace to organic matter and to ferric oxide. All varieties of colour, from white to yellow, red, brown, and black, are thus derived, the darker colours indicating, as a rule, the better agricultural conditions.

In addition to the research work going on, the Bureau of Soils is also engaged in a soil survey of the States, the results of which are issued in the form of circulars dealing with particular soil types. The basis of the survey is the mechanical analysis of the soil; but the officer in charge makes full local investigations, so that the report always takes account of the agricultural conditions. Among the reports issued, so far, are those dealing with the Portsmouth sandy loam, the Sassafras silt loam, the Norfolk fine sandy loam, and the Norfolk fine sand. In a general introductory circular Dr. Whitney describes in non-technical language the kind of examination that is made in the laboratory, and the limitations to which soil analysis is subjected. The account is very interesting, and will be found useful to others engaged in this work.

Messrs. Hart and Peterson, of the Wisconsin Agricultural Experiment Station, have recently published their work on the sulphur requirements of farm crops. Some years ago Mr. Dymond directed attention to the problem here, and showed that the supply of sulphates was not always adequate to the needs of the crop. A similar conclusion is reached by Messrs. Hart and Peterson, and they suggest that, in order to meet the losses due to drainage and cropping, it will be necessary for permanent fertility to supply sulphates to the soil.

The biochemical significance of phosphorus is discussed by Miss Caird in a paper read before the Royal Society of Victoria, a reprint of which was recently to hand. The low phosphorus content of the Australian soils is well known; it appears, also, that Australian native grasses have a markedly lower phosphorus content than European, and that the wood of Australian trees is lower in phosphates than European trees. Acclimatised European grasses contain more phosphorus than the native sorts, but less than the same kinds grown in Europe. Finally, it is pointed out that the loss of phosphorus from Victorian grass lands by export of their products is considerable, and must be made good.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.[1]

ORIGINATING on the occasion of the formal opening of the Yerkes Observatory in October, 1897, the Astronomical and Astrophysical Society of America now includes in its membership most of the workers in astronomy and allied subjects throughout the Western Continent, and many from other countries. Inaugurated for the purpose of advancing astronomy and astrophysics, its system has been to hold an annual meeting of the nature of a conference, lasting for several days, generally at a different location each year. Accounts of the meetings, with abstracts of the various papers presented, have been published from year to year either in *The Astrophysical Journal* or in *Science*. At the tenth annual meeting, held at Yerkes, August, 1907, the publication of the present volume of proceedings was authorised, and its preparation entrusted to Prof. W. J. Hussey, of the Detroit Observatory at Ann Arbor, Michigan. It contains full particulars of the organisation of the society, and abstracts of the papers presented at all the meetings; the majority of these are now well known, and being only short summaries are not suitable for further abstraction.

The society undertakes the organisation of special branches of astronomical investigation, in a similar manner to the various sections of the British Astronomical Association. One of the most important of these deals with the collection of data referring to meteors, and it has strongly recommended the establishment of a network of photographic stations about one hundred miles apart for the purpose of obtaining a record as complete as possible of all the meteors appearing within the network. Automatic instruments of as simple and inexpensive type as can be obtained are recommended.

Another section deals with cometary phenomena, and the society financed a special expedition to Honolulu for the photographic recording of Halley's Comet in May, 1910, in charge of F. Ellerman, of the Mount Wilson Observatory.

In a report of progress on the radial velocity determinations at the Lick Observatory, W. W. Campbell mentions that the programmes of observation for the Mills spectrograph attached to the 36-inch equatorial, and for the D. O. Mills expedition to Santiago, Chile, have aimed to secure at least four spectrograms of every star down to 5·0 visual magnitude, with three-prism dispersion if possible, and of fainter stars with two-prism dispersion. Up to June 1, 1907, three-prism spectrograms of 882 stars had been obtained at Mount Hamilton. It was expected that the programme would be completed by June, 1910. On the D. O. Mills expeditions Messrs. Wright and Curtis have obtained 530 stars brighter than 5·01 visual magnitude, and 150 stars fainter than 5·00 magnitude. The total number of separate stars the spectra of which have been photographed is 1368. Many new spectroscopic binaries have been discovered during the progress of the reductions, but it has only been possible to investigate fully the orbits of a few of the total number now known.

CHARLES P. BUTLER.

COAST-SURVEYING.[2]

IN surveying, uniformity of method may be carried to a point at which it militates against maximum efficiency, which demands that each region should be surveyed by the method most suited to its character and the object in view. While a uniform method of operations facilitates the compilation of results, a reasonable adaptation of method to the case in hand distinguishes a scientific survey from a mechanical process of measurement.

Dr. Ball has been engaged for several seasons in surveying the eastern desert of Egypt, including both the mining area and the Red Sea coast, carrying on a triangulation of approximately second-order and a plane-table topographical survey at the same time. In aiming at the greatest economy of time, together with adequate accuracy, he has employed the method described in this paper along the coast of the Red Sea. Having fixed by triangulation a series of points on moderately high ground overlooking the coastal plain, he determines a series of points on the sea-margin by observing their directions and the depression-angles with a theodolite. Thus the azimuths of the lines are obtained from that of a side of the triangulation, and the determined altitude of the observation point furnishes, with the depression-angle, the distance of the sea-margin. So far the method is not new; but the computations involved are troublesome, and this has prevented the more general use of it.

To surmount this difficulty Dr. Ball uses a scale, to be specially constructed by the surveyor for each station occupied, such that when the apparent angle of depression to a point on the coast is observed the scale will enable the true distance of the point from the station to be at once laid down on the chart. The height of the station being accurately known from the triangulation, the distances corresponding to the different depression-angles can be computed for each 5′ and laid off to scale without any great expenditure of time. When a large extent of coastline is to be mapped on a single scale, and numerous stations will be occupied, it will be more economical to construct a single-scale diagram, from which any desired scale can be taken; instances of such a diagram for both metric and British units are given.

This method should greatly facilitate the work of a surveyor engaged on a coast survey who thoroughly understands the use of his theodolite and is possessed of adequate neatness and accuracy in drawing. The accuracy of the method is fully discussed, and the limits of distance for which it can be employed are investigated on the assumption that distances shall be correct to within 100 metres, while the altitude of the station is not more than 1 metre in error, the error of depression-angle does not exceed 10″, and the coefficient of refraction is liable to a variation not exceeding 20 per cent. of itself. This study was undertaken by Mr. H. E. Hurst, of the Survey Department, and the whole memoir forms a very thorough piece of work and an instructive addition to field-surveying.

H. G. L.

WORK OF A LONDON NATURAL HISTORY SOCIETY.[1]

THE South London Entomological and Natural History Society has existed since 1872, and now numbers 169 members, many of whom are among the most prominent entomologists of the day. The volume of publications before us is well printed and illustrated, and as it is not likely to be so widely circulated as it deserves, it may be well to give a detailed list of the various interesting papers included in it.

Robert Adkin, "On the Lepidoptera of a London Garden." Discusses the conversion of the country village of Lewisham into a suburban district, and the results of thirty years' experience of what was, entomologically, an actually barren plot of ground when laid out as a garden. During this time, about 180 species of butterflies and moths, out of the British list of about 2000, were obtained, of which eleven were butterflies. Among these is *Celastrina argiolus*, which appears to have been common at Lewisham in Stainton's time, and is still a common garden insect at Chiswick, in quite a different part of London. No great rarities are enumerated, but this was perhaps hardly to be expected; on the other hand, a large number of species are mentioned as having been only taken or observed *once*.

Robert Adkin, "Notes on *Hepialus humuli* and its Shetland forms." The writer considers that the form *thulensis* is restricted to Shetland. Alfred Sich, "Larval Legs." Deals with their development in certain Lepidoptera. H. J. Turner, "A few days with the butterflies of Zermatt." Account of a collecting tour. Alfred Sich, "The Middlesex home of *Clausilia biplicata*." Notes on the former occurrence of this and other land-shells in a locality

[1] Publications of the Astronomical and Astrophysical Society of America. Vol. i.—Organisation, Membership, and Abstracts of Papers, 1897–1909. Pp. xxvii+347. (Ann Arbor, Michigan: The Society, 1910.)

[2] "A New Method of Coast-surveying." By Dr. J. Ball. Survey Department Paper, No. 21. (Cairo, 1911.)

[1] Proceedings of the South London Entomological and Natural History Society, 1910–11. With nine plates. Pp. xvi+175. (London: The Society, Hibernia Chambers, London Bridge, S.E., n.d.) Price 4s. 6d.

(now destroyed) at Chiswick. J. Platt Barrett, "The Butterflies of Sicily." Includes "sixty-five Sicilian butterflies out of the ninety-seven given by Ragusa." Dr. T. A. Chapman, "On insect teratology" (remarks to introduce discussion on teratological specimens). W. J. Kaye, "An entomological trip to South Brazil" (Lepidoptera). W. J. Lucas, "The natural order of insects Neuroptera." A general sketch of the families, with illustrations of examples. R. A. S. Priske and H. Main, "Notes on the glow-worm, *Lampyris noctiluca*." W. J. Kaye, annual address, read June 26, 1911. The address is chiefly devoted to the neuration of Lepidoptera, but also contains obituary notices, &c., that of J. W. Tutt being specially noteworthy.

The volume also includes a list of members at the beginning, and an abstract of proceedings at the end.

TRANSMISSION OF TRYPANOSOMES.

IT will be most unwelcome news to many that, according to a recent number of the Bulletin of the Sleeping Sickness Bureau (No. 29, August 17), Dr. Taute, at Tanganyika, has succeeded in transmitting a human trypanosome to monkeys by means of *Glossina morsitans*. So long as it was believed that *G. palpalis* alone was capable of transmitting the trypanosomes of human beings, it was hoped that the range of sleeping sickness would be coterminous with the distribution of this species of fly; but if other tsetses also can transmit the disease, there seems to be no reason why it should not spread over practically the whole African continent. Too much weight must not be laid, however, on laboratory experiments, the success of which, as the editor of the bulletin remarks, does not prove that the like is of common occurrence in nature.

Quite recently, however, a disease of human beings has been found to occur in northern Rhodesia and Nyasaland in regions where only *G. morsitans*, and no *G. palpalis*, is stated to occur, caused by a trypanosome which has been named *Trypanosoma rhodesiense*, since it shows certain peculiarities distinguishing it from the typical *T. gambiense* of sleeping sickness.

In the same number of the bulletin a summary is given of further researches by Chagas on the human trypanosome of Brazil, of which an account was published in NATURE (August 4, 1910, p. 142). Chagas has found that the parasite multiplies in other tissues besides the lungs, namely, the cardiac muscle, the central nervous system, and the striated muscles more especially; he believes that in the lungs a multiplication of sexual forms takes place, and that the multiplication in the tissues is asexual. The infection caused by this trypanosome, transmitted by a bug (Conorhinus sp.), attacks the whole population in the districts in which it occurs, so that children probably all sicken in their first year, and either die or pass over to the chronic stage. The chronic disease shows various forms, but two more especially, those in which heart-symptoms occur and others in which nervous symptoms preponderate. The goitre frequently seen in the province of Minas Geraes is believed to be attributable to the same infection.

THE BRITISH ASSOCIATION AT PORTSMOUTH.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. F. E. WEISS, D.Sc., PRESIDENT OF THE SECTION.

GREATLY as I prize the honour done me by the Council of the British Association in electing me to the office of President of the Botanical Section, my gratification has been heightened by the knowledge that the meetings of this section would be graced by the presence of the distinguished group of Continental and American botanists who have just taken part in the International Phytogeographical Excursion to the British Isles.

I am sure that I am voicing the unanimous feeling of the section in offering them a hearty welcome to our deliberations, and, in conveying to them our sense of the honour they have done us by their acceptance of the invitation of this Association, I should like to express our hope that by their participation in our proceedings they will help us to promote the advancement of botanical science, for which purpose we are met together.

In view of these special circumstances in which we forgather, it may seem inappropriate if I deal, as I shall be doing, in my Presidential Address mainly with fossil plants, with the study of which I have been for some time occupied; but I need hardly assure our visitors that, while we entertain some feelings of satisfaction at the contributions made during the past half-century towards our knowledge of extinct flora of Britain, yet, as the later sittings of this section will show, and as they have no doubt realised during their peregrinations through this country, our botanical sympathies and energies are by no means limited to this branch of botanical study. Moreover, I hope during the course of my address to point out the ecological interest which is afforded by certain aspects of Palæobotany.

On the sure foundations laid by my revered predecessor, the late Prof. Williamson, so vast a superstructure has been erected by the active work of numerous investigators that I must limit myself in this address to exploring only certain of its recesses, and I shall consequently confine myself to some aspects of Palæobotany which have either not been dealt with in those able expositions of the subject given to this section by previous occupants of this presidential chair, or which may be said to have passed since then into a period of mutation.

The great attractiveness of Palæobotany, and the very general interest which has been evinced in botanical circles in the progress of recent investigations into the structure of fossil plants, are due to the light they have thrown upon the relationship and the evolution of various groups of existing plants. It was the lasting achievement of Williamson to have shown, with the active cooperation of many working-men naturalists from the Lancashire and Yorkshire coalfields, that the structure of the coal-measure plants from these districts can be studied in microscopic preparations as effectively as has been the case with recent plants since the days of Grew and Malpighi. Indeed, had Sachs lived to continue his marvellous historical account of the rise of botanical knowledge up to the year 1880 or 1890, he would undoubtedly have directed attention to the remarkable growth of our knowledge of extinct plants gained by Binney and Williamson from the plant remains in the calcareous nodules of English coal-seams, and by Renault from the siliceous pebbles of Autun. We are not likely to forget the pioneer work of these veterans, though since then investigations of similar concretions from the coal deposits of this and other countries have been undertaken by numerous workers, and have revealed further secrets from that vast store of information which lies buried at our feet.

The possibilities of impression material had indeed been practically exhausted in 1870, and further advance could only come from new methods of attacking the problems that still remained to be solved. The most striking recent instance of the insufficiency of the evidence of external features alone was Prof. Oliver's demonstration of the seed-bearing nature of certain fern-like plants, based on microscopical comparison of the structure of the cupule of Lagenostoma, with the fronds of Lyginodendron, after which discovery confirmatory evidence speedily came to hand from numerous plant impressions examined by Kidston, Zeiller, and other observers.

Undoubtedly in the hands of a less competent and far-sighted observer than Williamson the new means of investigation might have proved as misleading as the old method had been in many instances. Indeed, as is well known, the recognition in the sections of Calamites and Sigillarias of the presence of secondary wood had caused Brongniart to place these plants among conifers, owing to his belief that no Vascular Cryptogams exhibited exogenous growth in thickness. It required all Williamson's eloquence and pugnacity to convert both British and French Palæobotanists to his views, ultimately accepted with such handsome acknowledgment by Grand' Eury, one of his antagonists, in his "Géologie et Palæontologie du Bassin Houiller du Gard."

It is curious that Grand' Eury refers in his introduction to the discovery of traces of secondary growth in Ophioglossum, and not to that of Isoëtes, a plant much more nearly related, as we now believe, to the Lepidodendraceæ, and the structure of which had been so thoroughly investigated by Hofmeister. Williamson, it is true, refers to the secondary growth in the stem of Isoëtes in his memoir on Stigmaria, but compares it with the periderm-forming cambium of that plant, and does not, therefore, recognise any agreement in the secondary growth of these two plants.

Adopting Von Mohl's interpretation of the root-bearing base of the Isoëtes plant as a "caudex descendens," Williamson instituted a morphological comparison between the latter and the branching Stigmaria, and came to the conclusion that they were homologous structures, a view which, as we heard at Sheffield, is supported by Dr. Lang on the strength of a re-examination of the anatomy of the stock of Isoëtes. If we do not accept Williamson's interpretation of the Stigmarian axis as a downward prolongation of caulome nature, the question remains open whether this underground structure represented a leafless modification of a normal leaf-bearing axis such as is known in the leafless rhizoms of Neottia and other saprophytic plants, or whether the Stigmarian axes were morphological entities of peculiar character. Grand' Eury, in comparing them with the rhizoms of Psilotum, accepted the former alternative, and, apart from morphological considerations, was led to this view by the fact that he had observed aërial stems arising in many instances as buds on the horizontal branches of Stigmaria. Confirmation of this mode of growth is still required, but it is quite conceivable that there may have been a mode of vegetative reproduction in the Stigmariæ analogous to that of Ophioglossum.[1]

The alternative interpretation of the Stigmarian axes as special morphological entities has received weighty support from Scott and Bower, who consider them comparable to the rhizophores of Selaginella, which, as is well known, may either be root-bearers, or in certain circumstances become transformed into leafy shoots. This peculiarity has led Goebel to regard them as special members, somewhat intermediate between stems and roots. But though they might therefore be regarded as of a primitive nature, the rhizophores of the Selaginellaceæ seem such specialised structures that I incline to agree with Bower that, so far as their correspondence with Selaginella is concerned, the Stigmarian axes would agree most closely with the basal knot formed on the hypocotyl of *Selaginella spinulosa*. Seeing, however, that the nearest living representative of the Lepidodendraceæ is in all probability Isoëtes, which Bower has aptly summarised as like "a partially differentiated Lepidostrobus seated upon a Lepidodendroid base," we must inevitably consider the root-bearing base of Isoëtes as homologous with the branching axes of Stigmaria, whatever their morphological nature may have been, and perhaps we shall be on the safest ground if we consider them both as different expressions of the continued growth of the lower region of the plant, which appears to have been a primary feature in the morphology of both these members of the Lycopodiales.

The somewhat considerable difference in external appearance between the homologous organs of these two plants may be considered bridged over by the somewhat reduced axes of Stigmariopsis and by the still more contracted base of the Mesozoic Pleuromoia, which, in spite of its very different fructification, we may unhesitatingly compare with Isoëtes so far as its root-bearing axis is concerned.

I was inclined at one time to seek an analogy for the Stigmarian axis in that interesting primitive structure, the protocorm of Phylloglossum, and of embryo Lycopods; but I now consider that the resemblances are largely superficial, and do not rest upon any satisfactory anatomical correspondence.

One of the features which has caused some divergence of opinion in the past as to the morphology of the Stigmarian axis has been the definite quincuncial arrangement and the apparent exogenous origin of the roots borne on these underground organs. Schimper, indeed, considered these two features so characteristic of foliar organs that he suggested that these so-called "appendices" might possibly be metamorphosed leaves. Not quite satisfied with this view, Renault endeavoured to establish the existence of two types of lateral organs on the Stigmarian axis, true roots with a triarch arrangement of wood and root-like leaves of monarch type. Williamson, however, clearly showed that the apparent triarch arrangement was really due to the presence at two angles of the metaxylem of the first tracheids of secondary wood, and reasserted the existence of only one type of appendicular organs, agreeing so closely, both in structure and in their orientation to the axis, on which they were borne, with the roots of Isoëtes that it would be impossible to deny the root nature of the Stigmarian "appendices" without applying the same treatment to the roots of Isoëtes.

Still, so distinguished a Palæobotanist as Solms Laubach, after a careful weighing of all the available evidence, continued to uphold Schimper's view of the foliar nature of these outgrowths, both in his "Palæophytologie" and in his memoir on Stigmariopsis, in which he stated that he was in complete agreement with Grand' Eury's conclusion: "Que ces organes sont indistinctement des rhizomes et que les Sigillaires n'avaient pas de racines réelles, ainsi que Psilotum." Indeed, in reviewing the account I gave of the occurrence of a special system of spiral tracheids in the outer cortex of the Stigmarian rootlets, Count Solms directed attention to their similarity to the transfusion tissue of Lepidodendroid leaves, and asserted that we have here a further indication of the former foliar nature of these rootlets. Personally, I still adhere to the belief, expressed at the time, that these peripheral cortical tracheids represent a special development required by a plant with an aquatic monarch root of the Isoëtes type and a large development of aërial evaporating surface. The fact that the lateral outgrowths from the Stigmarian axis have been generally considered to be exogenous is not a valid argument against their root nature, as the same origin is ascribed to the roots of Phylloglossum and to those produced on the rhizophores of Selaginella. Probably, indeed, as Bower points out in his masterly exposition of the "Origin of a Land Flora," in dealing with the Lycopodiales, "the root in its inception would, like the stem of these plants, be exogenous." According to the "recapitulation theory," indeed, the exogenous formation of the roots in the embryo of certain Lycopods, as well as of the first roots of Isoëtes and the first root of the Filicales, might be regarded as the retention of a more primitive character in these particular organs. The roots of Stigmaria, even if exogenous, might therefore merely represent a more ancestral stage. This difference between the roots of Isoëtes and the rootlets of Stigmaria may, however, be more apparent than real, for my colleague, Dr. Lang, has directed my attention to the fact that there appear to be in Stigmaria remnants of a small-celled tissue on the outside of what has generally been taken to be the superficial layer of the Stigmarian axis, and a careful investigation of this point inclines me to agree with him that very probably the Stigmarian rootlets were actually formed like those of Isoëtes, somewhat below the surface layer, which, after the emergence of the rootlets, became partially disorganised. Should this surmise prove correct, when apices of Stigmaria showing structure come to light, the last real difference between the rootlets of Isoëtes and the rootlets of Stigmaria will have disappeared, and the view for which Prof. Williamson so strongly contended will be finally established.

While a careful comparison of Isoëtes with the extinct Lycopodiaceous plants may be taken to settle finally its systematic position, the Psilotaceæ have been somewhat disturbed by such comparisons. Placed formerly without much hesitation in the phylum Lycopodiales, certain features in their organisation, such as the dichotomy of their sporophylls and the structure of their fructification generally, have suggested affinity with that interesting group of extinct plants, the Sphenophyllales. Their actual inclusion in this group by Thomas and by Bower may

[1] It is of interest in this connection to note that Potonié has recently put forward the suggestion that many of these vertical outgrowths from the more or less horizontal Stigmarian axes, some of which, as figured and described by Goldenberg, taper off rapidly to a point, without any trace of ramification, may be comparable with the conical "knees" of Taxodium, and represent woody pneumatophores so common in the Swamp Cypress and other swamp-inhabiting trees.

seem, perhaps, somewhat hazardous, considering the differences existing between the Psilotaceæ and Sphenophyllum; and the more cautious attitude of Seward, in setting up a separate group for these forms, seems, on the whole, more satisfactory than forcing these aberrant relatives of the Lycopods into the somewhat Procrustean bed of Sphenophyllales, which necessitates the minimising of such important differences as the dichotomous branching of the axis and the alternate arrangement of their leaves, though the latter character allows, it is true, of some bridging over. But, even adopting this more cautious attitude, the study of the Sphenophyllales has been of great help in coming to a clearer understanding of certain morphological peculiarities of the Psilotaceæ, quite apart from the flood of light which this synthetic group of Sphenophyllales has thrown upon the relationship of the Lycopodiales to the Equisetales.

More far-reaching in its bearing on the relationships of existing plants has been the study of those interesting fern-like plants which seem to show in their vegetative organs a structure possessing both fern-like and Cycadian affinities. Full of interest as these so-called Cycadofilices were in their vegetative organisation, they were destined to rivet on themselves the attention of all botanists by the discovery of their fructifications. No chapter in the recent history of Palæobotany is more thrilling than the discovery, by the patient and thorough researches of Prof. Oliver, of the connection between Lyginodendron and the well-known palæozoic seed, Lagenostoma. With Dr. Scott as sponsor, this new and startling revelation met with ready acceptance, and, thanks to the indefatigable energies of Palæobotanists, no fossil fern seemed at one time safe from possible inclusion among the Pteridospermæ.

The infectious enthusiasm with which the discovery of the seed-bearing habit of the Lyginodendreæ and the Medullosæ was greeted carried all before it, and we in England, particularly, have perhaps not looked carefully enough into the foundations upon which rested the theory that these groups form the "missing links" between the Ferns and Cycads. A criticism against the wholesale acceptance of this view has been put forward by Prof. Chodat,[1] of Geneva, that distinguished and versatile botanist whom we have on several occasions had the pleasure of welcoming among us. Couched throughout in friendly and courteous language, and full of admiration for the work of those who were concerned in the establishment of the group of Cycadofilices, now termed Pteridospermæ, Prof. Chodat suggests that English Palæobotanists have not sufficiently appreciated the work of Bertrand and Corneille[2] on the fibro-vascular system of existing ferns, and have not revised, in the light of the researches of these French investigators, the interpretation given to the arrangement of the primary vascular tissues of Lyginodendron. In Chodat's opinion the structure of the primary groups of wood found in the stem and in the double leaf-trace of this plant is not directly comparable with the arrangement found in the petiole of existing Cycads. In the latter the bulk of the metaxylem is centripetal, while we have, in addition, a varying amount of small-celled centrifugal wood towards the outside of the protoxylem, and, though separated from it by a group of parenchymatous cells, the bundle may be conveniently described as mesarch. In Lyginodendron, and the same applies to Heterangium, the primary bundles of the stem appear at first sight to be mesarch too, but in Chodat's opinion, if I understand him correctly, the metaxylem is exclusively centrifugal in its development, but, widening out and bending inwards again, in form of the Greek letter ω, the two extremities of the metaxylem are united on the inside of the protoxylem, forming an arrangement described by Bertrand and Corneille in the case of several fern petioles under the name of "un divergeant fermé."

Several details of structure, such as the type of pitting of the metaxylem elements and the separation of the protoxylem from the adaxial elements of metaxylem by parenchymatous cells, confirm Chodat in his view that the primary bundles of Lyginodendron are not really mesarch, and that the stem of Lyginodendron is essentially Filicinean in nature. Chodat cites other characters, such as the presence of sclerised elements in the pith, and the absence of mucilage ducts, in support of his view of the purely filicinean affinities of the Lyginodendreæ. The presence of secondary thickening in Lyginodendron, he regards not as indicative of Cycadian affinity, but merely as another instance of secondary growth in an extinct Cryptogam, taking up very much the position of Williamson in his earlier controversy with French botanists with regard to the secondary thickening of Calamites and Lepidodendreæ. Chodat is also at variance with Kidston and Miss Benson as to the nature of the microspores borne on the fronds of Lyginodendron or Lyginopteris, as he prefers to call this plant. He certainly figures some very fern-like sporangia, attached to the fronds of Lyginodendron, but anyone who has worked with the very fragmentary and somewhat disorganised material contained in our nodules knows how difficult it is to be absolutely certain of structural continuity. Nevertheless a re-investigation of the whole question of the microsporangia of Lyginodendron seems to me clearly called for by the publication of Chodat's figures.

As regards the seed-bearing habit of Lyginodendron, Chodat adopts wholeheartedly Oliver's correlation of Lagenostoma with the fronds of Lyginodendron, but would regard the seed, apparently devoid of endosperm at the time of pollination, as a somewhat specialised macrosporic development, of more complex structure, but analogous in its nature to the seed-like organ exhibited by Lepidocarpon in another phylum of the Pteridophyta. "In any case," he concludes, "the origin and the biology of this kind of seed must have been very different from those of the seeds of the Gymnosperms."

This contention, based mainly on the tardy development of the endosperm in Lagenostoma, is the least weighty part of Chodat's criticism, for it has never been asserted that the seeds were identical with those of existing Cycads. We know that the seed-habit was adopted by various groups of Vascular Cryptogams, and it is revealed in fossil plants in various stages of evolution, so that it may be readily presented to us at a special stage of its evolution in Lyginodendron. Moreover, we must remember that in so highly organised a Gymnosperm as Pinus, the macrospore itself is not fully developed at the time of pollination. Though not suggesting this as a primitive feature in the case of the pine, we can well imagine how, by a gradual process of "anticipation," the prothallus might become established before pollination in any group of primitive seed-bearing plants. There are other more specialised rather than primitive features in the complex structure of Lagenostoma which might with much more reason be invoked, to show that the seed of Lyginodendron does not form a step in the series of forms leading to the Cycadian ovule.

But leaving this point out of consideration, Chodat brings forward some strong reasons for his conclusions that the Lyginodendreæ were plants possessing stems of purely fern-like structure, increasing in thickness by means of a cambium, that their foliage was of filicinean structure, but provided with two kinds of sporangia, microsporangia similar to those of Leptosporangiate ferns, and macrosporangia of specialised type, containing a single macrospore. This group, therefore, Chodat regards as a highly specialised group of ferns, which, he considers, shows no particular connection with the Cycads, and may have formed the end in a series of highly differentiated members of the Filicineæ.

Of the Medullosæ, on the other hand, Chodat takes a very different view. Both in the structure of their primary and secondary growth, as well as in their polystely, he sees close affinity of these forms to the Cycads, borne out by smaller secondary features, such as the presence of mucilage ducts and the simple form of pollen-chamber. Chodat considers the agreement of the Medullosæ with the Cycadaceæ to be so close that he regards them as Protocycadeæ, the fern-like habit being restricted to the position of the sporangia on the vegetative fronds. Medullosa, therefore, would be only one link in the chain connecting the Cycads with the Filicales, and a link very

[1] Chodat, R.: "Les Ptéropsides des temps paléozoïques," *Archives des Sciences physiques et naturelles*, Genève, tome xxvi, 1903.

[2] Bertrand, C. E., and Corneille, F.: "Étude sur quelques charactéristiques de la structure des filicinées actuelles," *Travaux et mémoires de l'Université de Lille*, 1902.

near the Cycadian end of that chain. Other forms more closely connected with the Filicinean phylum are still to be sought.

In bringing Prof. Chodat's views to your notice, I do not wish to urge their acceptance, but his criticism seems to me sufficiently weighty to demand a careful reconsideration of the structure and affinities of the Lyginodendreæ, which, whatever may be their ultimate position in our scheme of classification, will continue in the future, as they have done in the past, to command the attention of all botanists interested in the evolution of plant life.

If the wholeheartedness with which we in England received the theory of the Cycadian affinity of Lyginodendron has laid us open to friendly criticism, I am afraid some of us may be accused of exceeding the speed-limit in our rapid acceptance of the Cycadoidean ancestry of the Angiosperms. Ever since Wieland put forth the suggestion in his elaborate monograph of the "American Fossil Cycads" that "further reduction and specialisation of parts in some such generalised type, like the bisporangiate strobilus of Cycadoidea, could result in a bisexual angiospermous flower," speculation as to the steps by which the evolution might have been brought about has been rife, and Hallier in Germany and Arber and Parkin in England have put forward definite schemes giving probable lines of descent. Arber and Parkin in their criticism and detailed suggestions connect phylogenetically with the Bennettitales, the Ranales, as primitive Angiosperms, and displace from this position the Amentales and Piperales, which were regarded by Engler as probably more closely related to the Proangiosperms. Of course, the resemblance between the amphisporangiate, or, as I should prefer to call it, the heterosporangiate "strobilus" of Cycadoidea, and the flower, say, of Magnolia is very striking, and the knowledge we have gained of the structure and organisation of the Bennettitales certainly invites the belief in a possible descent of the Angiosperms from this branch of the great Cycadian plexus; but the ease with which the flower of the Ranales can in some respects be fitted on to the "flower" of Cycadoidea raises suspicion. Critics of the Arber-Parkin hypothesis may possibly incline to the view that "truth is often stranger than fiction," and that the real descent of the Angiosperms may have been much less direct than that put forward in these recent hypotheses. The particular view of the morphology of the intraseminal scales and seed pedicles adopted by Arber and Parkin is, as they admit, not the only interpretation that can be put upon these structures, and the views on this point will probably remain as various as are those of the female cone of Pinus. Even if we regard the ovulate portion of the Cycadoidean "flower" as a gynæcium, and not as an inflorescence, we are bound to admit, as do Arber and Parkin, that it is highly modified from the pro-anthostrobilus type with a series of carpels bearing marginal ovules. Cycadoidea was evidently a highly specialised form, and may well have been the last stage in a series of extinct plants.

Arber's very sharp separation of mono- and amphisporangiate Pteridosperms does not seem to me quite justified. Amphisporangiate forms may have been preserved, or may have arisen anew in various groups of Pteridosperms or in their descendants. Heterospory, we know, originated independently in at least three of the great phyla of vascular Cryptogams, and originally, no doubt, the same strobilus contained both macro- and microsporangia, as was the case in Calamostachys Casheana, in the strobili of most Lepidodendraceæ, and as is still the case in the strobili of Selaginella and in Isoëtes. Even in the existing heterosporous Filicineæ, micro- and macrospores are found on the same leaf and on the same sorus; and though in the higher Cryptogamia and the lower Phanerogamia there may have been a tendency to an iso-sporangiate condition, yet, as the two kinds of spores are obviously homologous in origin, nothing is more natural than an occasional reversion to a heterosporangiate fructification. Thus, in the group of Gymnosperms, we have many instances of the occurrence of so-called androgynous cones. In 1801, at the meeting of the British Association at Leeds, I described such amphisporangiate cones which occurred regularly on a *Pinus Thunbergii* in the Royal Gardens of Kew, and only this spring I was able to gather several hermaphrodite cones of *Larix europea*. They have, of course, been observed and described by many authors for a variety of Gymnosperms. What more likely than that many extinct Gymnosperms may have developed heterosporangiate fructifications? It is not necessary, therefore, to fix on one group of ancestors for the origin of all existing Angiosperms. Indeed, the great variety of forms, both of vegetative and reproductive organs, which we meet with in the Angiosperms, not only to-day, but even in the Cretaceous period, in which they first made their appearance, warrants, I think, the belief in a polyphyletic origin of this highest order of plants. It is no doubt true, as Wieland points out, "that the plexus to which Cycadoidea belonged, as is the case in every highly organised plant type, presented members of infinite variety," and, indeed, so far as the vegetative organisation goes, we know already, through the labours of Nathorst, of such a remarkable form as *Wielandiella angustifolia*, while Wieland has shown us a further type in his Mexican Williamsonia. Nevertheless, these diverse forms all agree in the structure of their gynæcium, the particular organ which is not so easy to bring into line with that of the Angiosperms.

I am quite alive to, though somewhat sceptical of, the possibility of a direct descent of the Ranales from the Cycadoideæ, but my hesitation in accepting Arber and Parkin's view of the ancestry of the Angiosperms is enhanced by the consideration that it seems almost more difficult to derive some of the apparently primitive Angiosperms from the Ranales, than the latter from Cycadoidea. Indeed, this common origin of Angiosperms from the Ranalian plexus will, I feel sure, prove the stumbling-block to any general acceptance of the Arber-Parkin theory. It is easy enough to assume that all Angiosperms with the unisexual flowers have been derived by degeneration or specialisation from forms with hermaphrodite flowers of the primitive Ranalian type, but unfortunately some of these degenerate forms possess certain characters which appear to me to be undoubtedly primitive.

It is difficult for those who accept Bower's view of the gradual sterilisation of sporogenous tissue not to regard the many-celled archesporium in the ovules of Casuarina and of the Amentales as a primitive character, and though, as Coulter and Chamberlain point out, this feature is manifested by several members of the Ranunculaceæ and Rosaceæ, as well as by a few isolated Gamopetalæ, its very widespread occurrence in the Amentales seems to indicate its more general retention in this group of plants, and does not agree readily with the theory that these unisexual orders are highly specialised plants, with much-reduced flowers. The possession of a multicellular archesporium is, however, not the only primitive character exhibited by some of the unisexual orders of the Archichlamydeæ. Miss Kershaw[1] has shown, in her investigation of the structure and development of the ovule of Myrica, that in this genus, which possesses a single erect ovule, the integument is entirely free from the nucellus, and is provided with well-developed vascular bundles, in both of which features it resembles very closely the palæozoic seed Trigonocarpus. The same features were shown, moreover, by Dr. Benson[2] and Miss Welsford to occur in the ovules of *Juglans regia*, and in a few allied genera, such as Morus and Urtica. Also in a large number of Amentales with anatropous ovules (Quercus, Corylus, Castanea, &c.), Miss Kershaw has demonstrated the occurrence of a well-developed integumentary vascular supply. No doubt a further search may reveal the occurrence of this feature in some other dicotyledonous ovules, but in the meantime it seems difficult to believe that such a primitive vascular system, which the Amentales share with the older Gymnosperms, would have been retained in the catkin-bearing group, if it had undergone far-reaching floral differentiation, while it had disappeared from the plants which in other respects remained primitive. It would be still more difficult to imagine that it had arisen in the Amentales subsequently to their specialisation.

There are other structural characters and general morphological considerations, which I have not time to deal with, which underlie the belief in the primitiveness of the

[1] *Annals of Botany*, vol. xxiii., 1909. [2] *Ibid.*

Amentales and some allied cohorts, and I trust they will be set forth in detail by a better systematist than I can claim to be. My object in bringing the matter forward at all is to point out some of the difficulties which prevent me from accepting a monophyletic origin of the Dicotyledons through the Ranalian plexus.

One of these difficulties lies in the relationship of the Gnetales to the Dicotyledons. Arber and Parkin have recently made the attempt to gain a clearer insight into the affinities of this somewhat puzzling group by applying to it the "strobilus theory [1] of Angiospermous descent." The peculiar structure of the flowers of Welwitschia lends itself particularly well to a comparison with those of Cycadoidea, and a good case can no doubt be made out for a hemiangiospermous ancestry of this member of the Gnetaceæ, and by reduction the other members, in many respects simpler, might be derived from a similar ancestor, though probably, so far as Ephedra and Gnetum are concerned, an equally good, if not better, comparison might be made with Cordaites. But even supposing we admit the possibility of a derivation of the Gnetales from an amphisporangiate Pteridosperm, I think the Amentales merit quite as much as the Gnetales to be considered as having taken their origin separately from the Hemiangiospermæ, and not from the Ranalian plexus. I find this view has been put forward also by Lignier [2] in his attempt to reconstruct the phylogenetic history of the Angiosperms, and I feel strongly that such a polyphyletic descent, whether from the more specialised anthostrobilate Pteridospermæ or from several groups of a more primitive Cycado-Cordaitean plexus, is more in accordance with the early differentiation of the Cretaceous Angiosperms, and with the essential differences existing now in the orders grouped together as Archichlamydeæ.

Attempts at reconstructing the phylogeny of the Angiosperms are bound to be at the present time largely speculative, but we may possibly be on the threshold of the discovery of more certain records of the past history of the higher Spermaphyta, since Dr. Marie Stopes has commenced to publish her investigations of the Cretaceous fossil plants collected in Japan, and Prof. Jeffrey has been fortunate enough to discover cretaceous plant-remains showing structure in America. The former have already provided us with details of an interesting Angiospermic flower, and if the latter have so far only yielded Gymnosperms, we may at all events learn something of the primitive forms of these plants, the origin of which is still as problematical as is that of the Angiosperms.

I trust that the criticisms I have made of the theory put forward by Messrs. Arber and Parkin will not be taken as a want of appreciation on my part of the service they have done in formulating a working hypothesis, but merely as an expression of my desire to walk circumspectly in the very alluring paths by which they have sought to explore the primæval forest, and not to emulate those rapid but hazardous flights which have become so fashionable of late.

While the description of new and often intermediate forms of vegetation has aroused such widespread and general interest in Palæobotany, other and more special aspects of the subject have not been without their devotees, and have proved of considerable importance. Morphological anatomy has gained many new points of view, and our knowledge of the evolution of the stele owes much to a careful comparison of recent and fossil forms, even when these investigations have produced conflicting interpretations and divergent views.

Another promising line of Palæobotanical research lies in the direction of investigations of the plant tissues from the physiological and biological points of view. Happily, the vegetable cell-wall is of much greater toughness than that of animal cells, and in consequence the petrified plant-remains found in the calcareous nodules are often so excellently preserved that we can not only study the lignified and corky tissues, but also the more delicate parenchymatous cells. Even root-tips, endosperm, and germinating fern-spores are often so little altered by fossilisation that their cells can be as easily studied as if the sections had been cut from fresh material. It is this excellence of preservation which has enabled us to gain so complete a knowledge of the anatomy of palæozoic plants, and since the detailed structure of plant organs is often an index of the physical conditions under which the plants grew, we are able to form some opinion as to the habitat of the coal-measure plants. Though a beginning has already been made in this direction by various authors, we have as yet only touched the fringe of the subject, and, as Scott points out in the concluding paragraph of his admirable "Studies," the biology and ecology of fossil plants offer a wide and promising field of research. Such studies are all the more promising, as we now have material from such widely separated localities as the Lancashire coalfield, Westphalia, Moravia, and the Donetz Basin in Russia.

Now that it has been definitely shown by Stopes and Watson that the remains of plants are sometimes continuous through adjacent coal-balls, we may safely accept their conclusion that these calcareous concretions were in the main formed *in situ*, and that the plant-remains they contain represent samples of the vegetable débris of which the coal-seam consists. We have in these petrifactions, therefore, an epitome, more or less fragmentary, of the vegetation existing in palæozoic times on the area occupied by the coal-seam, and the Stigmarian roots in the underclay, as well as other considerations, lead us to believe that the seam more frequently represents the remains of the coal-measure forest carbonised *in situ*. While this seems to be the more usual formation of coal-seams, it is obvious from the microscopic investigations of coal made by Bertrand, and as has recently been so clearly set forth by Arber in his "Manual on the Natural History of Coal," that in the case of bogheads and cannels the seam represents metamorphosed sapropelic deposits of lacustrine origin. In other cases, again, considerations of the nature of the coal and the adjacent rocks may incline us to the belief that some, at any rate, of the deposits of coal may be due to material drifted into large lake-basins by river agency.

Broadly speaking, however, and particularly when dealing with the seams from which most of our petrified plant-remains have been collected, we may consider the coal as the accumulated material of palæozoic forests metamorphosed *in situ*. What, then, were the physical and climatic conditions of these primæval forests? The prevalence of wide air-spaces in the cortical tissues of young Calamitean roots, as indeed their earlier name Myriophylloides indicates, leads us to believe that, as in the case of many of their existing relatives, they were rooted under water or in waterlogged soil. We gather the same from the structure of Stigmaria, while the narrow xerophytic character of the leaves at any rate of the tree-like Calamites and Lepidodendra closely resembles the modifications met with in our marsh plants. It has been suggested by several authors that the xerophytic character of the foliage of many of our coal-measure plants may be due to the fact that they inhabited a salt marsh. A closer examination of the foliage, however, of such plants as Lepidodendron and Sigillaria does not reveal the characteristic succulency associated with the foliage of most Halophytes, and in view of the absence of such water-storing parenchyma, the well-developed transfusion-cells of the Lepidodendreæ can only be taken to be a xerophytic modification such as is met with in recent Conifers.

The specialisation of the tissues indeed is only such as is quite in keeping with the xerophytic nature of marsh plants. Moreover, the particular group of Equisetales are quite typical of fresh water, and we should expect that if their ancestors had been Halophytes, some at any rate at the present day would have retained this mode of life. Nor have we at the present time any halophytic Lycopodiales, while Isoëtes, the nearest relative to the Lepidodendra, is an aquatic or sub-aquatic form associated with fresh water.

Among the Filicales, *Acrostichum aureum* seems to be the only halophytic form, inhabiting as it does the swamps of the Ceylon littoral,[1] and though, as Miss Thomas has

[1] Arber, E. A. N., and Parkin, J.: "Studies on the Evolution of Angiosperms," "The Relationship of the Angiosperms to the Gnetales," *Annals of Botany*, vol. xxii., 1908.

[2] Lignier, O.: "Essai sur l'Evolution morphologique du Règne vegetal," *Bull. de la Soc. Linnéenne de Normandie*, 6 sér., 3 vol., 1909, réimprimé Février 1911.

[1] Tansley, A. G., and Fritsch: "The Flora of the Ceylon Littoral," *New Phytologist*, vol. iv., 1905.

pointed out, its root structure is in close agreement with that of many palæozoic plants, its frond shows considerable deviation from that of Lyginodendron or Medullosa, both of which plants, as Pteridosperms, are on a higher plane of evolution, and might therefore be expected to show a more highly differentiated type of leaf. But, on the contrary, these coal-measure plants show a more typically Filicinean character, both as regards the finely dissected lamina, and also in the more delicate texture of the foliage compared with the specialised organisation of the frond of *Acrostichum aureum*, described by Miss Thomas.

Nor is it necessary to call to aid the salinity of the marsh to explain the excellent preservation of the tissues of the plant-remains in the so-called coal-balls, in view of the well-known power of humic compounds to retard the decay of vegetable tissues. In addition to these arguments, I might direct attention to the presence of certain fungi among the petrified débris, as more likely to be found in fresh water than in marine conditions. Peronosporites, so common in the decaying Lepidodendroid wood, and the Urophlyctis-like parasite of Stigmarian rootlets, seem to me to support the fresh-water nature of the swamp; just as the occurrence of the mycorhiza, described by Osborn, in the roots of Cordaites seems to indicate the presence of a peaty substratum for the growth of that plant. Potonié also refers to the occasional occurrence of Myriapoda and fresh-water shells as indicative of the fresh-water origin of at least many of the coal-deposits, and a common feature of the petrified remains of coal-measure plants is the occurrence of the excrements of some wood-boring larvæ in the passages tunnelled by these palæozoic organisms through the wood of various stems.

A strong argument in favour of the brackish nature of these swamps would be supplied by the definite identification of Traquairia or Sporocarpon as Radiolaria, though we must remember that certain marine Cœlenterata find their way up into the Norfolk Broads, and fresh-water Medusæ are by no means unknown in different parts of the tropics. Of course, if the coal-measure swamps were estuarine or originated in fresh-water lagoons near the sea, they may have been liable from time to time to invasions of salt water, sufficient to account for the presence of occasional marine animals, but without constituting a halophytic plant association.

Potonié, who has made so close a study of the formation of coal, and supports the theory of its fresh-water origin, considered for a long time the comparison between the coal-measure swamp and the cypress swamps of North America, as the nearest but at the same time a somewhat remote analogy, more particularly as he believed that the nature of the coal-measure vegetation required a tropical and also a moister climate than obtains in the southern States of North America. Though, in view of the great development of Pteridophytic vegetation in countries like New Zealand, I think Potonié possibly exaggerates the temperature factor, he is probably right in assuming a fairly warm climate for the coal-measure forest. The difficulty, so far, has been to account for the great thickness of humic or peaty deposits which must have accumulated for the formation of our coal-seams, in view of the fact that extensive peat-formation is generally associated with a low temperature. In the tropics, peat may be deposited at high altitudes, where there is low temperature and high rainfall, but it is generally supposed that the rate of decomposition of vegetable remains is so active that lowland peat-formation was out of the question. Dr. Koorders, however, has observed a peat-producing forest in the extensive plain on the east side of Sumatra, about a hundred miles from the coast. This swamp-forest has been recently re-explored at the instance of Prof. Potonié, and he finds it to agree closely with the vegetative peculiarities which he considers must have been presented by the vegetation of the coal-measure forest. A typical "Sumpflachmoor," this highly interesting tropical swamp has produced a deposit of peat amounting in some places to 30 feet in thickness. The peat itself consists mainly of the remains of the Angiospermic vegetation of which the forest is made up, including pollen-grains and occasional fungal filaments; the preservative power, which has enabled this accumulation of débris to take place, being due to the peaty water which is seen above the roots of the bulk of the vegetation. The latter consists mainly of dicotyledonous trees belonging to various natural orders, and they mostly show such special adaptations as breathing roots (pneumatophores) and often buttress roots. With the exception of a tree-fern, Pteridophyta, Liverworts, and Mosses, and, indeed, all herbaceous vegetation, are poorly represented in this swamp, though high up in the branches of the trees there is a fair number of epiphytes, and at the edge of the swamp-forest lianes, belonging particularly to the palms, play an important part in the vegetation. The water, partly on account of its peaty nature, partly owing to the intense shade, is almost devoid of Algæ, and none of these organisms were found in the peat itself. The interesting account given by Potonié of this tropical peat-formation is very suggestive when certain features, as, for example, the absence or relative paucity of certain of the lower groups of plants, such as Algæ and Bryophyta, in the peat, are compared with the plant-remains in some of our coal-seams. Replacing the now dominant Angiosperms by their Pteridophytic representatives in palæozoic times, we have a very close parallel in the two formations.

Another interesting question arises when we consider the great variety of types of vegetation met with among the plant-remains of the coal-seams. For in addition to the limnophilous Calamites and Lepidodendraceæ mentioned above, the coal-balls abound with the remains of representatives of the Filicales, the Pteridospermæ, and the Cordaitaceæ. Were these also members of this swamp vegetation, or have their remains been carried by wind or water from surrounding areas? With regard to some plant-remains, namely, those found exclusively in the roof nodules, the latter was undoubtedly the case; for we have ample evidence, both in their preservation and their mode of occurrence, that they have drifted into the region of the coal-measure swamp after its submergence below the sea. This would apply to such plants as *Tubicaulis Sutcliffii* (Stopes), *Sutcliffa insignis* (Scott), *Cycadoxylon robustum*, and *Poroxylon Sutcliffii*, and other forms, the remains of which have so far not been observed in the coal-seam itself. These plants represent a vegetation of non-aquatic type, and may be taken to have grown on the land areas surrounding the palæozoic swamps. But, on the other hand, we have remains of many non-aquatic plants in the coal-seam itself, closely associated with fragments of typical marsh-plants. How can their juxtaposition be explained?

The advance of our knowledge of ecology points, I think, to a solution of this difficulty. No feature of this fascinating study, which has of late gained so prominent a place in botanical investigation, is more interesting than to trace out the succession of plant associations within the same area, noting the ever-changing conditions which the development of each association brings about. If we follow with Schroeter the gradual development of a lacustrine vegetation from the reed-swamp through the marsh (or Flachmoor) to a peat-moor (Hochmoor), we see how one plant association makes place in its turn for another. May not the mixture of various types of vegetation which we meet with in the petrifactions of our coal-seam represent the transition from the open Calamitean or Lepidodendroid swamp to a fen or marsh with plentiful peat-formation, due to the gradual filling up of the stagnant water with plant-remains? Thus in places, at any rate, a transition from aquatic to more terrestrial types of vegetation would take place, while the tree-like forms rooted in the deeper water would continue to flourish. The coal-measure swamp in this stage would differ from the tropical swamp of Kooders by a more abundant undergrowth of herbaceous and climbing plants, rooted in damp humus and passing off gradually into drier peat. Such an undergrowth of Cryptogamic types, mainly Filicinean or Pteridospermic, would have admirable conditions for luxuriant development, apart from the provision of a suitable substratum for its roots, owing to the narrow xerophytic nature of the foliage on the canopy of the trees under which it grew.

Here, too, we see the explanation of the striking difference between the microphyllous and arborescent Calamites and Lepidodendraceæ, and the large ombrophile foliage of the Filicineæ and Pteridosperms, which spread out their shade-leaves under the cover of marsh xerophytes, in exactly the same way as Prof. Yapp has so admirably depicted for recent plants in his account of the "Stratification in the Vegetation of a Marsh."

The development of a mesophytic vegetation in the shelter of the marsh xerophytes makes it unnecessary to postulate an obscuration of the intense sunlight by vapours, as was done by Unger and Saporta for the Carboniferous period. The assumption of a variety of conditions of plant life within the same area helps materially to clear up the difficulties presented by the somewhat incongruous occurrences met with in the petrified plant-remains. The presence of fragments of Cordaites, mixed with those of Calamites and Lepidodendra, in the coal-balls cannot always be explained either by a drift theory or by conceiving the fragments to be wind-borne; but, given an area of retrogressive peat above the ordinary water-level, even so xerophytic a plant as Cordaites might well establish itself there, its mycorhiza-containing roots being well adapted for growth in drier peat. The curious occurrence of more or less concentric rings in the secondary wood of the stem and roots of Cordaites may represent a response, probably not to annual variations of climate, but to abnormal periods of drought, which would affect the upper-peat layers, but not the water-logged soil in which were rooted the Calamites and Lepidodendra.

If, as I suspect, we had in the peat deposit of the coal-seam a succession of associations, we ought to find its growth and history recorded by the sequence of the plant-remains, very much as Mr. Lewis has discovered with such signal success in our Scottish peat-bogs. That some differences occur in the plant-remains building up a seam can be noted by a microscopic examination of the coal itself, in which, as Mr. Lomax tells me, the spores of Lepidodendra occur in definite bands. But no systematic attempt has as yet been made to investigate from this point of view the seams charged with petrified plant débris. Before the Shore pit, which was reopened last summer through the renewed generosity of Mr. Sutcliffe, was finally closed down, I obtained two series of nodules, ranging from the floor to the roof of the seam, and have had these cut for detailed examination. I should not, however, like to make any generalisation from these isolated series, but intend, during the coming winter, to investigate in the same manner further series taken from large blocks of nodules, which have been removed bodily so as to retain the position they occupied in the seam. Though at present the data are only fragmentary, there seems to be some indication that the plant-remains are not without some relation to their position in the seam. Of course, Stigmarian rootlets are ubiquitous, and in the nodules of the lower part of the seam predominant, but other plant-remains appear to be more frequently found at one level of the seam than another. The problem, however, is very involved, and it has become apparent that it is as important to study the fine débris in which the larger fragments are embedded as the distribution of these latter. Moreover, attention must be paid to the stage of decomposition presented by the particles forming the matrix of the nodule, as this varies in the lower and upper parts of a seam, very much as in a peat-bed we can distinguish the lighter-coloured fibrous peat from the darker layers at the base of a peat-cutting. Mr. Lomax, who has a unique experience of these coal-balls, informs me that he can tell whether a nodule is from the top or bottom of the seam by the lighter or darker colour of the matrix. The importance of applying the methods which have been so successful in elucidating the history of modern peat-deposits to the investigation of the coal-seam will be clearly appreciated both by palæobotanists and ecologists, and this particular problem offers a striking illustration of the interdependence of various branches of botanical investigation. It is fortunate, indeed, that the two fields of work, Palæobotany and Plant Ecology, though they have been subjected to fairly intensive cultivation, have not become exclusively the domain of specialists. The strength and progress of modern Botany have been due to the close collaboration of workers engaged in different branches of botanical science, and the fact that British ecologists have combined to attack a series of the problems from very diverse points of view leads one to hope that, with a continuance of that intimate cooperation which has characterised their work so far, and with the added stimulus of the friendly visit of our distinguished colleagues from abroad, considerable progress may be expected in the future in this branch of botanical study. Privileged as I have been to assist at the deliberations of the British ecologists, without as yet having taken any active part in their work, I feel myself at liberty to point with appreciation to the excellent beginning they have made of a botanical survey of Great Britain and Ireland, as well as to the more detailed investigations of special associations and formations, such as the woodlands, the moorlands, the fens, the broads, salt marshes, and shingle beaches. I am glad to think that our foreign visitors have been able to see these interesting types of vegetation under the guidance of those who have made a special study of these subjects.

The importance to ecologists of an up-to-date critical Flora was dwelt upon by my predecessor in this presidential chair, and this obvious need may be regarded as a further illustration of the inter-relationship of the various aspects of Botanical Science. Though it has been obvious to all that the swing of the pendulum has been for a long time away from pure systematic botany, I am convinced that the great development of plant ecology, of which we have many indications, will not merely lessen the momentum of the swinging pendulum, but will draw the latter back towards a renewed and critical study of the British flora. That a revival of interest in systematic botany will come through the labours of those who are engaged in survey work and other forms of ecological study, is foreshadowed by the fact that Dr. Moss has undertaken to edit a "New British Flora," which will, I believe, largely fulfil the objects put forward by Prof. Trail in his Presidential Address. I trust, however, that in addition to the ecologists, those botanists who are interested in genetics will contribute their share towards the completion of our knowledge of critical species, varieties, and hybrids, all of which offer such intricate problems alike to the systematist and to the student of genetics.

De Vries prefaced his lectures on "Species and Varieties, their Origin by Mutation," with the pregnant sentence: "The origin of species is an object of experimental investigation," and this is equally true of the study of the real and presumptive hybrids of our British flora, which may be investigated either synthetically or, when fertile, also analytically, as in some cases their offspring show striking Mendelian segregation. Some good work has already been accomplished in this direction, but more remains to be done, and we have here an important and useful sphere of work for the energies of many skilled plant-breeders.

I would therefore like to plead for intimate collaboration between all botanists, hopeful that, as progress in the past has come through the labours of men of wide sympathies, so in the future, when studies are bound to become more specialised, there will be no narrowing of interests, but that the various problems which have to be solved will be attacked from all points of view, the morphological, the physiological, the ecological, and the systematic. Thus by united efforts and close cooperation of botanists of all schools and of all countries we shall gain the power to surmount the difficulties with which our science is still confronted.

SUB-SECTION K.

AGRICULTURE.

OPENING ADDRESS BY W. BATESON, M.A., F.R.S., CHAIRMAN OF THE SUB-SECTION.

THE invitation to preside over the Agricultural Subsection on this occasion naturally gave me great pleasure, but after accepting it I have felt embarrassment in a considerable degree. The motto of the great Society which has been responsible for so much progress in agricultural affairs in this country very clearly expresses the subject of our deliberations in the words "Practice with Science," and to be competent to address you, a man should be well conversant with both. But even if agriculture is allowed to include horticulture, as may perhaps be generally conceded, I am sadly conscious that my special qualifications are much weaker than you have a right to demand of a President.

The aspects of agriculture from which it offers hopeful lines for scientific attack are, in the main, three: Physiological, Pathological, and Genetic. All are closely interrelated, and for successful dealing with the problems of any one of these departments of research, knowledge of the results attained in the others is now almost indispensable. I myself can claim personal acquaintance with the third or genetic group alone, and therefore in considering how science is to be applied to the practical operations of agriculture, I must necessarily choose it as the more special subject of this address. I know very well that wider experience of those other branches of agricultural science or practical agriculture would give to my remarks a weight to which they cannot now pretend.

Before, however, proceeding to these topics of special consideration, I have thought it not unfitting to say something of a more general nature as to the scope of an applied science, such as that to which we here are devoted. We are witnessing a very remarkable outburst of activity in the promotion of science in its application to agriculture. Public bodies distributed throughout this country and our possessions are organising various enterprises with that object. Agricultural research is now everywhere admitted as a proper subject for University support and direction.

With the institution of the Development Grant a national subsidy is provided on a considerable scale in England for the first time.

At such a moment the scope of this applied science and the conditions under which it may most successfully be advanced are prominent matters of consideration in the minds of most of us. We hope great things from these new ventures. We are, however, by no means the first to embark upon them. Many of the other great nations have already made enormous efforts in the same direction. We have their experience for a guide.

Now, it is not in dispute that wherever agricultural science has been properly organised valuable results have been attained, some of very high importance indeed; yet with full appreciation of these achievements, it is possible to ask whether the whole outcome might not have been greater still. In the course of recent years I have come a good deal into contact with those who in various countries are taking part in such work, and I have been struck with the unanimity that they have shown in their comments on the conditions imposed upon them. Those who receive large numbers of agricultural bulletins purporting to give the results of practical trials and researches will, I feel sure, agree with me that with certain notable exceptions they form on the whole dull reading. True they are in many cases written for farmers and growers in special districts, rather than for the general scientific reader, but I have sometimes asked myself whether those farmers get much more out of this literature than I do. I doubt it greatly. Nevertheless, to the production of these things much labour and expense have been devoted. I am sure, and I believe that most of those engaged in these productions themselves feel, that the effort might have been much better applied elsewhere. Work of this unnecessary kind is done, of course, to satisfy a public opinion which is supposed to demand rapid returns for outlay, and to prefer immediate apparent results, however trivial, to the long delay which is the almost inevitable accompaniment of any serious production. For my own part, I much doubt whether in this estimate present public opinion has been rightly gauged. Enlightenment as to the objects, methods, and conditions of scientific research is proceeding at a rapid rate. I am quite sure, for example, that no organisation of agricultural research now to be inaugurated under the Development Commission will be subjected to the conditions laid down in 1887 when the Experimental Stations of the United States were established. For them it is decreed in Sect. 4 of the Act of Establishment:—

"That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit."

It would be difficult to draft a condition more unfavourable to the primary purpose of the Act, which was "to conduct original researches or verify experiments on the physiology of plants and animals" with agricultural objects in view. I can scarcely suppose the most prolific discoverer should be invited to deliver himself more than once a year. Not only does such a rule compel premature publication—that nuisance of modern scientific life—but it puts the investigator into a wrong attitude towards his work. He will do best if he forget the public and the newspaper of his State or Territory for long periods, and should only return to them when, after repeated verification, he is quite certain he has something to report.

In this I am sure the best scientific opinion of all countries would be agreed. If it is true that the public really demand continual scraps of results, and cannot trust the investigators to pursue research in a reasonable way, then the public should be plainly given to understand that the time for inaugurating researches in the public's name has not arrived. Men of science have in some degree themselves to blame if the outer world has been in any mistake on these points. It cannot be too widely known that in all sciences, whether pure or applied, research is nearly always a very slow process, uncertain in production and full of disappointments. This is true, even in the new industries, chemical and electrical, for instance, where the whole industry has been built up from the beginning on a basis developed entirely by scientific method and by the accumulation of precise knowledge. Much more must any material advance be slow in the case of an ancient art like agriculture, where practice represents the casual experience of untold ages and accurate investigation is of yesterday. Problems, moreover, relating to unorganised matter are in their nature simpler than those concerned with the properties of living things, a region in which accurate knowledge is more difficult to attain. Here the research of the present day can aspire no higher than to lay the foundation on which the following generations will build. When this is realised it will at once be perceived that both those who are engaged in agricultural research and those who are charged with the supervision and control of these researches must be prepared to exercise a large measure of patience.

The applicable science must be created before it can be applied. It is with the discovery and development of such science that agricultural research will for long enough best occupy its energies. Sometimes, truly, there come moments when a series of obvious improvements in practice can at once be introduced, but this happens only when the penetrative genius of a Pasteur or a Mendel has worked out the way into a new region of knowledge, and returns with a treasure that all can use. Given the knowledge it will soon enough become applied.

I am not advocating work in the clouds. In all that is attempted we must stick near to the facts. Though the methods of research and of thought must be strict and academic, it is in the farm and the garden that they must be applied. If inspiration is to be found anywhere it will be there. The investigator will do well to work

"As if his highest plot
To plant the bergamot."

It is only in the closest familiarity with phenomena that we can attain to that perception of their orderly relations, which is the beginning of discovery.

To the creation of applicable science the very highest gifts and training are well devoted. In a foreign country an eminent man of science was speaking to me of a common friend, and he said that as our friend's qualifications were not of the first rank he would have to join the agricultural side of the university. I have heard remarks of similar disparagement at home. Now, whether from the point of view of agriculture or pure science, I can imagine no policy more stupid and short-sighted.

The man who devotes his life to applied science should be made to feel that he is in the main stream of scientific progress. If he is not, both his work and science at large will suffer. The opportunities of discovery are so few that we cannot afford to miss any, and it is to the man of trained mind who is in contact with the phenomena of a great applied science that such opportunities are most often given. Through his hands pass precious material, the outcome sometimes of years of effort and design. To tell him that he must not pursue that inquiry further because he cannot foresee a direct and immediate application of the knowledge is, I believe almost always, a course detrimental to the real interests of the applied science. I could name specific instances where in other countries thoroughly competent and zealous investigators have by the shortsightedness of superior officials been thus debarred from following to their conclusion researches of great value and novelty.

In this country, where the Development Commission will presumably for many years be the main instigator and controller of agricultural research, the constitution of the Advisory Board, on which Science is largely represented, forms a guarantee that broader counsels will prevail, and it is to be hoped that not merely this inception of the work, but its future administration also, will be guided in the same spirit. So long as a train of inquiry continues to extend, and new knowledge, that most precious commodity, is coming in, the enterprise will not be in vain and it will be usually worth while to pursue it.

The relative value of the different parts of knowledge in their application to industry is almost impossible to estimate, and a line of work should not be abandoned until it leads to a dead end, or is lost in a desert of detail.

We have, not only abroad, but also happily in this country, several private firms engaged in various industries—I may mention especially metallurgy, pharmacy, and brewing—who have set an admirable example in this matter, instituting researches of a costly and elaborate nature, practically unlimited in scope, connected with the subjects of their several activities, conscious that it is only by men in close touch with the operations of the industry that the discoveries can be made, and well assured that they themselves will not go unrewarded.

Let us on our part beware of giving false hopes. We know no hæmony "of sovran use against all enchantments, mildew blast, or damp." Those who are wise among us do not even seek it yet. Why should we not take the farmer and gardener into our fullest confidence and tell them this? I read lately a newspaper interview with a fruit-farmer who was being questioned as to the success of his undertaking, and spoke of the pests and difficulties with which he had had to contend. He was asked whether the Board of Agriculture and the scientific authorities were not able to help him. He replied that they had done what they could, that they had recommended first one thing and then another, and he had formed the opinion that they were only in an experimental stage. He was perfectly right, and he would hardly have been wrong had he said that in these things science is only approaching the experimental stage. This should be notorious. There is nothing to extenuate. To affect otherwise would be unworthy of the dignity of science.

Those who have the means of informing the public mind on the state of agricultural science should make clear that though something can be done to help the practical man already, the chief realisation of the hopes of that science is still very far away, and that it can only be reached by long and strenuous effort, expended in many various directions, most of which must seem to the uninitiated mere profitless wandering. So only will the confidence of the laity be permanently assured towards research.

Nowhere is the need for wide views of our problems more evident than in the study of plant-diseases. Hitherto this side of agriculture and of horticulture, though full of possibilities for the introduction of scientific method, has been examined only in the crudest and most empirical fashion. To name the disease, to burn the affected plants, and to ply the crop with all the sprays and washes in succession ought not to be regarded as the utmost that science can attempt. There is at the present time hardly any comprehensive study of the morbid physiology of plants comparable with that which has been so greatly developed in application to animals. The nature of the resistance to disease characteristic of so many varieties, and the modes by which it may be ensured, offers a most attractive field for research, but it is one in which the advance must be made by the development of pure science, and those who engage in it must be prepared for a long period of labour without ostensible practical results. It has seemed to me that the most likely method of attack is here, as often, an indirect one. We should probably do best if we left the direct and special needs of agriculture for a time out of account, and enlisted the services of pathologists trained in the study of disease as it affects man and animals, a science already developed and far advanced towards success. Such a man, if he were to devote himself to the investigation of the same problems in the case of plants, could, I am convinced, make discoveries which would not merely advance the theory of disease-resistance in general very greatly, but would much promote the invention of rational and successful treatment.

As regards the application of Genetics to practice, the case is not very different. When I go to the Temple Show or to a great exhibition of live stock, my first feeling is one of admiration and deep humility. Where all is so splendidly done and results so imposing are already attained, is it not mere impertinence to suppose that any advice we are able to give is likely to be of value?

But so soon as one enters into conversation with breeders, one finds that almost all have before them some ideal to which they have not yet attained, operations to perform that they would fain do with greater ease and certainty, and that, as a matter of fact, they *are* looking to scientific research as a possible source of the greater knowledge which they require. Can we, without presumption, declare that genetic science is now able to assist these inquirers? In certain selected cases it undoubtedly can—and I will say, moreover, that if the practical men and we students could combine our respective experiences into one head, these cases would already be numerous. On the other hand, it is equally clear that in a great range of examples practice is so far ahead that science can scarcely hope in finite time even to represent what has been done, still less to better the performance. We cannot hope to improve the Southdown sheep for its own districts, to take a second off the trotting record, to increase the flavour of the muscat of Alexandria, or to excel the orange and pink of the rose Juliet. Nothing that we know could have made it easier to produce the Rambler roses, or even to evoke the latest novelties in sweet peas, though it may be claimed that the genetic system of the sweet pea is, as things go, fairly well understood. To do any of these things would require a control of events so lawless and rare that for ages they must probably remain classed as accidents. On the other hand, the modes by which combinations can be made, and by which new forms can be fixed, are through Mendelian analysis and the recent developments of genetic science now reasonably clear, and with that knowledge much of the breeder's work is greatly simplified. This part of the subject is so well understood that I need scarcely do more than allude to it.

A simple and interesting example is furnished by the work which Mr. H. M. Leake is carrying out in the case of cotton in India. The cottons of fine quality grown in India are monopodial in habit, and are consequently late in flowering. In the United Provinces a comparatively early-flowering form is required, as otherwise there is not time for the fruits to ripen. The early varieties are sympodial in habit, and the primary apex does not become a flower. Hitherto no sympodial form with cotton of high quality has existed, but Mr. Leake has now made the combination needed, and has fixed a variety with high-class cotton and the sympodial habit, which is suitable for cultivation in the United Provinces. Until genetic physiology was developed by Mendelian analysis, it is safe to say that a practical achievement of this kind could not have been made with rapidity or certainty. The research was planned on broad lines. In the course of it much light was obtained on the genetics of cotton, and features of interest were discovered which considerably advance our knowledge of heredity in several important respects. This work forms an admirable illustration of that simultaneous progress both towards the solution of a complex physiological problem and also towards the successful attainment of an economic object which should be the constant aim of agricultural research.

Necessarily it follows that such assistance as genetics can at present give is applicable more to the case of plants and animals which can be treated as annuals than to creatures of slower generation. Yet this already is a large area of operations. One of the greatest advances to be claimed for the work is that it should induce raisers of seed crops especially to take more hopeful views of their absolute purification than have hitherto prevailed. It is at present accepted as part of the natural perversity of things that most high-class seed crops must throw "rogues," or that at the best the elimination of these waste plants can only be attained by great labour extended over a vast period of time. Conceivably that view is correct, but no one acquainted with modern genetic science can believe it without most cogent proof. Far more probably we should regard these rogues either as the product of a few definite individuals in the crop, or even as chance impurities brought in by accidental mixture. In either case they can presumably be got rid of. I may even go further and express a doubt whether that degeneration which is vaguely supposed to be attendant on all seed crops is a physiological reality. Degeneration may perhaps affect plants like the potato which are continually multiplied asexually, though the fact has never been proved satisfactorily. Moreover, it is not in question that races of plants taken into unsuitable climates do degenerate rapidly from uncertain causes, but that is quite another matter.

The first question is to determine whether a given rogue has in it any factor which is *dominant* to the corresponding character in the typical plants of the crop. If it has, then we may feel considerable confidence that these rogues have been introduced by accidental mixture. The only alternative, indeed, is cross-fertilisation with some distinct variety possessing the dominant, or crossing within the limits of the typical plants themselves occurring in such a way that complementary factors have been brought together. This last is a comparatively infrequent phenomenon, and need not be considered till more probable hypotheses have been disposed of. If the rogues are first crosses the fact can be immediately proved by sowing their seeds, for segregation will then be evident. For example, a truly round seed is occasionally, though very rarely, found on varieties of pea which have wrinkled seeds. I have three times seen such seeds on my own plants. A few more were kindly given me by Mr. Arthur Sutton, and I have also received a few from M. Philippe de Vilmorin—to both of whom I am indebted for most helpful assistance and advice. Of these abnormal or unexpected seeds some died without germinating, but all which did germinate in due course produced the normal mixture of round and wrinkled, proving that a cross had occurred. Cross-fertilisation in culinary peas is excessively rare, but it is certainly sometimes effected, doubtless by the leaf-cutter bee (Megachile) or a humble-bee visiting flowers in which for some reason the pollen has been inoperative. But in peas crossing is assuredly not the source of the ordinary rogues. These plants have a very peculiar conformation, being tall and straggling, with long internodes, small leaves, and small flowers, which together give them a curious wild look. When one compares them with the typical cultivated plants which have a more luxuriant habit, it seems difficult to suppose that the rogue can really be recessive to such a type. True, we cannot say definitely *a priori* that any one character is dominant to another, but old preconceptions are so strong that without actual evidence we always incline to think of the wilder and more primitive characteristics as dominants. Nevertheless, from such observations as I have been able to make, I cannot find any valid reason for doubting that the rogues are really recessives to the type. One feature in particular is quite inconsistent with the belief that these rogues are in any proper sense degenerative returns to a wild type, for in several examples the rogues have *pointed* pods like the cultivated sorts from which they have presumably been derived. All the more primitive kinds have the dominant stump-ended pod. If the rogues had the stump pods they would fall into the class of dominants, but they have no single quality which can be declared to be certainly dominant to the type, and I see no reason why they may not be actually recessives to it after all. Whether this is the true account or not we shall know for certain next year. Mr. Sutton has given me a quantity of material which we are now investigating at the John Innes Horticultural Institution, and by sowing the seed of a great number of individual plants separately I anticipate that we shall prove the rogue-throwers to be a class apart. The pure types then separately saved should, according to expectation, remain rogue-free, unless further sporting or fresh contamination occurs. If it prove that the long and attenuated rogues are really recessive to the shorter and more robust type, the case will be one of much physiological significance, but I believe a parallel already exists in the case of wheats, for among certain crosses bred by Prof. Biffen, some curious spelt-like plants occurred among the derivatives from such robust wheats as Rivet and Red Fife.

There is another large and important class of cases to which similar considerations apply. I refer to the bolting or running to seed of crops grown as biennials, especially root crops. It has hitherto been universally supposed that the loss due to this cause, amounting in Sugar Beet as it frequently does to five, or even more, *per cent.*, is not preventable. This may prove to be the truth, but I think it is not impossible that the bolters can be wholly, or almost wholly, eliminated by the application of proper breeding methods. In this particular example I know that season and conditions of cultivation count for a good deal in promoting or checking the tendency to run to seed; nevertheless one can scarcely witness the sharp distinction between the annual and biennial forms without suspecting that genetic composition is largely responsible. If it proves to be so, we shall have another remarkable illustration of the direct applicability of knowledge gained from a purely academic source. "Let not him that girdeth on his harness boast himself as he that putteth it off," and I am quite alive to the many obstacles which may lie between the conception of an idea and its realisation. One thing, however, is certain, that we have now the power to formulate rightly the question which the breeder is to put to nature; and this power and the whole apparatus by which he can obtain an answer to his question—in whatever sense that answer may be given—has been derived from experiments designed with the immediate object of investigating that scholastic and seemingly barren problem, "What is a species?" If Mendel's eight years' work had been done in an agricultural school supported by public money, I can imagine much shaking of heads on the County Council governing that institution, and yet it is no longer in dispute that he provided the one bit of solid discovery upon which all breeding practice will henceforth be based.

Everywhere the same need for accurate knowledge is apparent. I suppose horse-breeding is an art which has by the application of common sense and great experience been carried to about as high a point of perfection as any. Yet even here I have seen a mistake made which is obvious to anyone accustomed to analytical breeding. Among a number of stallions provided at great expense to improve the breed of horses in a certain district was one which was shown me as something of a curiosity. This particular animal had been bred by one of the provided stallions out of an indifferent country mare. It had been kept as an unusually good-looking colt, and was now travelling the country as a breeding stallion, under the highest auspices. I thought to myself that if such a practice is sanctioned by breeding acumen and common sense, Science is not, after all, so very ambitious if she aspires to do rather better. The breeder has continually to remind himself that it is not what the animal or plant *looks* that matters, but what it *is*. Analysis has taught us to realise, first, that each animal and plant is a double structure, and next that the appearance may show only half its composition.

With respect to the inheritance of many physiological qualities of divers kinds we have made at least a beginning of knowledge, but there is one class of phenomena as yet almost untouched. This is the miscellaneous group of attributes which are usually measured in terms of size, fertility, yield, and the like. This group of characters has more than common significance to the practical man. Analysis of them can nevertheless only become possible when pure science has progressed far beyond the point yet reached.

I know few lines of pure research more attractive and at the same time more likely to lead to economic results than an investigation of the nature of variation in size of the whole organism or of its parts. By what factors is it caused? By what steps does it proceed? By what limitations is it beset? In illustration of the application of these questions I may refer to a variety of topics that have been lately brought to my notice. In the case of merino sheep

I have been asked by an Australian breeder whether it is possible to combine the optimum length of wool with the optimum fineness and the right degree of crimping. I have to reply that absolutely nothing is yet known for certain as to the physiological factors determining the length or the fineness of wool. The crimping of the fibres is an expression of the fact that each particular hair is curved, and if free and untwisted would form a corkscrew spiral, but as to the genetics of curly hair even in man very little is yet known. But leaving the question of curl on one side, we have, in regard to the length and fineness of wool, a problem which genetic experiment ought to be able to solve. Note that in it, as in almost all problems of the "yield" of any product of farm or garden, two distinct elements are concerned—the one is *size*, and the other is *number*. The length of the hair is determined by the rate of excretion and length of the period of activity of the hair follicles, but the fineness is determined by the number of follicles in unit area. Now analogy is never a safe guide, but I think if we had before us the results of really critical experiments on the genetics of size and number of multiple organs in any animal or even any plant, we might not wholly be at a loss in dealing with this important problem.

A somewhat similar question comes from South Africa. Is it possible to combine the qualities of a strain of ostriches which has extra long plumes with those of another strain which has its plumes extra lustrous? I have not been able fully to satisfy myself upon what the lustre depends, but I incline to think it is an expression of fineness of fibre, which again is probably a consequence of the smallness and increased number of the excreting cells, somewhat as the fineness of wool is a consequence of the increased number and smallness of the excreting follicles.

Again the question arises in regard to flax, how should a strain be bred which shall combine the maximum length with maximum fineness of fibre? The element of number comes in here, not merely with regard to the number of fibres in a stem, but also in two other considerations: first, that the plant should not tiller at the base, and, secondly, that the decussation of the flowering branches should be postponed to the highest possible level.

Now in this problem of the flax, and not impossibly in the others I have named, we have questions which can in all likelihood be solved in a form which will be of general, if not of universal, application to a host of other cognate questions. By good luck the required type of flax may be struck at once, in which case it may be fixed by ordinary Mendelian analysis, but if the problem is investigated by accurate methods on a large scale, the results may show the way into some of those general problems of size and number which make a great part of the fundamental mystery of growth.

I see no reason why these things should remain inscrutable. There is indeed a little light already. We are well acquainted with a few examples in which the genetic behaviour of these properties is fairly definite. We have examples in which, when two varieties differing in number of divisions are crossed, the lower number dominates—or, in other words, that the increased number is a consequence of the removal of a factor which prevents or inhibits particular divisions, so that they do not take place. It is likely that in so far as the increased productivity of a domesticated form as compared with its wild original depends on more frequent division, the increase is due to loss of inhibiting factors. How far may this reasoning be extended? Again, we know that in several plants—peas, sweet peas, Antirrhinum, and certain wheats—a tall variety differs in that respect from a dwarf in possessing one more factor. It would be an extraordinarily valuable addition to knowledge if we could ascertain exactly how this factor operates, how much of its action is due to linear repetition, and how much to actual extension of individual parts. The analysis of the plants of intermediate size has never been properly attempted, but would be full of interest and have innumerable bearings on other cases in animals and plants, some of much economic importance.

That in all such examples the objective phenomena we see are primarily the consequence of the interaction of genetic factors is almost certain. The lay mind is at first disposed, as always, to attribute such distinctions to anything rather than to a specific cause which is invisible. An appeal to differences in conditions—which a moment's reflection shows to be either imaginary or altogether independent—or to those vague influences invoked under the name of Selection, silently postponing any laborious analysis of the nature of the material selected, repels curiosity for a time, and is lifted as a veil before the actual phenomena; and so even critical intelligences may for an indefinite time be satisfied that there is no specific problem to be investigated, in the same facile way that, till a few years ago, we were all content with the belief that malarial fevers could be referred to any damp exhalations in the atmosphere, or that in suppuration the body was discharging its natural humours. In the economics of breeding, a thousand such phenomena are similarly waiting for analysis and reference to their specific causes. What, for instance, is self-sterility? The phenomenon is very widely spread among plants, and is far commoner than most people suppose who have not specially looked for it. Why is it that the pollen of an individual in these plants fails to fertilise the ova of the same individual? Asexual multiplication seems in no way to affect the case. The American experimenters are doubtless right in attributing the failure of large plantations of a single variety of apples or of pears in a high degree to this cause. Sometimes, as Mr. W. O. Backhouse has found in his work on plums at the John Innes Horticultural Institution, the behaviour of the varieties is most definite and specific. He carefully self-fertilised a number of varieties, excluding casual pollination, and found that while some sorts—for example, Victoria, Czar, and Early Transparent—set practically every fruit self-pollinated, others, including several (perhaps all) Greengages, Early Orleans, and Sultan, do not set a single fruit without pollination from some other variety. Dr. Erwin Baur has found indications that self-sterility in Antirrhinum may be a Mendelian recessive, but whether this important suggestion be confirmed or not, the subject is worth the most minute study in all its bearings. The treatment of this problem well illustrates the proper scope of an applied science. The economic value of an exact determination of the empirical facts is obvious, but it should be the ambition of anyone engaging in such a research to penetrate further. If we can grasp the *rationale* of self-sterility we open a new chapter in the study of life. It may contain the solution of the question What is an individual?—no mere metaphysical conundrum, but a physiological problem of fundamental significance.

What, again, is the meaning of that wonderful increase in size or in "yield" which so often follows on a first cross? We are no longer content, as Victorian teleology was, to call it a "beneficial" effect and pass on. The fact has long been known and made use of in breeding stock for the meat market, and of late years the practice has also been introduced in raising table poultry. Mr. G. N. Collins,[1] of the U.S. Department of Agriculture, has recently proposed with much reason that it might be applied in the case of maize. The cross is easy to make on a commercial scale, and the gain in yield is striking, the increase ranging as high as 95 per cent. These figures sound extravagant, but from what I have frequently seen in peas and sweet peas, I am prepared for even greater increase. But what *is* this increase? How much of it is due to change in number of parts, how much to transference of differentiation or homœosis, as I have called it—leaf-buds becoming flower-buds, for instance—and how much to actual increase in size of parts? To answer these questions would be to make an addition to human knowledge of incalculably great significance.

Then we have the further question, How and why does the increase disappear in subsequent generations? The very uniformity of the cross-breds between pure strains must be taken as an indication that the phenomenon is orderly. Its subsidence is probably orderly also. Shull has advocated the most natural view that heterozygosis is the exciting cause, and that with the gradual return to the homozygous state the effects pass off. I quite think this may be a part of the explanation, but I feel difficulties, which need not here be detailed, in accepting this as a complete account. Some of the effect we may probably also attribute to the combination of complementary factors;

[1] Bureau of Plant Industry, Bulletin No. 191, 1910.

but whether heterozygosis, or complementary action, is at work, our experience of cross-breeding in general makes it practically certain that genetic factors of special classes only can have these properties, and no pains should be spared in identifying them. It is not impossible that such identification would throw light on the nature of cell division and of that meristic process by which the repeated organs of living things are constituted, and I have much confidence that in the course of the analysis discoveries will be made bearing directly both on the general theory of heredity and on the practical industry of breeding.

In the application of science to the arts of agriculture, chemistry, the foundation of sciences, very properly and inevitably came first, while breeding remained under the unchallenged control of simple common sense alone. The science of genetics is so young that when we speak of what it also can do we must still for the most part ask for a long credit; but I think that if there is full cooperation between the practical breeder and the scientific experimenter, we shall be able to redeem our bonds at no remotely distant date. In the mysterious properties of the living bodies of plants and animals there is an engine capable of wonders scarcely yet suspected, waiting only for the constructive government of the human mind. Even in the seemingly rigorous tests and trials which have been applied to living material apparently homogeneous, it is not doubtful that error has often come in by reason of the individual genetic heterogeneity of the plants and animals chosen. A batch of fruit trees may be all of the same variety, but the stocks on which the variety was grafted have hitherto been almost always seminally distinct individuals, each with its own powers of luxuriance or restriction, their own root-systems, and properties so diverse that only in experiments on a colossal scale can this diversity be supposed to be levelled down. Even in a closely bred strain of cattle, though all may agree in their "points," there may still be great genetic diversity in powers of assimilation and rapidity of attaining maturity, by which irregularities by no means negligible are introduced. The range of powers which organic variation and genetic composition can confer is so vast as to override great dissimilarities in the conditions of cultivation. This truth is familiar to every raiser and grower, who knows it in the form that the first necessity is for him to get the right breed and the right variety for his work. If he has a wheat of poor yield, no amount of attention to cultivation or manuring will give him a good crop. An animal that is a bad doer will remain so in the finest pasture. All praise and gratitude to the student of the conditions of life, for he can do, and has done, much for agriculture, but the breeder can do even more.

When more than fifteen years ago the proposal to found a school of agriculture in Cambridge was being debated, much was said of the importance of the chemistry of soils, of researches into the physiological value of foodstuffs, and of other matters then already prominent on the scientific horizon. I remember then interpolating with an appeal for some study of the physiology of breeding, which I urged should find a place in the curriculum, and I pointed out that the improvement in the strains of plants and animals had done at least as much—more, I really meant—to advance agriculture than had been accomplished by other means. My advice found little favour, and I was taken to task afterwards by a prominent advocate of the new school for raising a side issue. Breeding was a purely empirical affair. Common sense and selection comprised the whole business, and physiology flew at higher game. I am, nevertheless, happy now to reflect that of the work which is making the Cambridge School of Agriculture a force for progress in the agricultural world the remarkable researches and results of my former colleague, Prof. Biffen, based as they have been on modern discoveries in the pure sciences of breeding, occupy a high and greatly honoured place.

In conclusion, I would sound once more the note with which I began. If we are to progress fast there must be no separation made between pure and applied science. The practical man with his wide knowledge of specific natural facts, and the scientific student ever seeking to find the hard general truths which the diversity of Nature hides—truths out of which any lasting structure of progress must be built—have everything to gain from free interchange of experience and ideas. To ensure this community of purpose those who are engaged in scientific work should continually strive to make their aims and methods known at large, neither exaggerating their confidence nor concealing their misgivings,

"Till the world is wrought
To sympathy with hopes and fears it heeded not."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Dr. Alex. Findlay, special lecturer in physical chemistry, is resigning his post in consequence of his acceptance of the chair of chemistry in the University of Wales at Aberystwyth.

Dr. Murray has resigned his post as assistant lecturer and demonstrator in chemistry, having been appointed head of the chemical and metallurgical department of Wolverhampton Technical School.

BY the will of Dr. S. J. Gee, late physician to St. Bartholomew's Hospital, the sum of about 20,000*l.* is left to his daughter for life, with contingent remainder to the Royal College of Physicians, London, upon trust, so far as possible, to form a permanent endowment fund for the college.

THE winter session of the London (Royal Free Hospital) School of Medicine for Women will be opened on Monday, October 2, with an introductory address by Sir Henry Butlin, P.R.C.S., upon "Research in Medicine and Women in Medical Research." Mrs. Garrett Anderson, president of the school, will occupy the chair.

MR. T. HARRIS, of the Imperial College of Science and Technology, and the Cavendish Laboratory, Cambridge, has been appointed lecturer and demonstrator in the physical department of the East London College in succession to Mr. E. Marsden. Mr. P. Kemp has been appointed lecturer in the electrical engineering department of the same college.

THE exchange of professors between Harvard University and the Ministry of Public Instruction in France comes into effect this winter for the first time, and the Bulletin of the American Geographical Society announces that Prof. W. M. Davis will go to Paris to lecture until the end of March, after the International Congress at Rome has ended. Prof. Diehl, of the Sorbonne, will go to Harvard University to lecture on Byzantine history.

A SPECIAL course of twelve lectures on illumination is to be given at the Polytechnic, Regent Street, during the present session. The lectures, which will be under the supervision of Mr. L. Gaster, editor of *The Illuminating Engineer*, will deal with all illuminants, including recent advances in electric, gas, oil, and acetylene lighting; the effect of light on the eye; the hygienic aspects of illumination; and the measurement of light and illumination. Practical problems, such as the lighting of schools, streets, and factories, will be treated in the second half of the course, commencing in January, 1912. Until December 5 the lectures will be held on Tuesday evenings at 7.30, and during January and February next on Thursday evenings at the same hour.

THE new session in the faculties of arts, laws, science, engineering, and medical sciences at University College, London, will begin on October 2. The list of public introductory lectures at the college contains the following, among others:—Wednesday, October 4, Prof. H. R. Kenwood on "The Scope of School Hygiene and the Legislative Provisions dealing with the School Child," being the first of a course of lectures on school hygiene specially designed for school teachers; Friday, October 6, Prof. G. Dawes Hicks on "Bergson's Conception of Creative Evolution" (this lecture is designed as an introduction to a course of four public university lectures to be delivered by Prof. Henri Bergson at University College on October 20, 21, 27, and 28). A course of public lectures on heating and ventilating engineering will be given by Mr. A. H. Barker, the introductory lecture on Tuesday, October 17, being on "Problems in Heating and Ventilation awaiting Solution by the Engineer." On the same day Mr. E.

Kilburn Scott, the newly appointed lecturer on electrical design, will begin his course on that subject.

A REVISED scheme of examination for inspectorships of mines has just been issued. The appointments are made after a competitive examination of candidates nominated by the Home Secretary. Each candidate must hold a first-class certificate under the Coal Mines Regulation Act, and must, within five years previous to his application, have been employed for two years as manager or under-manager of a coal mine, or in some other responsible capacity requiring regular attendance underground in a coal mine. Practical knowledge and experience of metalliferous mining and quarrying will also be taken into consideration. Candidates must be between twenty-three and thirty-five years of age at the time of examination. The revised subjects of examination are:—(1) English; (2) elementary mathematics; (3) elementary geology; (4) coal mining; (5) ore and stone mining; (6) electricity in mines; (7) law relating to mines and quarries; (8) oral examination; (9) chemistry; (10) physics. The last two are optional. The latest date for the return of the filled-up nomination form relative to the next appointments is October 15. Forms of application and full particulars can be obtained from the Private Secretary, Home Office, London.

THE seventeenth volume of reports, for the academic year 1909–10, from the universities and university colleges which participate in the annual grant made by Parliament for "University Colleges in Great Britain," and from the three colleges in Wales which receive a grant, has been published as a Blue-book (Cd. 5872). For the financial year 1909–10 the amount of grant paid by the Treasury to university colleges in England was 96,100*l.*, and for the year 1910–11, 101,250*l.* In the year 1909–10, 15,000*l.* was added to the annual grant in aid of university education in Wales. An introduction to the reports signed by the President of the Board of Education enumerates the private benefactions in aid of university education in this country made during the year under review, which have been announced from time to time in these columns. Apart from the recent munificent gifts to Reading University College, these benefactions were not comparable in magnitude or importance with those recorded in the previous report. The introduction goes on to say:—"The small extent to which university work is endowed by private benefaction in this country is emphasised, if comparison is made with the measure of support in other countries. Thus, within a year of its foundation the Kaiser Wilhelm Society for the promotion of science in Germany had at its disposal a capital of half a million sterling, which is being devoted to the equipment of institutes at which men already eminent in their respective subjects will be installed. In France, M. Auguste Lautreuil left 284,000*l.* towards the promotion of science in that country. In the United States Mr. Rockefeller handed over 764,000*l.* to the Rockefeller Institute for Medical Research, which he had previously endowed with large sums. These three instances are sufficient to show how small is the endowment of research in this country as compared with others, and from what a disadvantage this country inevitably suffers in the advancement of learning and research, now more than ever before essential to the welfare and prosperity of the nation."

THE reports referred to in the above note show that nearly 33 per cent. of the income of the English colleges was derived from fees, about 15 per cent. from endowments, a little more than 14·5 per cent. from grants from local education authorities, and 28 per cent. from the Exchequer. In the case of Welsh colleges, nearly 25 per cent. of their total income was derived from fees, nearly 6 per cent. from endowments, 6 per cent. from local education authorities, and 53·5 per cent. from the Exchequer. As a result of an increased Treasury grant the total annual income of the Welsh university colleges rose from 50,000*l.* to about 65,000*l.* The total number of students of all kinds for 1909–10 was returned as 22,187 in England (of whom 8174 were full-time students) and 1710 for Wales. No students taking courses for matriculation have been included amongst the full-time students. The total numbers of degree students in England rose from under 4400 to nearly 4900. In Wales the numbers increased from 1175 to 1191. The number of post-graduate students in the English universities and colleges concerned grew from 1052 to 1255, while in Wales it fell from 45 to 37. The number of part-time students of all kinds in England reached the figure of more than 13,700. Only about 1200 of these were reading for degrees or attending post-graduate courses.

THE new calendar of Armstrong College, Newcastle-upon-Tyne, directs attention to the fact that the faculty of science in the University of Durham is seated entirely at Armstrong College. In addition to pure science the college gives instruction in engineering (mechanical and civil), electrical engineering, mining, metallurgy, naval architecture, and agricultural science. The agricultural department of the college directs the Northumberland County Agricultural Experimental Station at Cockle Park, and the Durham County Station for Dairy Research at Offerton Hall. For the purpose of forestry instruction the college is in possession of 900 acres of wood at Chopwell, in the county of Durham, and its zoological equipment includes a laboratory of marine biology at Cullercoats, on the Northumbrian coast. Amongst prospectuses of technical institutes which have reached us may be mentioned those of the Sir John Cass Technical Institute, Aldgate, and the Northern Polytechnic Institute, Holloway. At the Sir John Cass Institute several new departures are being made. The curriculum of students in the fermentation industries now includes courses on "Brewing and Malting" and the "Micro-Biology of the Fermentation Industries." In the physics department, lectures and demonstrations will be given on "colloids," which will deal with their relation to technical problems. The special courses on liquid, gaseous, and solid fuel in the metallurgy department have also been extended, and will include laboratory work of fuel analysis and on gas analysis. There are also special features in the work of the Northern Polytechnic, and one of importance is the day school of building, which provides a practical course of training for those about to enter any profession or business connected with the construction of buildings, with surveying, or with municipal engineering. The course of work in the school provides instruction in both the principles and processes of building work, and should be of interest to parents who intend to place their sons in the architectural or surveying professions, and to builders whose sons are destined to take a future share in the management of a business.

THE eighth report of the Commissioners for the Exhibition of 1851 to the Home Secretary has been issued as a Blue-book [Cd. 5723]. The last report was published in 1889. The report proper runs to some twenty-six pages, the remaining part of the volume of 132 pages being given over to appendices, which include copies of leases, the charter of the Imperial College of Science and Technology, general regulations, accounts, and so on. Full details are given of the various steps taken by the commissioners to carry out their object of forming a centre at South Kensington for institutions engaged in the promotion of science and art, and more especially in their application to industry. As regards the consideration of future policy, the commissioners say:—"When we became free from the encumbrance of a heavy mortgage debt we were enabled to devote a considerable portion of our income to scholarships for scientific research. The remainder has been invested from time to time, so that we are now in a position to increase the scope of our activities. We have accordingly considered the uses to which we should apply our funds in the immediate future. It is not contemplated to disturb the existing provision of scholarships for purposes of research; but in our opinion a point has been reached when the capital resources of the commission should no longer be applied to assist in the erection of buildings at South Kensington, and when the balance of the income derived from our present funds should be so used as to give a further impetus to scientific and artistic training consistent with the objects of our charter. We believe that our income can be used to great advantage by the provision of scholarships and bursaries endowed, not for all time, but for limited periods, and directed specially to encourage not only research work, but also the training of 'captains of industry.' We shall, moreover, endeavour to include in any extension that we may hereafter devise for our scheme of scholarships some provision for encouraging the study of the fine arts on lines corresponding to those which have proved so efficacious in relation to science and its applications. In such assistance as we may afford from time to time to the solution of problems affecting the industrial welfare of the nation, we shall have regard principally to schemes which from their nature require support from other than ordinary sources."

THE first part of the Board of Education statistics of public education in England and Wales for the school year 1909–10, dealing with educational statistics, has been published (Cd. 5843). In his preface Sir Robert Morant points out that the Board has not for the year under review been able to make any substantial change in the statistics of technical institutions, evening schools, and allied classes. It is hoped, however, that when the proposed new regulations have come into operation, it will be possible to provide a series of tables relating to "further education," in which the various types of schools will be more clearly differentiated than is at present possible. As regards technical institutions—that is to say, institutions giving an organised course of instruction in day classes, including advanced instruction in science, or in science and in art, and provided with a staff and equipment adequate for the purpose and fulfilling other requirements laid down by the Board—there were 35 recognised during the year; and they provided 124 courses in which 736 teachers were employed. The number of students who attended at any time during the year was 2946, and on 2584 of these grants were paid by the Board. Of these 2946 students, 190 were under 16 years of age, 735 under 18 but over 16, 1284 over 18 but under 21 years of age, and 737 were over 21. In addition to these students of technical institutions there are many other students studying science and technology in day technical classes. In a series of tables the Board provides information of 230 courses held in 109 institutions in which day technical classes were recognised, but points out that "the 'day technical classes' to which the following tables relate constitute merely a small fraction of the whole number of day technical classes in existence in England.". In the 230 courses mentioned there were 10,924 students taught by 983 teachers.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 4.—M. Armand Gautier in the chair.—Kr. **Birkeland**: The electrical constitution of the sun. A development of views put forward in two earlier communications. The photosphere is regarded as a sea of electric arcs. The bearing of these views on Laplace's nebular hypothesis is discussed, since, if matter is radiated under the action of electrical forces, it is not necessary to assume that at one time the nebula extended to the orbit of Neptune, and this reduces the force of Moulton's objections to Laplace's theory.—M. **Merlin**: Some theorems of arithmetic and an enunciation which contains them. Henri **Villat**: A mixed problem of the theory of harmonic functions in an annular area.—Ed. **Griffon**: A singular case of variation by budding in the peach tree. A description of the appearance of shoots of almond, bearing blossom, on a peach tree.—Marcel **Baudouin**: Human post-mortem actions on the human bones in the bone caves of the polished stone period.—Stanilas **Meunier**: An Egyptian meteorite recently presented to the museum. This meteorite appears to belong to a new lithological type, and will be described in detail in a later communication.

September 11.—M. Armand Gautier in the chair.—Émile **Picard**: An addition to a theorem relating to integral equations of the third species.—Armand **Gautier**: The mechanism of the variation of race, and the molecular transformations which accompany these variations.—A. **Korn**: An important class of asymmetrical nuclei in the theory of integral equations.—Tr. **Lalesco**: Theorem on characteristic values.—L. E. J. **Brouwer**: The theorem of M. Jordan in space of n dimensions.—A. **Blondel**: The various methods of measuring orientation in wireless telegraphy.—C. **Statescu**: Solutions of heterogeneous magnetic salts in a heterogeneous magnetic field.—P. **Mahler** and E. **Goutal**: The use of combustion under pressure for estimating carbon in steel. A modified calorimetric bomb, not enamelled, and having a capacity of 1 litre, has been used for the direct combustion of iron and steel in oxygen under a pressure of 25 atmospheres. The carbon dioxide produced is absorbed in a standard solution of baryta. The method is shown to compare favourably, as regards accuracy, with the usual methods, and has the advantages of rapidity and ease of execution.—Paul **Vuillemin**: Mutation of a hybrid transmitted to its descendants.—E. **Roubaud**: The Chæromyies, a new Diptera with larvæ sucking the blood of mammals.—H. **de Dorlodot** and Ach. **Salée**: The synchronism of the Carboniferous limestone of the Boulonnais with that of Belgium and England.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part ii. for 1911, contains the following memoirs communicated to the society:—

January 14.—C. **Runge**: The radio-activity of air from the open sea.

February 25.—H. **Weyl**: The asymptotic distribution of particular solutions in integral equations.—G. **Angenheister** and C. **Rohloff**: Meteorological observations in the South Seas, from the Samoa Observatory.

March 11.—R. **Gans**: The electron theory of ferromagnetism, ii.—G. **Tammann**: The alterations in the properties of metals due to mechanical treatment.

The Business Communications of the society, part i. for 1911, contain the ninth report on the publication of Gauss's works, and the tenth report of the Samoa Observatory for 1910–11.

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