THURSDAY, OCTOBER 8, 1903.

MILITARY TOPOGRAPHY.

Recherches sur les Instruments, les Methodes et le Dessin Topographiques. By le Colonel A. Laussedat. Tome ii., part ii. Pp. 287. (Paris: Gauthier-Villars, 1903.)

THE second volume of Col. Laussedat's exhaustive work on topography, which has just been published, deals with the art of metrophotography as developed in Europe generally and in France in particular; condensing the opinions and experiments of leading men of science, and epitomising their results. Attempts to adapt the principles of natural perspective to topography in France date from the middle of the last century. French methods were adopted by Germany in 1865; Italy followed suit in 1875; and in Austria, Maurer executed a military reconnaissance of some importance (which could have been attained in no other way) in 1887. There has gradually accumulated a large amount of scientific literature in Austria dealing with this subject; and in 1889 the Swiss engineer S. Simon had made a photographic survey of Jungfrau. Russia has been busy for many years in the Trans-Caucasus and in Persia, working on similar methods to those of Switzerland, whilst Greece, Brazil and Madagascar have all contributed results of scientific value towards the development of the art. Spain has been interested since 1863, and in 1899 an "excellent ouvrage" was produced in Madrid by two engineers, Iriarte and Navarro, which seems to have been the most complete work on the subject up to the date of Laussedat.

New Zealand and Australia have not been idle; but amongst our colonies it is to Canada chiefly that we look for the most practical experiments leading to the most noteworthy results in this as in every other branch of topographic art. In the United States as early as 1886, photographic methods for rapid reconnaissance were taught at West Point; but it is to the Canadian experts, Deville and Fleurer, that we owe most of our practical knowledge. A general summary of Canadian results will be found in Wilson's useful work on topographic art.

England and English surveyors alone contribute nothing to the world's knowledge of this branch of surveying, although of all countries in the world England is probably most interested in its development. Colonel Laussedat, noting that as early as 1869 Colonel J. Baillie proposed that photography should be utilised as an aid to reconnaissance, suggests that the absence of all result may be due to the fact that its military application precluded it from publication—"il est probable que des résultats à la fois curieux et utiles ont pu être obtenus dans un ordre d'idées qui ne se prête pas à la publicité." But he is probably unaware that the preliminary art of topography is as yet undeveloped in England; and that we are still a long way from the scientific consideration of any of its more subtle branches. It is true that in India (where the knowledge of topography is an every day practical necessity) some experiments have been made with the Bridges-Lee instrument (the phototheodolite), but there are good reasons why photography as an aid to surveying should only be applicable in exceptional cases and under exceptional conditions in that country. The ultimate practical value of metrophotography lies in the power which it places in the hands of one accomplished topographer to do the work of many. It is a financial question in the long run, but, as Col. Laussedat does not fail to point out, it is useless in the hands of an amateur. It requires a surveyor (or an artist) of exceptional ability and experience as a topographer to render it effective. Workmen of this stamp are rare anywhere and command good value for their work. In India the simpler form of topography attained by the use of the plane table (which is invariably superior in its final results to those of metrophotography when applied to ordinary country by ordinary workmen) is attained cheaply and satisfactorily; for the native labour of India is cheap, abundant, and specially adapted by nature to this form of art. Metrophotography, therefore, would probably not pay.

The practical application of metrophotography has been well exemplified by Le Bon in India, in aid of archæological research; by Legros as an explorer; by Vallot as a mountaineer (in which direction it is specially useful), and by many other Frenchmen in various ways in different parts of the world, leaving no room for doubt as to its value in exceptional circumstances, and the necessity for its continued development. But Laussedat is at some pains to quote the opinion of the Canadian expert Deville, who proves clearly the limitations of the art, and shows that photographic topography is just as much dependent on accurate preliminary triangulation as any other form of topography. He enters fully into the difficulties which beset the method, both as to the determination of scale and the representation of orographic features by contours.

A variety of new instruments designed to aid in the reduction of photographs to plan are described, and the scientific principles involved in their construction are discussed at length—such as the trirégle of Nicholson, the perspectograph of Hermann Ritter, Hanck's apparatus, and the perspecteur panoramique of Ch. von Ziegler. Some of the problems offered for the consideration of his readers are of considerable mathematical complexity. A good deal has been added to that which has already appeared in vol. i. on the subject of telephotography (which was employed with so much success by engineers during the siege of Paris), and forms a particularly fascinating chapter in this work.

A chapter on balloon and kite flying reconnaissance, with an inquiry into the nature of the instruments used and of their attachments, as well as into the principles involved in determining the scale of the resulting photograph and in the reduction of observations, is interesting; although it is difficult to believe that automatic observations taken from flying kites or balloons can be made valuable for military purposes unless applied to the illustration of positions within which two or three points have been accurately fixed by one of the ordinary methods of terrestrial survey. The results of the first trial in the kite flying for plan photographic purposes were published in *La Nature* by M. Batut in 1888, so that the experiment is by no means new; but we doubt if this system has ever really added any valuable results to the reconnaissance information obtained by more usual methods in time of war; and it is conceivable that only for military purposes under stringent conditions would such methods be applicable. Stereophotography is the subject which concludes Col. Laussedat's review of instruments and methods. This, indeed, forms a most useful variation on ordinary metrophotographic observations, for it is obvious that the representation of orographic features as effected by this well known process conveys a far more readable impression to the eye of the nature of the country photographed, the rise and fall of undulations, the gradation of slopes, &c., than any flat photograph can possibly convey. It is a branch of photography applied to topography which has received very considerable attention in France, and it promises to become a very valuable aid in the process of reducing landscape photographs to topographical maps in future.

Colonel Laussedat has undoubtedly written a most valuable book—one which will be a standard authority for years on the subjects which he treats so ably. Men of science and experts may not agree as to the practical utility of some of the methods discussed; but they are discussed impartially, carefully, and in almost exhaustive detail, and the reader is left to form his own conclusions. There are yet many countries in the world which are greatly in need of good topographical illustration of the natural features contained in them. There are still vast areas unmapped, if not unexplored. Thus Col. Laussedat's book appears at a most appropriate time, when the demand for topography is the first demand of the administrator, and the necessity for utilising every method which promises to effect a saving of time and expense is paramount. It should find a place in every scientific library with any pretension to completeness.

T. H. H.

NATURE STUDY AS A SCHOOL SUBJECT.

An Introduction to Nature Study. By E. Stenhouse. Pp. x + 422. (London: Macmillan and Co., Ltd., 1903.) Price 3*s.* 6*d.*

SINCE the attempt was made a year or two ago to introduce into our rural elementary schools the subject called "nature-study," really such a general introduction to the science of living things as will give the pupil a means of taking an interest in his environment, there has been a great lack of adequate books for the teacher. Several men, Dr. Armstrong, Prof. Miall, and Prof. Lloyd Morgan, for instance, have spoken about the spirit in which the work should be undertaken, nor are there wanting books which indicate the method to be followed, that of experiment and observation. But the ordinary teacher without any particular training in the subject has wanted more systematic guidance, his previous training has been in the wrong direction, and the many text-books that have been hurried on to the market have only tended to confirm his probable original error that nature-study consisted in reading about natural objects or anything bearing on country life.

At last, however, we have a text-book of the right kind, something that we can unreservedly recommend to the teacher, both as a guide to the method he should follow and as a storehouse of instructions concerning the details of experiments within his reach. The book is avowedly written to cover section i. of the Board of Education course in general biology; it is equally well suited to the more recent syllabuses in nature-study or the elementary stage in agriculture and rural economy issued by the same department.

The book opens with a study of the growth of the plant, first describing the elementary experiments illustrating the structure and development of the seedling, then the function of leaf, stem and flower.

A little more might have been done to show how many of the experiments can be rendered quantitative, so as to yield exercises in measurement and continuous record keeping; indications also might have been given of how the teaching could be brought home to the country child by illustrations from farm or garden practice. For example, it is easy to carry out experiments in the garden on the best depths at which seeds of various sizes should be sown, on the necessity of a good seed bed, or the harm wrought by plastering seeds into wet sticky soil, all of which give practical point to the lessons derived from the experiments in class. Again, the structure of the stem finds many appropriate illustrations in the various methods of propagation by cuttings or layers, buds or grafts, the healing of wounds on a tree, knots and other common features in timber.

The discussion of plant families and orders is refreshingly free from technicalities, though here again more might be made of systematic observations from month to month of the development of characteristic structures like tubers, bulbs, corms, &c.

The animal life section gives first of all some elementary instruction about physiology and structure, taking the rabbit as a text, and then discusses briefly the characteristics of our commoner mammals. The section on birds contains a good chapter on the development of the hen's egg during incubation, followed by an account, brief but suggestive, of a few familiar birds. A chapter on the frog and its development from the egg is followed by one on insects, dealing with the structure and life-history of one or two common forms.

The scope of the book is obviously considerable, and it is by no means desirable to use it wholesale, but in the hands of an intelligent teacher who will select the sections most suitable to his conditions, practise himself in the experiments, and then get his pupils to help him to carry out numerous repetitions, who finally will add local illustrations and practical applications, the book will be of the utmost service in systematising his instruction and guiding it along the fruitful lines of experiment and research.

A. D. H.

OUR BOOK SHELF.

Ergebnisse der Physiologie. Edited by L. Asher (Bern) and K. Spiro (Strassburg). Erster Jahrgang. 1 Abtheilung. Biochemie. Pp. xix+929. (Wiesbaden: J. F. Bergmann, 1902.) Price 17 marks.

THE German physiological school is engaged just now in producing a monumental work. Under the able editorship of Drs. Asher and Spiro, two of the most energetic of the younger physiologists of the Fatherland, the most eminent workers in different branches of the science have been persuaded to contribute of their best. We notice also that among the collaborators are several from other countries in addition. The editors do not aim at producing a text-book even for the advanced student, but a series of essays, each written by a master of his craft on some subject to which he has paid particular attention, and has himself made a subject of investigation. Giving, as each article does, not only the history of the subject with full biographical references, but also an account of the latest discoveries, and discussions of conflicting views on the many vexed questions treated, it will prove a veritable mine of facts to the investigator, and will, indeed, be indispensable to all who are attempting real and serious work in the future.

The volume before us treats of what it is now the fashion to call biochemistry, and we notice with pleasure that some of the articles deal with the comparative and also with the botanical aspects of this rapidly growing branch of physiology. We shall not attempt to give a *résumé* of the book, or even a list of the articles and their authors. This is a sort of book which must be read, and not merely talked about. Suffice it to say that among the authors are those of the standing of I. Munk, Hammarsten, F. Voit, Pawlow, Hugo Wiener, and Hofmeister.

In any work in which many participate, there is always a certain amount of inequality. In the present volume this is not so noticeable as in most books of a similar nature, for each author seems to have made a special effort to produce an article or articles of the highest possible standard.

We do not pretend that the book is light or attractive reading, and we imagine that the authors themselves would be the first to repudiate any suggestion that they intended it to be so. The German language, for one thing, does not lend itself to such a frivolous purpose. It is solid, hard reading, written with the German ideal of thoroughness for the student and the worker by those who are themselves workers and students.

Thermodynamik. By Prof. Dr. W. Voigt. Band i. (Sammlung Schubert, vol. xxxix.) Pp. xvi + 360; with 43 figures. (Leipzig: G. J. Göschen, 1903.) Price 10 marks.

THE subject of thermodynamics can be treated either as a deductive or as an experimental science. According to the former method, the second law affords a definition of absolute temperature, and a perfect gas is a hypothetical substance, defined by certain conditions, which is proved to possess the property of acting as a thermometer for the measurement of absolute temperature. In the present case the opposite treatment is followed. The book opens with an introduction dealing with thermometry and calorimetry, followed up by a section on the equivalence of work and heat in which the specific heat of water finds its old traditional title of mechanical equivalent of heat, and the methods of determining it are severally and separately discussed. The next chapter deals with the thermodynamics of perfect gases, and includes sections on Carnot's cycle as applied to such gases. It is not until the third chapter that the second law is applied generally to bodies defined by two variables, while in the fourth or last chapter the principles of thermodynamics are extended to systems defined by any number of variables. The book thus has its parallel, to a certain extent, in those treatises on applied mechanics which deal with the equilibrium of levers or motion of pulleys before introducing the parallelogram of forces or the laws of motion. At the present time many students working in physical laboratories acquire an experimental knowledge of principles which their lack of mathematical ability prevents them from approaching from the deductive side. No doubt this is a pity, but while such students continue to exist and to require teaching, it is difficult to see how a subject like thermodynamics could better be presented to them than is done in Prof. Voigt's treatise.

Arithmetic for Schools and Colleges. By John Alison, M.A., F.R.S.E., and John B. Clark, M.A., F.R.S.E. Pp. xliii+304. (Edinburgh: Oliver and Boyd, 1903.) Price 2*s.* 6*d.*

No better exposition of the nature of arithmetical operations and of proofs of the various rules of arithmetic than that which these two Scottish authors here present to us can be found. The first twelve chapters treat of the more theoretical branch of the subject, and explain with great exactness the laws of arithmetical processes and the manipulation of vulgar and decimal fractions. The authors never miss an opportunity of pointing out the means of shortening a calculation and, at the same time, of explaining and justifying the process. In these first twelve chapters we would specially signalise those on "laws of operations" and "decimal approximations" as interesting to the philosophically minded student; but, indeed, the whole of the work is marked by great thoroughness. In the chapter on evolution, Horner's method is explained and amply illustrated. There is a very good chapter on the metric system, including its employment in dynamics, heat, and electricity, illustrated by a large collection of examples. The nature of ratio and proportion is also very well explained and exemplified in three special chapters. The practical subjects (percentages, profit and loss, interest, &c.) are treated as mere examples of the theory of proportion.

Once only in the book do we meet with a vicious Saxon expression: "If the first term of a proportion be greater than the second, the third *shall be* [instead of *is*] greater than the fourth" (p. 202); but this is not repeated in subsequent similar propositions.

Except by the introduction of the diagrammatical relations between variable quantities, as exhibited by curves on squared paper, it is difficult to see how this very excellent treatise could be improved.

G. M. M.

Les Materiaux artificiels. By Marie-Auguste Morel. Pp. 178. (Paris: Gauthier-Villars and Masson et Cie.)

THIS volume belongs to the "Encyclopédie Scientifique des Aide-Mémoire," published under the general editorship of M. Léauté. It contains information of an interesting kind about numerous materials used in building and other constructive arts. The first chapter, on semi-artificial substances, includes a treatment of lime, cements, bricks, tiles, and other materials. This is followed by successive chapters giving accounts of those artificial materials dependent for their manufacture on technical chemistry; those used in association with metal armatures; those—such as mortar, artificial stone—formed when artificial materials are mixed with other non-metallic substances. The concluding sections include a miscellany of subjects, such as the preservation of wood, the use of soluble glass, and a description of Lincrusta-Walton.

LETTERS TO THE EDITOR.

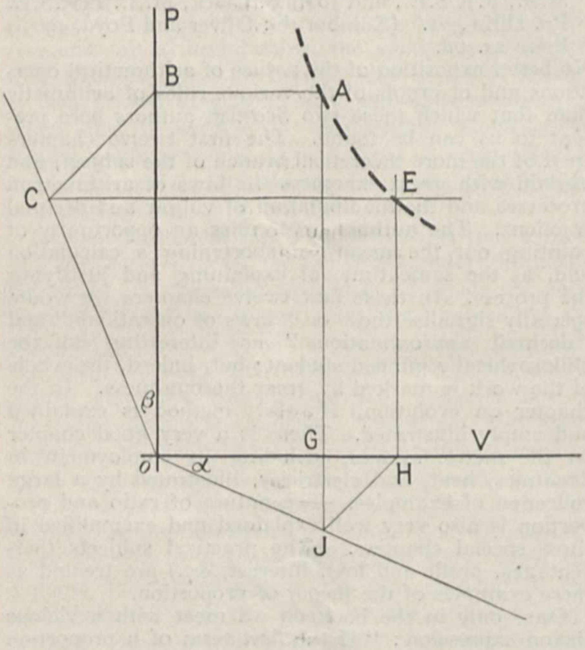
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Expansion Curves.

EVERY man who has studied steam or gas or oil engines knows that if there is one construction more important than another it is to draw a curve representing the law

$$pv^n = \text{constant}$$

through any given point. Here is an exceedingly simple, ingenious method of doing this which I have just found in a pamphlet by Mr. E. J. Stoddard, of Detroit. Let A be the given point so that AB represents a given volume,



and AG a given pressure. Set off any convenient angle, VOJ $=\alpha$ say. Compute an angle β such that

$$1 + \tan\beta = (1 + \tan\alpha)^n,$$

and set off BOC $=\beta$. Produce AG to J. Now make OBC $=$ JHO $=45°$, and project from C and H to find E a point in the curve. The proof is obvious.

It is evident that OC may be drawn to the right of OB, and OJ above OV, to save paper if necessary.

J. PERRY.

Royal College of Science, S.W., September 23.

Botany in Boys' Schools.

PROF. W. W. WATTS said in his address to the Geology Section of the British Association, "there is no science in which materials for elementary teaching are so common, so cheap, and everywhere so accessible."

In the light of this statement I sought material for the teaching of another science—botany—in a north London playground last week.

The Angiosperms were represented by thirteen natural orders. With a single representative each of the algæ and fungi, thirty-eight species in all were found growing in or on a soil which is almost entirely ballast!

It seems a pity that botany should be so rarely taught in boys' schools when a single playground yields materials "so cheap and so accessible." H. J. GLOVER.

Stationers' School, Hornsey, N., September 23.

Radium and the Cosmical Time Scale.

CERTAIN letters have appeared in NATURE upon the bearing of the properties of radium upon the cosmical time scale. These letters are based on the assumption that radium, or some equally active body, exists in the sun and contributes materially to the output of solar energy. If this assumption were true, we ought, I think, to be able to detect the rays peculiar to radio-active bodies on the surface of the earth—they should bear some proportion to the great stream of light and heat waves which reaches us.

Now a solution of iodoform in chloroform is very sensitive to the β and γ rays. A purple coloration is produced by the rays from 5mg. of radium bromide even after filtering through 1cm. of lead. On the other hand, I find that direct sunlight (if heating be obviated) has no action when the thinnest opaque screen is interposed even after many days. Some of my solutions are now nearly two months old, and they have been exposed in light-tight cardboard boxes to such sunshine as has reached us during that period. They are quite unchanged.

It is, of course, possible that the stream of rays needs to be above a certain critical density in order to decompose the iodoform, but in any case my experiments prove that the β and γ rays reach us at most only in faint quantities from the sun. W. B. HARDY.

Gonville and Caius College, Cambridge.

Loss of Weight of Musk by Volatilisation.

I SHOULD like to direct the attention of your correspondent "S. W." (p. 496) to *N. Cimento* for May, 1902 (or abstract 1986, *Science Abstracts*, 1902), in which E. Salvioni says that he has shown the loss of weight of musk by volatilisation.

The measurements were made by a special form of balance. F. R. SEXTON.

Park Lodge, Kingston-on-Thames, September 5.

CONDENSATION NUCLEI.[1]

IN a previous paper under the not very appropriate title "Experiments with Ionised Air," Prof. Barus has described observations, made by means of his modified steam-jet methods, upon the nuclei found in air which has passed over phosphorus, together with measurements of the electrical leakage through air thus treated. The first chapter of the present volume is taken up with a continuation of the work by the methods there described.

There is no reason to expect the properties of air which has been exposed to phosphorus to be characteristic of ionised air generally; the recent experiments of Harms, and of Elster and Geitel, have, it is true, shown that ions are probably present, but the conditions are much more complicated than in cases of simple ionisation, such as that due to X-rays, owing to the presence of the products of the oxidation of the phosphorus. It is probably to the presence of the products of the oxidation of phosphorus vapour, as was pointed out in 1866 by Schmid, that the formation of the phosphorus cloud is due. The cloud nuclei are not free ions; in the "experiments with ionised air" it was found that the number of nuclei was undiminished by even a strong electric field; additional evidence is brought forward in the first chapter of the present paper, where experiments are described showing different temperatures for the maxima of nucleation and of ionisation. But such evidence was not required to show that these nuclei are not ordinary free ions, for in dust-free air ionised by X-rays or the rays from radio-active substances (in all cases, indeed, in which the ions have the normal velocity under

1 "The Structure of the Nucleus, a continuation of 'Experiments with Ionised Air.'" By Carl Barus. (Smithsonian Contributions to Knowledge, Hodgkins Fund, 1903.)

a potential gradient of a volt per cm.) the same definite degree of supersaturation, approximately fourfold, is required to produce a cloud; the phosphorus cloud, on the other hand, does not require any sensible degree of supersaturation for its production.

There is evidence in these papers of strange misconceptions on the subject of ionisation. One is surprised in a paper dealing with "ionised air" to find such a statement as that on p. 53, "$n_0=3.6\times 10^4$, agreeing very well with J. J. Thomson's 4×10^4 as the number of ions in air ionised to saturation by the X-rays."

In measurements of the leakage of electricity through air which has passed over phosphorus one would expect the apparatus to be designed in such a way that there should be no danger of the leakage observed being mainly due to the surface of the insulating supports becoming conducting by contact with the phosphorus fumes. The failure to take such precautions detracts greatly from the value of the electrical observation described in these papers.

Chapter ii. and the remaining chapters of the volume on the structure of the nucleus contain an account of experiments upon the clouds produced by rapid expansion. There can be no doubt that such experiments are easier of interpretation than those made by steam-jet methods. Prof. Barus begins with experiments on the colour phenomena attending the rapid expansion of moist air containing nuclei, generally phosphorus and "punk" nuclei. It is only when few nuclei are present, and the drops formed on expansion thus comparatively large, that *normal* coronas, as Barus calls them, are seen surrounding a luminous source viewed through the cloud. It is only to such coronas that the ordinary theory of the corona applies; the gorgeous colour phenomena observed when the drops are very small, numerous and uniform in size are much more difficult to interpret. If it were possible to deduce the size of the cloud particles from the colour phenomena observed with a given expansion, a most convenient method of determining the number of nuclei present would be available, for the quantity of water separating out as a consequence of a given expansion can be calculated, and hence the number of drops could be determined if the size of each were known. With this end in view Prof. Barus, in the absence of an exact theory of the colours, attempted to determine the size of the drops corresponding to a given arrangement of colours by an experimental method. On certain assumptions the relative numbers of the drops in a whole series of successive expansions, giving a corresponding series of colour phenomena, were known, the drops in the final expansions being large enough to give normal coronas, from which by comparison with lycopodium coronas the radii of the drops, and hence their number, could be determined; thence could be deduced the number and size of the drops in each of the previous expansions. It is very doubtful if the method can be made a trustworthy one.

Expansion experiments made with other vapours than that of water are next described, benzol, carbon bisulphide, ethyl and methyl alcohol and other vapours being used. Water vapour obviously differs from most other vapours in one very important respect, *i.e.* it is lighter than air. In the experiments made by Prof. Barus the air was contained in a large vessel with a pool of liquid at the bottom; when the liquid was water the moist air would rise to the top, and mixing would thus take place automatically by convection until the whole volume was saturated; in the case of liquids like benzol the heavy vapour-charged air would lie at the bottom, the vapour only gradually diffusing upwards. Uniform distribution of vapour, and hence the production of circular coronas on expansion, are to be expected with water, while with benzol, unless artificial stirring has been employed or a long interval has been allowed for diffusion, only the lowest strata will be saturated with vapour, and the amount of liquid available for each drop formed on expansion will, if the nuclei are uniformly distributed, diminish from below upwards; distorted coronas, or in extreme cases an arrangement of the colours in horizontal strata, are to be expected. The upper part of the vessel may remain free from cloud, the upper boundary of the cloud marking the level at which just enough vapour is present to give drops with the degree of expansion used. Even when uniform distribution of the vapour has been obtained, it will be destroyed by the first expansion made and the subsequent entrance of the dry air introduced to bring the pressure back to that of the atmosphere.

The phenomena observed by Prof. Barus are exactly what one would expect from these considerations, but he makes no reference to the above mentioned important difference in the conditions attending experiments with water vapour and with other vapours. His interpretation of the observed phenomena is, in fact, quite different. "When sulphur or other nuclei are put into the globe containing benzol vapour the result is peculiar. Instead of distributing themselves homogeneously throughout the receiver they usually collect in a heavy band near the bottom. This is invisible until revealed by the first exhaustion, when a heavy sluggish fog bank is seen, only a few centimetres high." Again, "The most curious feature in connection with benzol as well as the preceding liquids is the subsidence of the invisible nucleated air immediately after influx and without exhaustion." The "graded condensation" is interpreted as showing the nature of the distribution in the vessel, not of the vapour, but of the nuclei, and an elaborate series of experiments to determine the rates at which the nuclei travel in different vapours is described; that rate of diffusion of the vapour rather than of the nuclei is involved is by far the more natural interpretation. (In a short paragraph, inserted apparently subsequently to the writing of the paper, the possibility of this interpretation is admitted.)

The fifth chapter treats of the nuclei produced by shaking liquids, particularly aqueous solutions. The production of nuclei by shaking, bubbling and spraying has been noticed by several observers, and the effect of dissolved substances in the water upon the persistence of the nuclei has been studied by Mr. H. A. Wilson. Prof. Barus here gives an interesting series of observations on a large number of solutions of varying degrees of concentration. These nuclei are regarded as minute drops of the solution employed, which have evaporated until the concentration of the dissolved substance becomes great enough to counterbalance the effect of the curvature upon the vapour pressure. The conditions of equilibrium of small drops containing substances in solution are made clear by a diagram. There can be little doubt that the nuclei obtained by shaking solutions, and probably also those produced from phosphorus and from most of the other sources used by Prof. Barus, are of this nature. There is, indeed, nothing novel in the view that nuclei of this kind exist. Barus, however, seems to imply that all nuclei, including what other experimenters have taken to be the ions produced by X-rays and similar agents, are of this type.

An extraordinary interpretation is given (on p. 161) of the experiments by which it was sought to determine the difference in the action as condensation nuclei of the positive and negative ions. "If one introduces nuclei or makes nuclei by aid of the X-rays, in what is virtually the acid and alkaline side of a battery, even if the ionised moist air is the electrolyte, one is conveying nuclei into or making nuclei out of different media." How it comes about that a perfectly definite degree of supersaturation is required to cause condensation on such nuclei, whether an electric field is applied or not, and whether they have been produced by strong or weak radiation or by other means, he does not attempt to explain. He brings forward in support of his view the further consideration that, "if a marked difference in efficiency of positive and negative ions is granted, then any ionised emanation neutral as a whole, like that of phosphorus, should produce two groups of nuclei. On condensation there should be two groups of coronal particles interpenetrating and subsiding through each other in the way I have frequently instanced in other experiments. No such effect has been observed." The answer to this is simply that the nuclei causing the phosphorus clouds are not free ions, like those produced by X-rays.

Prof. Barus concludes with a suggestion as to the origin of atmospheric electricity, according to which nuclei become negatively charged as the solution which they contain becomes diluted by absorption of water.

C. T. R. Wilson.

THE GEOLOGY OF AUSTRIA-HUNGARY.

To know, even in a general fashion, the provinces of Austria-Hungary, with their immense range of scenic types and their picturesque variety of nationalities, goes far in itself towards a liberal education. The lover of landscape, as well as the geologist, will find much of interest in the new "Führer für die geologischen Exkursionen in Oesterreich," issued in connection with the ninth International Geological Congress in Vienna. This bulky work is divided, like that of the Russian congress, into numerous separate *brochures*, but forms, none the less, a permanent work of reference for our libraries. To obtain the guide and other publications before they become scarce, a subscription to the secretariat of the congress of twenty-seven shillings or so every three years seems not a heavy price to pay.

In the Austrian guide we have the work of some forty-five authors, describing in a compact and lucid form the districts that they have made their own. In this respect, though covering a far wider field, it resembles that handbook of English geology, the "Geological Excursions," issued by our Geologists' Association. The names of the writers imply in themselves the spirit of a scientific congress. We do not see the groups and cliques seated in the parliamentary Chamber in Vienna, and threatening one another with the literal outpouring of ink; but we find instead a body devoted in common to the reception of the stranger, and anxious that in each province he shall find something memorable and distinctive.

Dr. Jahn opens with the Older Palæozoic area of Bohemia, which includes the Moldau sections above Prag and the ravine at Karlstein, one of the noblest scenes of mediæval Europe. Prof. A. Hofmann describes the silver-mines of Přibram, and Prof. Slavík and others deal with the Cretaceous of northern Bohemia. In this latter paper it is pleasant to note the insertion of the euphonious Tchech names of villages after the German forms, a practice already to some extent imitated in Ireland. August Rosiwal conducts us through the more severely German district of Karlsbad and other health-resorts upon the frontier. Prof. Suess's important theory of the distinction between nascent and "vadose" waters appearing at the earth's surface is duly referred to. If this series of papers leads to a better appreciation of the rural districts of Bohemia, the writers will have done good service. Few visitors have seen what lies upon the plateau and outside the towns—the hamlets with bulbous church-towers, set of necessity beside the lakes, which gather in the hollows of the granite; the broad undulations of a purely agricultural landscape, broken here and there by some magnificent group of castle-towers; the crumpled rim of the country on the south-west, where one plunges down through the forest to Bavaria; or the sheer phonolite necks of the north, rising like islands above a haze formed by the smoke of Cainozoic coal. Here, however, we reach the holiday-region of the Elbe, known to dwellers in Dresden, and pleasantly described and illustrated by J. E. Hibsch in a *brochure* of seventy pages.

Another important series of papers deals with Galicia, the Miocene salt-beds of Wieliczka being, of course, included. Less visited are the petroleum-beds of Borysław, now one of the active fields of enterprise, where the folding of the Miocene strata assigns a maximum age to the uplift of the Karpathians. Oberbergrat Johann Holobek connects the various deposits of hydrocarbons with the extreme fissuring of the sandstones along the region of overfolding. Nearer the great chain, Oligocene menilite-shales are brought up over the Miocene on the south-west limb of the synclinal, and the oil, though flowing in fissures, appears generally accumulated in the bend.

What novelty lies before those who visit Drohobycz, Zaleszczyki, Kasperowce, and Worochta, following Drs. Grzybowski and Szajnocha, can only be known to those who have had glimpses of remote Galicia. Not the least interesting feature of Austrian Poland is the view of the drift-covered Russian plateau across the frontier, and the ever-present sensation of that mysterious and arbitrary *cordon*, along which the white-capped cavalry ride night and day and keep the verge of Europe.

From a geological point of view, the country of the famous limestone *Klippen* is of the first importance. Similar tectonic problems arise wherever beds of varying powers of resistance become crushed together. In a neat section V. Uhlig shows the relation of the northern "Klippenzone" to the overfolds and thrusts on the flank of the Tatra range. The fertile basin of Liptó is included on the south of the granite mass, and one can picture again the streams leaping into it from the forest-slopes of the Karpathians, and the grey crags towering up beyond, and the descent northward on the rain-swept levels of the Magura. This last region of little disturbed Eocene and Oligocene strata leads on to the highly faulted and upturned "Klippenzone." North of this the Older Cainozoic is strongly folded, whence Herr Uhlig concludes that the massive Klippen protected the corresponding beds on their south flank from the pre-Miocene earth-pressures. These same pressures had, however, considerable effect among the Klippen themselves, and have so far squeezed the masses of various ages together as to tend to obliterate unconformities. The author, however, urges that the band of Klippen represents a series of true islands of Jurassic strata in an Upper Cretaceous and Eocene sea, the deposits of which at one time practically overwhelmed them. They are thus not detached fault-blocks without roots, although the pre-Miocene movements have influenced their present prominence and position. Fig. 14 shows the bold character of the resulting scenery. The memoir then describes the structure of the Tatra chain, with a series of sections which will be welcomed by all who aspire to look further than the classic example of the Alps.

Perhaps one regretfully swings back to Salzburg and the Salzkammergut, though the detailed paper by E. Kittl on the stratigraphy of the latter area is accompanied by an admirable bibliography and a map in colours. Yet why should one regret that a region of such preeminent scenery lies comparatively near us, and is at times unconformably overstepped by the non-geological tourist? The next series of papers carries us away to Styria and the valley of the Mur, where miles of torrent and ravine, of grey limestone crag above and sunny maize below, await the unconventional traveller, and lure him ever eastward, until he emerges on the plain of Hungary. Then follows a number of papers on the environs of Vienna, a city set so happily in a land of geological contrasts. Until we have seen and touched it, we scarcely realise that, a few miles south of Laxenburg, the dusty rise over a castle-crowned projection represents the passage of the Alps. South-west lies the true mountain-episode of the Semmering, fully expounded, with a fine map, by Franz Toula. Westward, we have the narrows of the Danube, and the variety of cliff and alluvial meadow so charmingly described by Prof. Penck. The river runs between Melk and Krems in a pre-Glacial valley, much of which was actually excavated before Oligocene times. The surface-features must originally have been very different, to allow of the formation of this deep cut across the southern projection of crystalline rocks, which almost connects Bohemia with the Alpine system.

The Dolomites, the Adige valley, and Predazzo still offer problems for many a friendly battle. The Carnic Alps present a newer field, and include the superb ravine of Pontebba, with a side-excursion to the limestone-fastness of the Predil. This comparatively low pass, with its fine angle on the south side, amid a veritable world of rocks, would in itself show how much awaits the tourist who will venture east of Venice.

Hungary will probably be dealt with in a special treatise for those who made the long excursion on the Danube. Bosnia and the Hercegovina are very briefly touched on, since the local government has prepared a separate "souvenir" for visitors. What this attention means will be appreciated by those who have experienced the hospitality of the "occupied provinces." From a congress down to the humble bicyclist, all receive a welcome in this old Slavonic highland, all visitors alike are considered of interest to the State. When one sits by the stream-side in some level *polje*, a lake-basin of Miocene times, and hears the muezzin call from the little wooden mosque among the trees, or when one chips the gabbros in the grim ravine of the Narenta, while sun-browned hill-men, like stage-bandits, stride gravely past upon the road, then one can realise, with a grateful heart, what Austria-Hungary means, not only to the geologist, but to Europe.

GRENVILLE A. J. COLE.

NOTES.

A COMMISSION has been appointed by the French Navy Board to inquire into the migrations of the sardine and the causes of the disappearance of this fish. The commission includes Prof. Vaillant, of the Paris Natural History Museum; M. Fabre Domergue, Inspector-General of Sea Fisheries; and M. Canu, director of the agricultural station at Boulogne-sur-Mer.

OWING to the appointment of Dr. Martin to the directorship of the Lister Institute, the chair of physiology is vacant at the University of Melbourne. Particulars as to duties, emoluments, &c., will be in the hands of the Agent-General for Victoria after October 8. The new professor will be required to commence his duties on March 1, 1904.

AN international exhibition of the manufacture and industrial applications of alcohol will be held in Vienna in April and May, 1904.

A PRESS despatch from Berlin states that the Imperial budget for 1904, now in preparation, allots 7500*l*. for combating typhus, which is specially virulent in Bavaria, Prussia and Alsace-Lorraine.

AN international congress on school hygiene is to be held at Nuremberg from April 4–9, 1904, under the presidency of Prof. Griesbach, of the University of Strassburg. The general secretary is Dr. Paul Schubert, to whom all communications relative to the congress should be addressed.

A REUTER telegram from Rio de Janeiro of October 1 states that the Brazilian Chamber has adopted the third reading of the Bill to establish an international steerable balloon competition to be held at Rio in 1904. The scheme has been submitted to the Senate.

MR. H. MAXWELL LEFROY, who has been appointed entomologist to the Government of India, is to be stationed at Surat, in the Bombay Presidency, pending the establishment of the permanent headquarters of the Imperial Agricultural Department now being organised under the orders of Lord Curzon.

THE necessary legal formalities in connection with the change of name of the Jenner Institute have now been completed, the Board of Trade having sanctioned the new name. The Institute will, therefore, now be known as the "Lister Institute of Preventive Medicine." The address, Chelsea Gardens, S.W., remains the same.

SIR THOMAS HANBURY has promised the Pharmaceutical Society of Great Britain securities of the annual value of 25*l*. for presentation with the Hanbury gold medal awarded biennially for research in the natural history of drugs. The medal, founded in memory of Daniel Hanbury, brother of Sir Thomas, was awarded this year to M. Eugène Collin, of Paris. As the result of Sir Thomas Hanbury's gift future recipients of the medal will also receive the sum of 50*l*.

A PROVISIONAL programme of the ordinary meetings of the Royal Geographical Society for the session 1903–4 has been published. Among the subjects to be dealt with in the meetings of this year we notice north polar exploration, 1898–1902, by Commander R. E. Peary, and the Patagonian Andes, by Colonel Sir T. H. Holdich. The arrangements made for meetings after Christmas include, among others, the Gulf Stream, by Mr. H. N. Dickson; the régime of the Nile, by Sir William E. Garstin, G.C.M.G.; the lakes of New Zealand, by Mr. Keith Lucas; and some adventures in Antarctic lands and seas, by Lieutenant E. H. Shackleton (Christmas lecture to young people).

A KITE-FLYING competition was held at the Alexandra Palace on Saturday last under the auspices of the Aëronautical Institute. The length of wire or string to be used was limited to one mile, and marks were awarded on the following points:—(*a*) The manner in which the kite leaves the ground; (*b*) the manner in which it ascends; (*c*) the steadiness of the kite; (*d*) the length of time required to let out the whole mile of wire or string; (*e*) the greatest average of the altitude as taken by a series of observations during the course of one hour; and (*f*) the rapidity and manner of descent. Only three competitors put their kites to the test, and the contest was easily won by Mr. S. F. Cody, whose kite quickly reached the limit distance and remained steady at that altitude in a strong wind. The kite used was one of a number which is being prepared for consignment to Portsmouth Dockyard.

AN influentially signed memorial on the subject of the improvement of agriculture was recently sent to the Government of Bombay, and is summarised in the *Pioneer Mail.* The memorialists propose that two botanic gardens should be established, one at Poona and one near Bombay, the former as the centre of investigation for the Deccan, and the latter for the Konkan and Gujarat. Each garden should be provided with a herbarium and with chemical and botanical laboratories, and to each should be attached a farm for agricultural and horticultural experiments. It is suggested that the scientific staff might be one chief botanist, one assistant botanist for Poona, one assistant botanist for Bombay, one chemist, one entomologist, and one mycologist. It is also suggested that the number of the experiment stations should be increased and the scope of the experiments extended; that local bodies should be encouraged by grants in aid to conduct experiments on lines prescribed by the department; that publicity should be given to the work of the department, and results of practical interest should be communicated through leaflets printed in the vernacular; that further measures for the improvement of agricultural stock should be taken by the State; and that the Forest Department should be invited to co-operate with the Agricultural Department in the work of experimenting with products likely to succeed in forest areas.

THE method of scientific investigation by observation and experiment was touched upon by Mr. Sidney Lee at the Working Men's College on Saturday last, in the course of a lecture on Bacon, who advocated and inaugurated the revival of experimental philosophy. Bacon's main anxiety, said Mr. Lee, was to see research in every branch of science adequately endowed and equipped, and in his "New Atlantis" he planned in somewhat fanciful language a great palace of invention, a great temple of science, where the pursuit of knowledge in all its phases was to be organised on principles of the highest efficiency. Whether a temple of science on the scale that Bacon imagined it would ever come into existence remained to be seen. At present the portents were not favourable for its emergence in this country. It seemed more likely to come first to birth in Germany or in America, where things of the mind received from the general public a consideration which was denied them here. The experience of a recent visit to America showed Mr. Lee that there was nothing here to compare with the widespread eagerness among the youth of the United States to enjoy academic scientific training. England's prestige owed very much to the triumphs won by men who were Bacon's disciples in methods of scientific research, many of whom stood indebted to ancient educational benefactors. Bacon was well alive to the means whereby a nation's intellectual prestige could best be sustained. He argued that for a nation to apply a substantial part of its material resources to the equipment of scientific work and exploration, a share of its resources which should grow greater with the growth of population and the increasing complexity of knowledge, was the surest guarantee of national glory and prosperity.

IN the report of observations made at the Bombay Government Observatory in the years 1900 and 1901, a feature which differentiates it from the reports of previous years is the prominence given to records obtained from seismographs. In the previous report a series of seismograms and a register of disturbances obtained from a Milne seismograph were given. These are now supplemented by similar information derived from a pair of heavy horizontal pendulums, which record with ink on a metal cylinder, and which have a sensibility for tilting three or four times that of the Milne apparatus. The chief differences in the records obtained from these two types of instruments are the ratios of the recorded amplitudes. These differ so widely that it may be inferred that "the dominant feature of the movements in the majority of disturbances does not indicate tilt." We are not told, however, whether the free periods of the three horizontal pendulums are identical or different.

M. E. ESTANAVE contributes to the *Journal de Physique* a list of the theses in mathematical and experimental physics presented for the doctorate of science in French universities during the nineteenth century.

MR. P. E. JOURDAIN contributes a note on Gauss's principle of least constraint to the *Mathematical Gazette*, and a general theorem on the transfinite cardinal numbers of aggregates of functions to the *Philosophical Magazine* for September.

A COMPARISON of Maxwell's theory with the older and newer theories of electromagnetism is given by Mr. Emil Cohn in the *Physikalische Zeitschrift* for September. It is pointed out among other conclusions that Maxwell's theory accounts in the simplest way for those phenomena which it is competent to explain.

IN a note contributed to the Lombardy *Rendiconti*, Prof. M. Cantone discusses the question whether the elastic constants of a substance are affected by the surrounding medium. The results obtained negative the idea of any such connection. In determining the torsional rigidity of platinum and caoutchouc filaments, the immersion of the filament in water produced no deviation in the torsion balance.

IN the *Proceedings* of the Physical Society, Dr. G. J. Parks describes some experiments on the thickness of the liquid film formed by condensation on the surface of the solid. In the case of cotton silicate, it was found by weighing the material before and after condensation that the thickness of the film came out to be about $13 \cdot 4 \times 10^{-6}$ of a centimetre, and when the film had reached this thickness no heating was produced on immersing the silicate in water.

THE *Journal* of the Western Society of Engineers contains a description of the latest experiments in aërial gliding by Mr. Wilbur Wright. A noticeable feature of these experiments is that the machine sustained as much as 165 lb. to the horse-power as contrasted with 28 in Mr. Maxim's machine and 31 in Prof. Langley's model of 1896. Furthermore, while Mr. Chanute's best experiments in 1896 gave angles of descent of 7½ to 11 degrees, Mr. Wright has succeeded in gliding at angles of 6 to 7 degrees, and even, in one case, at as low an angle as 5 degrees.

IN the *Rivista d'Italia*, Mr. Italo Giglioli, director of the agricultural station at Rome, deals with certain agricultural questions affecting the south of Italy. After reviewing the principal vegetable products now produced by Italy the author suggests, as possible outlets for fresh enterprise, the cultivation of (1) the camphor plant (*Laurus camphora*); (2) the insecticide *Pyrethrum cinerariaefolium*; and (3) the india-rubber plant (*Ficus elastica*). The author sees no reason why the production of india-rubber in Italy should not be a success.

PROF. ALESSANDRO VOLTA, in a note appended to a paper in the Lombardy *Rendiconti*, directs attention to an unpublished manuscript of Volta in which it is stated that negative electricity is dissipated with three times the facility of positive electricity. It thus appears that the difference of the two electricities in their behaviour in electric discharges was known to Volta. Attention is also directed to remarks by Volta on flame discharges, in which it is asserted that such discharges are not affected by the smoke produced. Prof. A. Volta's own researches show that flames of oil, petroleum, gas, and alcohol have approximately the same resistance, but for alcohol flames containing copper chloride the resistance is lower.

THE August number of the *Journal* of the Royal Microscopical Society is mainly devoted to optical theories of the microscope. This subject is introduced by a paper on Helmholtz's theory by Mr. J. W. Gordon, in addition to which Lord Rayleigh's paper from the *Philosophical Magazine* of 1896 is reprinted, together with a further communication from the same writer, and remarks by Dr. Johnstone Stoney, Dr. Siedentopf and others are reported in the Society's *Proceedings*. Among important points under discussion is the property that there is no theoretical limit to the smallness of an isolated luminous object which can be visible through the microscope. The limitations imposed by the undulatory theory affect only the distance apart of two objects or the fineness of structures in order that they may be capable of resolution.

WE have received a circular issued under the auspices of the German Ornithological Society, and signed by Mr. J. Thienemann, of Rossitten, Keer, Nehrung, East Prussia, directing attention to an experiment about to be made with the view of increasing our knowledge of the seasonal wanderings of birds. During the present autumn and next spring it is proposed to capture at Rossitten some hundreds, or perhaps thousands, of rooks (or crows?), upon the foot of each of which is to be fastened a metal ring bearing a number and the date of capture, after which the birds are to be set at liberty. Whenever such marked birds are killed, it is requested that the leg bearing the ring may be cut off and forwarded to Rossitten, with a label recording the date and place of capture.

THE latest issue (vol. xxxi. parts ii. and iii.) of Gegenbaur's *Morphologisches Jahrbuch* appears in mourning on account of the death, in June last, of its learned founder, who superintended the journal nearly to the completion of the twenty-ninth volume. A full biography is promised in the next number. Among the contents of the present issue is an article on the comparative anatomy and development of the heart and aorta in vertebrates, by Mr. A. Greil, and a second, by Dr. K. Fürbringer, on the visceral skeleton of sharks and rays. In a third, Mr. K. Gehry demonstrates that the bunch of axillary muscles ("Achselbogen") in man really represents the panniculus carnosus of lower mammals.

THE first part of the "Aarbog" of the Bergen Museum is devoted entirely to descriptions of the invertebrate fauna of Norway and its seas. Miss E. Arnesen contributes the second instalment of her account of the sponges, dealing in this section with the halichondrine group of the Monaxonida. The nemertean worms are described at considerable length by Mr. R. C. Punnett, of Cambridge, who records a number of new species collected by himself and Dr. Nordgaard in the fjords round Bergen in the summers of 1901 and 1902. Another article, by Mr. E. T. Browne, of University College, London, deals with medusas from Norway and Spitsbergen, among which are several novelties.

WE have received vol. xxxiii. part ii. of *Travaux de la Société Impériale des Naturalistes de St. Pétersbourg*. Its contents include an article on biological method in "zoo-psychology," by Mr. W. Wagner, a second, by Mr. H. Goebel, on the birds of Lapland and the Solovetski Islands, and a third, by Mr. K. St. Hilaire, on the change of substance in cells and connective tissue. The latter article is largely based on the acid-secreting glands of molluscs. As regards the birds of Lapland, the author finds that out of a total of 198 species, 133 are certainly known to breed in that country, while another 34 probably do so. Of the remainder, 17 are stragglers and 6 winter visitors, while 1 is a pelagic species, and the other 7 are found only in the Solovetski Islands.

THE September number of *Animal Life* contains an article by Mr. Lydekker on local variation in the giraffe, illustrated by one coloured plate and a number of photographic reproductions from paintings. After referring to the marked differences between the Somali giraffe (*Giraffa reticularis*) and the typical *G. camelopardalis*, the author points out that evidence is gradually accumulating as to the existence of a number of local races of the latter. The article is chiefly based upon specimens now, or recently, living in the Duke of Bedford's collection at Woburn and in the Zoological Society's Gardens, and on two mounted examples in the Natural History Museum. The Woburn and Regent's Park forms are definitely identified, but, owing to the unsatisfactory nature of the description of two subspecies founded by a German writer, the author has refrained from giving names to the British Museum specimens, which clearly indicate distinct races. A name is, however, assigned to the Congo giraffe.

AN official report has been issued in Simla on the mortality caused by wild beasts and snakes in India. In 1902 the total mortality caused by wild animals was 2836, of which 1046 are reported as being due to tigers, and deaths reported from snake-bite numbered 23,166. In addition 80,796 cattle were destroyed by wild animals, and 9019 by snakes. The number of wild animals for the destruction of which rewards were paid in 1902 was 14,983, of which 1331 were tigers; the number of snakes killed was 72,595. The amount paid in rewards for the destruction of wild animals was Rs. 1,00,987, and for the destruction of snakes Rs. 3529.

A NOTABLE contribution to the subject of proteid metabolism is made by Mr. E. Godlewski in a paper which appears in the *Bulletin international de l'Académie des Sciences de Cracovie*. The general conclusions arrived at are that flowering plants, *i.e.* germinating seedlings as well as fungi, can, in the dark and in an atmosphere devoid of CO_2, absorb and work up nitrogen from nitrates even to the extent of building up proteid substances; but for the continued formation of proteids to any considerable extent a supply of plastic carbohydrate must be present in order to furnish the energy required, such, for instance, as the sugar or starch present in germinating tubers or bulbs. Also, according to the author, light has a direct as well as an indirect action in increasing the amount of proteid substances formed.

A SMALL brochure on "Propagating Plants," written by Mr. D. S. Fish, of the Royal Botanic Garden, Edinburgh, will be found useful by amateur gardeners who wish to obtain practical information on the methods of raising seedlings, striking cuttings, and similar matters. It is published by Messrs. Dawbarn and Ward, London.

THE "Guide to the Sydney Botanic Gardens," which has been prepared by the director, Mr. J. H. Maiden, with assistance from other members of the staff, bears witness to the wealth of vegetation which has been planted round

Farm Cove, a bay in the famous harbour of Port Jackson. The collections of cycads and conifers, including nearly a dozen species of both Macrozamia and Podocarpus, are particularly noteworthy. The plan adopted in the "Guide" is to give a list of the important plants to be found in each bed, with brief notes on native and the more interesting foreign species.

Two handy little publications have been issued by Messrs. James Woolley, Sons, and Co., Ltd., of Manchester. One, known as the "Science Teacher's Pocket Book and Diary, 1903-4," costs a shilling, and the other, the "Science Student's Note Book, 1903-4," costs 6*d*. Both books contain about forty pages of useful constants in physical and chemical science, together with other numbers in constant use in the laboratory.

Messrs. Aston and Mander are now manufacturing for the use of technical and other schools drawing instruments provided with several useful improvements. The adjusting screws cannot be detached from the instruments, and so be lost, the inking-in pens are easily cleaned, and a patent hook-and-nut method of holding the needles effectually prevents breakages when clamping, and renders it easy to change the needles.

Several volumes of the first annual issue of the "International Catalogue of Scientific Literature" have recently been received. The volume on chemistry (part ii.) contains 671 pages, referring to papers published since the end of 1900. The literature published in 1901, together with a portion of that published in 1902, is catalogued in the volumes on palæontology, general biology, human anatomy, physical anthropology, and physiology (part ii.); the last volume includes papers on experimental psychology, pharmacology, and experimental pathology, and occupies 664 pages.

Copies have been received of the last two half-yearly volumes—xxxii. and xxxiii.—of the *Journal* of the Anthropological Institute of Great Britain and Ireland. Among numerous other important contributions, the earlier volume contains the Huxley lecture for 1902, on right-handedness and left-brainedness, by Prof. D. J. Cunningham, F.R.S. The more recent volume includes the address by the president, Dr. A. C. Haddon, F.R.S., delivered at the annual general meeting of the Institute in January last. The volumes are profusely illustrated with beautifully reproduced plates, and serve to show the excellent work the Institute is doing. Similar researches are, in the United States and elsewhere, liberally subsidised by the State, but the Anthropological Institute, working without such support, is enriching the Empire by collecting and publishing a mass of well-arranged information of which any scientific department might legitimately be proud.

The additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*) from the Albert Nyanza, a Patas Monkey (*Cercopithecus patas*) from Gondokoro, presented by Colonel Bruce; two Geoffroy's Cats (*Felis geoffroii*) from Chaco, Argentina, presented by Mr. A. C. Crewe; a Puma (*Felis concolor*), two Vicunas (*Lama vicugna*), a Condor (*Sarcorhamphus gryphus*) from Puna de Jujuy, presented by Baron Ott; a Rosy-faced Love-bird (*Agapornis roseicollis*) from South Africa, presented by Mrs. Healey; a Mandarin Duck (*Æx galericulata*) from China, presented by Mrs. Balston; two Wagler's Pit Vipers (*Lachesis wagleri*) from Singapore, presented by Mr. A. Herbert; a Back-marked Snake (*Coluber scalaris*), European, presented by Mr. W. A. Harding; four Horned Lizards (*Phrynosoma cornutum*) from Colorado, presented by Mr. Edwin Webb; two Carinated Lizards (*Liocephalus carinatus*) from the West Indies, five Hispid Lizards (*Agama hispida*) from South Africa, five Round-spotted Lizards (*Stenodactylus guttatus*) from North Africa, five Black-spotted Lizards (*Algiroides nigropunctatus*) from the Borders of the Adriatic, two Wall Lizards (*Lacerta muralis*, var. *genéi*), two Wall Lizards (*Lacerta muralis*, var. *badriagoe*) from Corsica, two Alaska Geese (*Bernicla minima*) from the Pacific Coast, deposited.

OUR ASTRONOMICAL COLUMN.

The Rotation of Saturn.—Writing to the October number of the *Observatory*, Herr Leo Brenner states that the rotation period of Barnard's large white spot on Saturn, as deduced from his observations, is *exactly* 10h. 38m., and that this value is rigidly confirmed by the observations of other German observers.

This period exactly agrees with that obtained by Mr. Denning as a mean of all the published observations, and, as that observer points out in a communication to the above-named journal, it indicates that the various belts and zones on Saturn have different rotation periods in a manner similar to those of Jupiter.

The recent disturbances on Saturn have now practically subsided, and can only be seen with the larger instruments.

The Broadening of Spectral Lines.—In a paper communicated to No. 34 vol. vi. of the *Philosophical Magazine* Mr. G. W. Walker discusses the causes which lead to the asymmetrical widening of spectral lines.

Taking it for granted that near to a luminous source, whether the luminosity be produced by electricity or by flame at high temperature, there must be a number of free negatively charged particles, he proceeds to show how these particles may modify the light which they receive, and again scatter it in a manner quite different to that obtaining in the "Doppler" or in any "damping" effect. These charged particles, under the influence of the plane waves, will then vibrate with a period different from that of the incident waves; thus, instead of homogeneous light, there will be a portion of the light scattered by the charged particles, and this portion will have a longer wave-length than the original light, its intensity varying in proportion to the number of freely charged particles present. This, however, does not account for those rare cases where the broadening takes place on the violet side of the normal line. To explain these cases Mr. Walker suggests that the continuous streams of charged particles will set up a magnetic field which may produce the Zeeman effect, in which Zeeman has frequently noted asymmetrical broadening towards the violet. Where this latter effect is greater than the former, then the broadening takes place on the violet edge of the original line.

The Spectrum of Hydrogen.—With the purpose of elucidating the connection between the "four-line" spectrum and the "many-line" spectrum of hydrogen, Mr. Louis A. Parsons, of the Johns Hopkins University, has made a series of experiments dealing with the spectrum of hydrogen obtained under many various conditions, and has embodied his results in a paper communicated to No. 2 vol. xviii. of the *Astrophysical Journal*.

After discussing the various theories which have previously been put forward in explanation of the phenomena, and dealing especially with that of Prof. Trowbridge, who supposes that the line spectrum is due to water vapour, and not to hydrogen pure and simple, Mr. Parsons describes the various pieces of apparatus he used and the experiments he performed, and then summarises his results in the following conclusions:—(1) The compound spectrum never occurs without the line spectrum, although the latter may occur alone at high pressures; (2) the line spectrum is characteristic of an abruptly oscillatory discharge, whilst the compound spectrum is produced by the continuous discharge; (3) the line spectrum may be produced by high temperatures occurring *locally* at points where the disruptive discharge occurs, but it is not due to the high temperature of the gas considered as a whole.

In regard to the fourth point, viz. the action of water vapour in producing the line spectrum, the experiments showed that the presence of moisture is an important factor in the production of this type of spectrum, but they do not lead to Prof. Trowbridge's conclusion that it is the spectrum of water vapour. Mr. Parsons is inclined to believe that the ionisation of the atoms, as they enter or leave the water molecule, may set up a distinct local oscillatory discharge, which he previously shows to be necessary for the production of the line spectrum.

THE ORBIT OF ξ BOÖTIS.—In a previous computation of the orbit of ξ Boötis, by Prof. W. Doberck, the elements obtained represented the observed angles up to the year 1888, but did not faithfully represent the observed distances for some time prior to that (*Astronomische Nachrichten*, No. 2129). It now appears that the angles might be represented by orbits having widely differing periods, so the same observer has recomputed the elements, mainly using the measured distances as is done in the case of η Cassiopeia. Using Thiele's method, which he recommends especially in the case of very eccentric orbits, he obtained the following elements, referred to the equinox of 1900·0, from normal places for 1836·5, 1876.5, and 1896·5 (*Astr. Nach.*, No. 3900):—

$\Omega = 183^\circ\ 8'$	$P = 140{\cdot}84$ years.
$\lambda = 314\ \ 6$	$T = 1907{\cdot}10$
$\gamma = 46\ \ 8$	$a = 5''{\cdot}115$
$e = 0{\cdot}6163$	Retrograde.

IN the *Memorie* of the Italian Spectroscopists' Society Mr. G. Boccardi gives a list of errata in various star catalogues and trigonometric tables which he discovered in the course of compiling the catalogue of stars of reference in the zone 46° to 55°, published by the Observatory of Catania. In addition, the same writer gives corrections for the ephemerides of the asteroid 292 Ludovica. An Italian translation, by Mr. A. Mascari, of Dr. W. J. S. Lockyer's paper on a probable relation between the solar protuberances and the corona is also published in the *Memorie* of the Society.

OPENING OF THE MEDICAL SCHOOLS.

AS usual at this time of the year, introductory addresses have been delivered during the past week at the opening of the various medical schools in different parts of the country. Some of these addresses are summarised below.

At the opening of the medical session at University College, London, on Monday, Prof. E. H. Starling, F.R.S., pleaded for the establishment of a post-graduate school of medicine. He remarked that the crying need at the present time was clinical research, which must be carried out in hospitals by men trained in scientific methods and willing to spend laborious days in their application to the problems of disease. The absence of workers who might utilise to the full the great mass of material presented by our hospitals was due to two factors, namely, the absence of academic ideals in London, and the lack of any adequate provision which might enable our best men to devote their early years to the advance of their profession by conscientious study and research. Prof. Starling advocated the foundation, in the University of London, of a school specially devoted to the advancement of medicine. Such postgraduate school must be in connection with a hospital, and might be founded by a modification of one of the existing medical schools, or be created *de novo* in connection with some general hospital. Forming part of the school should be laboratories for experimental physiology and pathology, for bacteriology, for medical chemistry, and for normal and morbid histology. In addition to the experimental department, there should be, preferably in the hospital building itself, a series of observational laboratories, where the conditions of the patients could be investigated with a scientific precision. Such a school could detract in no way from the present advantages of our medical schools, but would rather add to their efficiency.

Sir Victor Horsley delivered an address on the subject of university education at the University of Birmingham on Monday. In the course of his remarks he urged the necessity for a multiplication of universities, and deprecated Sir W. Anson's dictum that what was wanted before universities was "an intelligent population." Under the present Government the whole direction of the Education Department had been placed in the hands of those whose ideas were regulated by the sterile training in dead languages and somewhat moribund systems of philosophy, unfortunately characteristic of an old university like Oxford. It did not seem to have occurred to the Parliamentary Secretary to the Board of Education that to the ordinary person the more obvious way of obtaining an intelligent population was to provide them with the highest and best means of educating themselves, and to increase and multiply those means in the midst of each populous district. It seemed to him shocking that the leading expert of the Education Department should hostilely attack not merely the present evolution of universities, but also the very earnest and carefully thought out propositions which the president of the British Association recently put forward with fresh force and interest. It had been reserved for Sir William Anson to raise the barren and worn-out strife between classical and scientific education. How could the physical science laboratories of our universities be considered to be too favoured by public opinion, as Sir William asserted, when their equipment and buildings left so much to be desired, and their endowments were so meagre that some 24 millions, it was estimated, must be expended to bring them into line with the universities of America? It was most unfortunate for the nation that the educational policy of the present Government was directed by officials holding such reactionary views. Let them hope that when the greatest statesman of our generation was placed by the country in his proper position as Prime Minister and leader of the nation a change would come over the spirit of the Education Department. The nation was under the delusion that universities flourished, first, on private endowments and benevolence; and, secondly, on the fees of students. Legislation to provide State aid for the universities was a duty which pressed heavily on a Government which did nothing to protect the people from the injury of drink and the waste of money which the drinking habit entailed. He suggested that the universities should cooperate in pressing a definite programme of State aid.

The first autumn term of the faculty of medicine at the University of Liverpool was inaugurated by Sir Dyce Duckworth, who, during an address on reverence and hopefulness in medicine, told the students that to equip themselves fittingly for the profession of medicine would demand some knowledge of the several sciences on which the science and art of medicine are based. Those who have had experience as examiners know well the difference, said Sir Dyce Duckworth, between candidates who have had the benefit of a liberal education before they entered upon medical study, and those who, although showing aptitude, have not had that advantage. It is the difference between efficiency and expertness, between width and narrowness.

Dr. J. W. Swan, F.R.S., gave the introductory address to the school of pharmacy of the Pharmaceutical Society. The events of the last sixty years, he said, showed conclusively that our want of thoroughness in education and the consequent want of imagination and capacity to appreciate the value of scientific research had caused us immense national loss. Dr. Elizabeth M. Pace, in addressing the students of the London School of Medicine for Women in connection with the Royal Free Hospital, gave an interesting historical sketch of the growth of facilities for the medical education of women during the last sixty years. At the Middlesex Hospital Mr. Justice Wills presided at the opening of the session, and Mr. William Hern, in welcoming the new students, pointed out that one of the great differences between the medical methods of past and present times was the substitution for the old empiricism, of treatment based upon an inquiry into the causes of disease. Mr. J. A. Bloxam, in the inaugural address at the Royal Veterinary College, told the students that if veterinary education was to march with the times, and if this country was to bear its part in the advancement of veterinary knowledge in the future, the State must follow the example set by other countries and contribute handsomely to the equipment and upkeep of the veterinary schools.

THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY A. C. SEWARD, F.R.S., FELLOW AND TUTOR OF EMMANUEL COLLEGE, LATE FELLOW OF ST. JOHN'S COLLEGE, CAMBRIDGE; LECTURER ON BOTANY IN THE UNIVERSITY, PRESIDENT OF THE SECTION.

IN 1883, the date of the last meeting held by the British Association at Southport, the late Prof. Williamson, of Manchester, delivered a Presidential Address before the Geological Section, in which he reviewed recent progress in palæobotanical research, with special reference to the vegetation of the Coal period. It would have been an interesting task to traverse the same ground to-day, in order to show what a vast superstructure has been built on the foundations which Williamson laid. In alluding to the controversies in which he bore so vigorous a part, Williamson spoke of the conflict as virtually over, though still reflected, "in the groundswell of a stormy past." Now that twenty years have elapsed we are able to recognise with no little satisfaction that his views are firmly established, and that the debt which we owe to his able interpretation of the relics of Palæozoic plant-life is universally acknowledged. Williamson's labours demonstrated the possibilities of microscopical methods in the investigation of Carboniferous plants; but at the time of publication his results did not receive that attention which their importance merited, and it is only in recent years that botanists have been induced to admit the necessity of extending their observations to the buried treasures of bygone ages. We have been slow to realise the truth of the following statement, which I quote from an able article on Darwinism in the *Edinburgh Review* for October of last year: "The recognition of the fact that in every detail the present is built on the past has invested the latter with a new title to respect, and given a fresh impulse to the study of its history." The anatomical investigation of extinct types of vegetation has done more than any other branch of botanical science in guiding us along the paths of plant-evolution during the earlier periods of the earth's history.

I cannot conclude this brief reference to Williamson's work without an expression of gratitude for the help and encouragement with which he initiated me into the methods of palæobotanical research.

FLORAS OF THE PAST: THEIR COMPOSITION AND DISTRIBUTION.

Introduction.

It is by no means easy to make choice of a subject for a presidential address. There is the possibility—theoretical rather than actual—of a retrospective survey of modern developments in the botanical world, and the opportunity is a favourable one for passing in review recent progress in that department of the science which appeals more especially to oneself. In place of adopting either of these alternatives, I decided to deal in some detail with a subject which, it must be frankly admitted, is too extensive to be presented adequately in a single address. My aim is to put before you one aspect of palæobotany which has not received its due share of attention: I mean the geographical distribution of the floras of the past. In grappling with this subject one lays oneself open to the charge of attempting the impossible—a not unusual characteristic of British Association addresses. I recognise the futility of expecting conclusions of fundamental importance from such an incomplete examination of the available evidence as I have been able to undertake; but a hasty sketch may serve to indicate the impressions likely to be conveyed by a more elaborate picture.

One difficulty that meets us at the outset in approaching the study of plant distribution is that of synonymy. "The naturalist," as Sir Joseph Hooker wrote in his "Introductory Essay to the Flora of New Zealand," "has to seek truth amid errors of observation and judgment and the resulting chaos of synonymy which has been accumulated by thoughtless aspirants to the questionable honour of being the first to name a species." Endless confusion is caused by the use of different generic and specific names for plants that are in all probability identical, or at least very closely allied. Worthless fossils are frequently designated by a generic and specific title: an author lightly selects a new name for a miserable fragment of a fossil fern-frond without pausing to consider whether his record is worthy of acceptance at the hands of the botanical palæographer.

An enthusiastic specialist is apt to exaggerate the value of his material, and to forget that lists of plants should be based on evidence that can be used with confidence in investigations involving a comparative treatment of the floras of the world. As Darwin said in the "Origin of Species": "It is notorious on what excessively slight differences many palæontologists have founded their species; and they do this the more readily if the specimens come from different substages of the same formation." It would occupy too much time to refer to the various dangers that beset the path of the trustful student, who makes use of published lists of local floras in generalising on questions of geographical distribution during the different eras of the past. Such practices as the naming of undeterminable fragments of leaves or twigs, the frequent use of recent generic names for fossil specimens that afford no trustworthy clue as to affinity, belong to the class of offences that might be easily guarded against; there are, however, other obstacles that we cannot expect to remove, but which we can take pains to avoid. An author in naming a fossil plant may select one of several generic names, any of which might be used with equal propriety; individual preferences assert themselves above considerations as to the importance of a uniform nomenclature. The personal element often plays too prominent a part. To quote a sentence from a non-scientific writer: "The child looks straight upon Nature as she is, while a man sees her reflected in a mirror, and his own figure can hardly help coming into the foreground."

In endeavouring to take a comprehensive survey of the records of plant-life, we should aim at a wider view of the limits of species and look for evidence of close relationship rather than for slight differences, which might justify the adoption of a distinctive name. Our object, in short, is not only to reduce to a common language the diverse designations founded on personal idiosyncrasies, but to group closely allied forms under one central type. We must boldly class together plants that we believe to be nearly allied, and resist the undue influence of considerations based on supposed specific distinctions.

The imperfection of the Geological record was spoken of by one of England's greatest geologists, in a criticism of the "Origin of Species," as "the inflated cushion on which you try to bolster up the defects of your hypothesis." On the other hand, Darwin wrote, in 1861: "I find, to my astonishment and joy, that such good men as Ramsay, Jukes, Geikie, and one older worker, Lyell, do not think that I have in the least exaggerated the imperfection of the record." No one in the least familiar with the conditions under which relics of vegetation are likely to have been preserved can for a moment doubt the truth of Darwin's words: "The crust of the earth, with its embedded remains, must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals."

As a preliminary consideration, we must decide upon the most convenient means of expressing the facts of geographical distribution in a concise form. The recognised botanical regions of the world do not serve our purpose; we are not concerned with the present position of mountain-chains or wide-stretching plains that constitute natural boundaries between one existing flora and another, but simply with the relative geographical position of localities from which records of ancient floras have been obtained. In the accompanying map I have divided the surface of the earth into six belts, from west to east. The most northerly or *Arctic Belt* includes the existing land-areas as far south as latitude 60°, comprising—1, Northern Canada; 2, Greenland and Iceland; 3, Northern Europe; 4, Bear Island and Spitzbergen; 5, Franz Josef's Land; 6, Northern Asia. The *North Temperate Belt*, extending from latitude 60° to 40°, includes—7, South Canada and the northern United States; 8, Central and Southern Europe; 9, Central Asia. The *North Subtropical Belt* comprises the land between latitude 40° and the Tropic of Cancer, including—10, the Southern States of North America; 11, Northern Africa, part of Arabia and Persia; 12, Thibet and part of China; 13, Japan. The *Tropical Belt*, embracing the land-areas between the Tropics of Cancer and Capricorn, includes—14, Central America and the northern part of South America; 15, Central Africa and

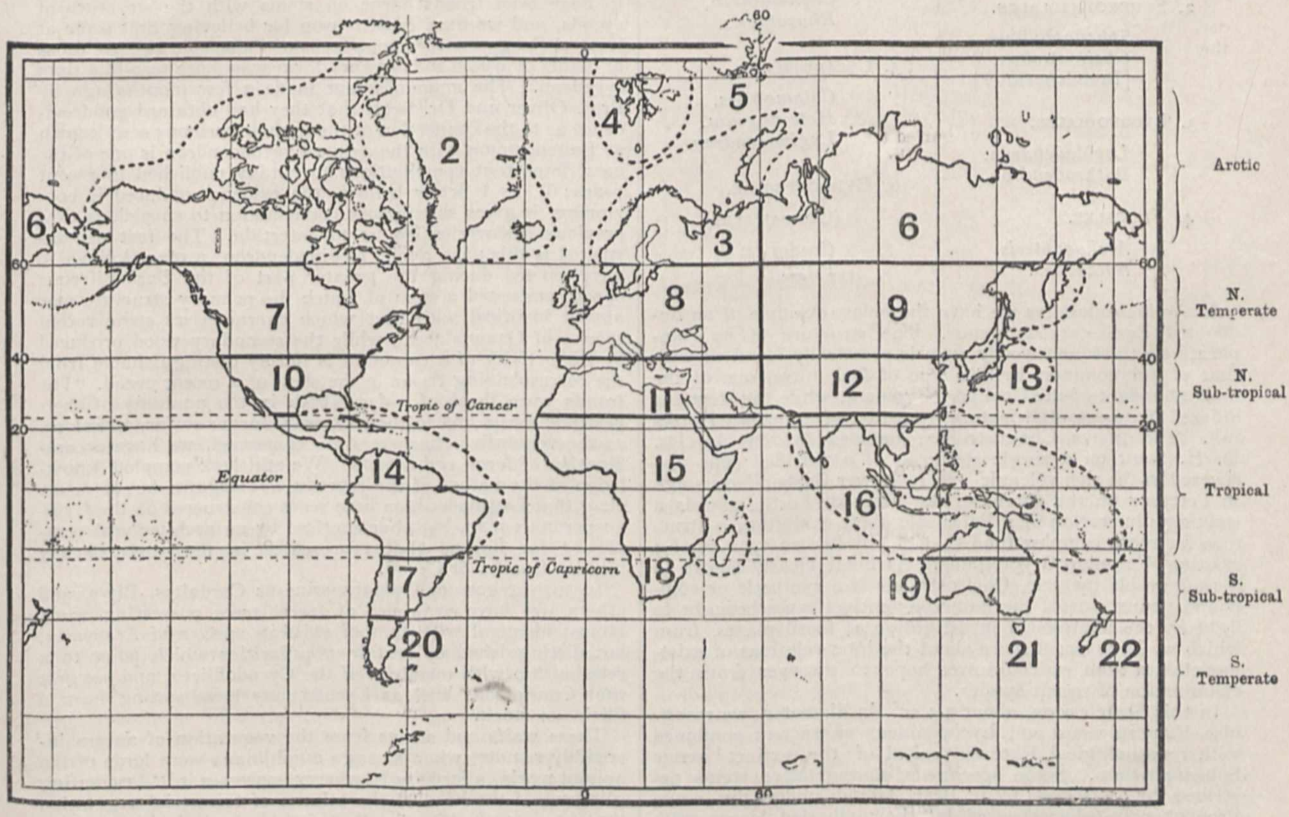
Madagascar; 16, India, the Malay Archipelago, and Northern Australia. The *South Subtropical Belt*, extending from the Tropic of Capricorn to latitude 40° south, includes—17, Central South America; 18, South Africa; 19, Central and Southern Australia. The *South Temperate Belt* includes—20, the extreme south of South America; 21, Tasmania; 22, New Zealand.

Pre-Devonian Floras.

The scanty records from pre-Devonian rocks afford but little information as to the nature of the vegetation that existed during the period in which were deposited the Cambrian, Ordovician, and Silurian strata that now form the greater portion of the Welsh and Cumberland hills. We must wait for further discoveries before attempting to give more than the barest outline of the plant-life of these remote epochs. Our knowledge of the plant-world which existed during the Silurian period is far too meagre to justify any statement as to geographical distribution. Of the few records of supposed Silurian plants, several have been shown to be unsatisfactory, and the nature of others is too uncertain to admit of accurate identification. The Lepidodendron-like fossil from the Clinton limestone of Silurian age in Ohio, described by Claypole in 1878 as Glyptodendron, has been referred by a later writer to a Cephalopod. Stur's Bohemian plants, described in 1881, are too imperfect to afford any information of botanical value; while the ferns and lepidodendroid plants recently recorded by Potonié from the Hartz Mountains are more likely to be of Devonian than Silurian age.

The genus Nematophycus, originally described by Dawson as Prototaxites, and afterwards referred by Carruthers to the Algæ, constitutes the most satisfactory example of a Silurian plant. This genus, which has fortunately been preserved in such a manner as to admit of minute microscopical examination, represents a widely spread algal type in Silurian and Devonian seas. It has been found in Silurian strata in Wales, Shropshire, and New Brunswick; also in Devonian rocks of Eastern Canada, New York, Ohio, and North-West Germany. The tubular elements composing the stems of some species of Nematophycus—which reached a diameter of 2 or 3 feet—exhibit a regular variation in width, giving the appearance of concentric rings of growth, as in the stems of the tree-like Lessonia, an existing genus of Antarctic seaweeds. This structural feature presents an impressive image in stone of a plant's rhythmical response to some periodically recurring conditions of growth in the waters of Palæozoic seas.

MAP I.—The Earth's Surface divided into Areas (1–22) for convenience in recording the Geographical Distribution of Fossil Plants.



Devonian and Lower Carboniferous Floras.

The earliest plants that have been found in sufficient number, and in a state of preservation which renders their identification possible, are those from Devonian rocks. From Bear Island, a small remnant of land situated within the Arctic circle, the late Prof. Heer described several Devonian plants; and more recently Prof. Nathorst, of Stockholm, has given a full account of this interesting and comparatively rich flora. The relics of plant-life preserved in this Arctic island carry us back through countless ages to a time when a luxuriant vegetation flourished in a region now occupied by ice-bound land and polar seas. As Edward Fitzgerald said, in speaking of his enjoyment of some geological book: "This vision of time is in itself more wonderful than all the conceptions of Dante and Milton." Devonian plants have been described by Feistmantel, Etheridge, and others from Australia; and the well-known Kiltorkan grits of Ireland have supplied a few well-preserved impressions of the oldest land-plants disinterred from British rocks.

As my aim is to sketch in broad outline the general facies of the vegetation which flourished at different stages in the earth's history, rather than to undertake a critical examination of the evidence as to the precise geological age of the plant-bearing beds, I propose to treat of Devonian and Lower Carboniferous floras as constituting one phase in the evolution of the plant-world. In speaking of the plants of the Devonian and Lower Carboniferous or Culm phase, it is not assumed that the specimens entombed in the snow-covered cliffs of Bear Island were actually contemporaneous with those found in rocks of the same geological period in the Southern hemisphere. The Bear Island rocks are, in the language which Huxley taught us to use, homotaxial with certain Devonian plant-bearing strata in other parts of the world; they occupy the same relative position in the geological series.

Homotaxy by no means implies contemporaneity; indeed, the late Edward Forbes maintained that similarity of organic contents of distant formations should be accepted as *prima facie* evidence of a difference in age.

What do we know as to the composition of the floras that flourished in the later stages of the Devonian and in the latter part of the Carboniferous era? The following list, which is by no means exhaustive, represents some of the more important generic types which may be very briefly described:—

1. EQUISETALES.
   Archaeocalamites.

2. SPHENOPHYLLALES.
   Sphenophyllum.
   Cheirostrobus.
   [*Pseudobornia?*]

3. LYCOPODIALES.
   Lepidodendron.
   Bothrodendron.

4. FILICALES.
   Archaeopteris.
   Adiantites.
   Rhodea.
   Cardiopteris.
   Todeopsis.
   Cephalotheca.
   Rhacopteris.

5. CYCADOFILICES.
   Calamopitys.
   Heterangium.
   Lyginodendron.

6. GYMNOSPERMÆ.
   (CORDAITALES).
   Cordaites.
   Pitys.

In Archæocalamites we have the oldest example of an undoubted Equisetaceous genus. The structure of its comparatively thick and woody stem is practically identical with that of our common British type of Calamites, one of the most abundant of the Coal period genera, while the strobilus differed in no essential feature from that of a modern Horsetail. The genus Cheirostrobus, founded in 1897 by Dr. D. H. Scott on a single specimen of a petrified cone discovered in the rich volcanic beds of Lower Carboniferous age at Pettycur on the shores of the Firth of Forth, affords a striking illustration of a Palæozoic plant exhibiting a structure far more complex than that of any known type among existing Vascular Cryptogams. As Scott clearly shows in his admirable memoir, Cheirostrobus is a synthetic or compound genus, one of the numerous extinct types brought to light by the anatomical investigation of fossil plants, from which we have learnt more about the inter-relations of existing classes than we could ever hope to discover from the examination of recent species.

In this Scotch cone, about 3·5 cm. in diameter, we recognise Equisetaceous and Lycopodinous characters combined with morphological features typical of the extinct genus Sphenophyllum. Some specimens of vegetative stems described by Nathorst from Bear Island under the name Pseudobornia—characterised by their whorled leaves with fimbriate blades borne on nodal regions separated by long internodes—may, as Scott has suggested, represent the branches of the tree of which Cheirostrobus was the cone. Both Devonian and Culm rocks have furnished many examples of Lycopodinous plants. The genus Bothrodendron, closely allied in habit to Lepidodendron, has been recorded from Bear Island, Ireland, and Australia, and the cuticles of a Lower Carboniferous species form the greater portion of the so-called paper-coal of Tula in Russia. Lepidodendron itself had already attained to the size of a forest tree, with anatomical features precisely similar to those of the succeeding Coal period species.

Our knowledge of the ferns is not very extensive. The genus Archæopteris from Ireland, Belgium, Bear Island, and North America has always been regarded as a fern, but we must admit the impossibility of accurately determining its systematic position until we possess a fuller knowledge of the reproductive organs and of its anatomical structure. Similarly the genera Rhacopteris, Adiantites, and Rhodea, with other characteristic members of the Lower Carboniferous vegetation, may be provisionally retained among the oldest known ferns. The genus Cardiopteris—a plant with large oblong or orbicular pinnules borne in two rows on a stout rachis—is known only in a sterile condition, and it is quite as likely that its reproductive organs may have been of the Gymnospermous as of the Filicinean type.

Renault has described under the name Todeopsis some petrified sporangia which appear to be practically identical with those of existing Osmundaceæ, and a new Devonian genus Cephalotheca has been instituted by Nathorst for fertile specimens of a strange type of plant which he refers to the Marattiaceæ. Of much greater importance than the sterile fern-like fronds, which cannot be assigned with confidence to a definite position, are the petrified remains of stems and leaves of such plants as Heterangium, Lyginodendron, Calamopitys, and others which demonstrate the existence of a class of synthetic genera combining Filicinean and Cycadean characters. These plants are of exceptional interest as showing beyond doubt that Ferns and Cycads trace their descent from a common ancestry. Some of the supposed ferns from Lower Carboniferous rocks are known to have been fronds borne on stems with the structure of cycads, and we have good reason for believing that some at least of the gymnospermous seeds of Palæozoic age are those of plants of which the outward form was more fern-like than cycadean. The announcement made a few months ago by Prof. Oliver and Dr. Scott that they had obtained good evidence as to the connection of the gymnospermous seed known as Lagenostoma with the genus Lyginodendron is one of the most important contributions to botany published in recent years; if, as I firmly believe, the evidence adduced is convincing, it gives satisfactory confirmation to suspicions that previous discoveries led us to entertain. The fact demonstrated is this: the genus Lyginodendron, a plant known to have existed during the greater part of the Carboniferous epoch, possessed a stem of which the primary structure was almost identical with that which characterises some recent species of Osmundaceæ, while the secondary wood produced by the activity of a cambium is hardly distinguishable from the corresponding tissue in the stem of a recent cycad. The fronds were those of a fern, both in the anatomy of their vascular tissue and in their external form; so far, therefore, as the vegetative characters are concerned, we have a combination of ferns and cycads. We still lack complete knowledge of the nature of the reproductive organs, but it seems clear that Lyginodendron bore seeds constructed on the Gymnospermous plan, but characterised by an architectural complexity far beyond that represented in the seeds of any modern Conifer or Cycad.

In such genera of Gymnosperms as Cordaites, Pitys, and others, we have examples of forest trees possessing wood almost identical with that of existing species of Araucaria, but distinguished by certain peculiarities which point to a relationship with members of the Cycadofilices, and suggest that Conifers as well as Cycads may have sprung from a filicinean stock.

These waifs and strays from the vegetation of an era incredibly remote, when strange amphibians were lords of the animal world, afford, as Newberry expresses it, "fascinating glimpses of the head of the column of terrestrial vegetation that has marched across the earth's stage during the different geological ages."

Two facts stand out prominently as the result of a general survey of what are practically the oldest records of plant-life. One is the abundance of types which cannot be accommodated in our existing classification founded solely on living plants.

The Devonian and Lower Carboniferous plants lead us away from the present along converging lines of evolution to a remote stage in the history of life; they bring us face to face with proofs of common origins, which enable us to recognise community of descent in existing groups between which a direct alliance is either dimly suggested or absolutely unsuspected if we confine our investigations to modern forms. We recognise, moreover, in such a plant as Archæocalamites an ancestor from which we may derive in a direct line the existing members of the Equisetales. In other types, by far the greater number, we see striking examples of Nature's many failures, which, after reaching an extraordinary complexity of organisation, gave place to other products of evolution and left no direct descendants.

Another fact that seems to stand out clearly is the almost world-wide distribution of several characteristic Lower Carboniferous plants. The accompanying table (Table I.), based on the artificial divisions marked out on the map, to which reference has already been made, shows how widely some of the plants had migrated from an unknown centre far back in a still more remote age. We are, as yet, unable to follow these Devonian plants to an earlier stage in their evolution. We are left in amazement at their specialised structure and extended geographical distribution, without the means of perusing the opening chapters of their history.

I. *Devonian and Lower Carboniferous Floras.—Table showing the Geographical Distribution of a few Characteristic Genera.*

Characteristic Types	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EQUISETALES																						
Archaeocalamites radiatus				×			×	×									×		×			
Calamites								×														
SPHENOPHYLLALES																						
Sphenophyllum				×				×														
Cheirostrobus								×														
LYCOPODIALES																						
Lepidodendron				×				×									×	×	×			
Bothrodendron				×			×	×											×			
FILICALES (?)																						
Archaeopteris				×			×	×											×			
Adiantites				×			×	×														
Rhacopteris								×									×		×			
Rhodea				×				×														
Cardiopteris				×				×														
CYCADOFILICES																						
Lyginodendron								×														
Heterangium								×														
CORDAITALES																						
Cordaites							×					×					×					

Upper Carboniferous (Coal-measures) and Permian Floras.

From the Lower Carboniferous formation we pass on to the wealth of material afforded by the Upper Carboniferous and Permian rocks. From the point of view of both botanists and geologists, the fossil plants obtained from the beds associated with the coal are of greater interest and importance than those of any other geological period. By a fortunate accident our investigations are not restricted to the examination of carbonaceous impressions and sandstone casts left by the stems and leaves of the Coal-period plants. By means of thin sections cut from the calcareous nodules of the coal-seams of Yorkshire and Lancashire, and from the silicified pebbles of France and Saxony, it is possible to make anatomical investigations of the coal-forest trees with as much accuracy as that with which we can examine sections of recent plants. The differences between the vegetation that witnessed the close of the Carboniferous era and that which flourished during the opening stages of the succeeding Permian epoch are comparatively slight. It has been demonstrated by Grand'Eury, Kidston, Zeiller, Potonié, and others, that it is possible both to separate the floras of the Coal-measures from those of Lower Permian age, and to use the plant species as trustworthy guides to the smaller subdivisions of the Coal-measures; but apart from these minor differences, the general facies of the vegetation remained fairly constant during the Upper Carboniferous and Lower Permian periods.

The vast forests of the Coal age occupied an extensive area of land on the site of the present United States of North America, stretching across Europe into Eastern Asia; under the shade of their trees lived "the stupid, salamander-like Labyrinthodonts, which pottered with much belly and little leg, like Falstaff in his old age." The plants of these Palæozoic forests seem to be revivified, as we subject their petrified fragments to microscopical examination. Robert Louis Stevenson has referred to a venerable oak, which has been growing since the Reformation and is yet a living thing liable to sickness and death, as a speaking lesson in history. How much more impressive is the conception of age suggested by the contemplation of a group of Palæozoic tree-stumps exposed in a Carboniferous quarry and rooted where they grew! An examination of their minute anatomy carries us beyond the mere knowledge of the internal architecture of their stems, leaves, and seeds; it brings us into contact with the actual working of their complex machinery. As we look at the stomata on the lamina of a leaf of one of those strange trees, and recognise a type of structure in the mesophyll-tissues which has been rendered familiar by its occurrence in modern leaves, it requires but little imagination to see the green blade spreading its surface to the light to obtain a supply of solar energy with which to extract carbon from the air. We can almost hear the murmur of plant-life and the sighing of the branches in the wind as the sap courses through the wood, and the leaves build up material from the products of earth and air; products that are to be sealed up by subsequent geological changes, until after the lapse of countless ages the store of energy accumulated in coal is dissipated through the agency of man.

The minute structure of the wood of the Calamites, Lycopods, and other trees, agrees so closely with that of existing types that we are forced to conclude that these Palæozoic plants had already solved the problem of raising a column of water more than 100 feet in height. The arrangement of the strengthening or mechanical tissues in the long flat leaves of Cordaites is an exact counterpart of that which we find in modern leaves of similar form. The method of disposition of supporting strands in such manner as to secure the maximum effect with the least expenditure of material was as much an axiom in plant architecture in the days of the coal-forests as it is now one of the recognised rules in the engineer's craft.

We need not pause to discuss the various opinions that have been expressed as to the conditions under which the forests grew; we may adopt Neumayr's view, and recognise a modern parallel in the moors of the sub-arctic zone, or find a close resemblance in the dismal swamp of North America. There is also the view expressed many years ago by Binney and warmly advocated by Darwin, that some at least of the Coal-period trees grew in salt-marshes, an opinion which receives support from several structural features suggestive of xerophytic characters recognised in the tissues of Palæozoic plants.

Time does not admit of more than the most cursory glance at the leading types of the Permo-Carboniferous floras. The general character of the preceding vegetation is retained with numerous additions. Archæocalamites is replaced by a host of representatives of the genus Calamites, an Equisetaceous type with stout woody stems and several forms of cones of greater complexity than those of modern Horsetails. Side by side with the Calamites there appear to have existed plants which, from their still closer agreement with Equisetum, have been described by Zeiller, Kidston, and others as species of Equisetites. The genus Sphenophyllum, a solitary type of an extinct family, was represented by several forms which, like the Galium of our hedgerows, may have supported their slender branches against the stems of stronger plants. Lycopods, with trunks as thick and tall as forest trees, were among the most vigorous members of the later Palæozoic forests. Although recent research has shown that several of the supposed ferns must be assigned to the Cycad-fern alliance, there can be no doubt that true ferns had reached an advanced state of evolution during the Permo-Carboniferous epoch. The abundance of petrified stems of the genus Psaronius, of which the nearest living representatives are probably to be found among the tropical Marattiaceæ, demonstrates the existence of true ferns. Others had more slender stems which clambered over the trunks of stouter trees, while some grew in the shade of Lepidodendron and Cordaites. The most striking fact as regards the Permo-Carboniferous ferns is the abundance of fertile fronds bearing sporangia which exhibit a more or less close agreement with those of the few surviving genera of Marattiaceæ. The more familiar type of sporangium met with in our existing fern-vegetation is also represented, and we have recently become familiar with several genera bearing sporangia exhibiting a close resemblance to those of modern Gleicheniaceæ, Schizæaceæ, and Osmundaceæ. The sporangial characteristics of the different families of living ferns are many of them to be found among Palæozoic types, but there is a frequent commingling of structural features showing that the ferns had not as yet become differentiated into so many or such distinct families as have since been evolved.

Prominent among the Gymnosperms of the Palæozoic forests must have been the genus Cordaites: tall handsome trees, with long strap-shaped leaves, recalling on a large scale those of the kauri pine of New Zealand. This genus, which has been made the type of a distinct group of Gymnosperms, combined the anatomy of an Araucaria with reproductive organs more nearly allied to the flowers of Cycads, and exhibiting points of resemblance with those of the Maidenhair-tree. It is not until the later stages of the Permo-Carboniferous epoch that more definite coniferous types make their appearance. The genus Walchia, in habit almost identical with *Araucaria excelsa*, the Norfolk Island pine, with Ulmannia and Voltzia, are characteristic members of the vegetation belonging to the later phase of the Permo-Carboniferous era. The Maidenhair-tree of the far East, one of the most venerable survivors in our modern vegetation, is foreshadowed in certain features exhibited by Cordaites and, as regards the form of its leaves, by Psygmophyllum, Wittleseya, and other genera. Psygmophyllum is known to have existed in Spitzbergen in the preceding Culm epoch, and Wittleseya occurs in Canadian strata correlated with our Millstone Grit. Leaves have been found in Permian rocks of Russia, Siberia, Western and Central Europe, referred to the genus Baiera, a typical Mesozoic type closely allied to Ginkgo. In the upper Coal-measures and lower Permian rocks a few pinnate fronds have been discovered, such as Sphenozamites, from the Permian of France, Pterophyllum from France and Russia, and Plagiozamites from the Permian of Alsace, which bear a striking likeness to modern Cycadean leaves. Throughout the Permo-Carboniferous era the Cycadofilices formed a dominant group; Lyginodendron, Medullosa, Poroxylon, and many other genera flourished in abundance as vigorous members of an ancient class which belongs exclusively to the past.

One distinctive characteristic of the vegetation of later Permo-Carboniferous days is the occurrence of the Cycad-like fronds already referred to; also the appearance of Voltzia and other conifers with species of Equisetites, pioneer genera of a succeeding era that constitute connecting links between the Palæozoic and Mesozoic floras.

What we may call the typical vegetation of the Coal-measures, which continued, with comparatively minor changes, into the succeeding era, flourished over a wide area in the northern hemisphere, suggesting, as White points out, an almost incredible uniformity of climate. The same type of vegetation extended as far south as the Zambesi in Africa, and to the vast coal-fields of China; it possibly existed also in high northern latitudes, but, since Heer's record of Cordaites in Novaya Zemlya in 1878, no further traces of arctic Permo-Carboniferous plants have been found. Calamites, Lepidodendron (with its near relative Sigillaria), Ferns, Cycadofilices, Cordaites, and other Gymnosperms, constitute the most familiar types. We have already noticed the existence in the southern hemisphere of Lower Carboniferous and Devonian genera identical with plants found in rocks of corresponding age within the Arctic circle. This agreement between the northern and southern floras was, however, not maintained in the later stages of the Palæozoic epoch. Australian plant-bearing strata homotaxial with Permo-Carboniferous rocks of Europe, have so far afforded no examples of Sigillaria, Lepidodendron, or of several other characteristic northern forms; in place of these genera we find an enormous abundance of a fern known as Glossopteris, a type which must have monopolised wide areas, suggesting a comparison with the green carpet of bracken that stretches as a continuous sheet over an English moor. With Glossopteris was associated a fern bearing similar leaves, known as Gangamopteris, and with these grew Schizoneura and Phyllotheca, members of the Equisetales. In addition to these genera there are others which bear a close resemblance to northern hemisphere types, such as Noeggerathiopsis, a member of the Cordaitales, and several species of Sphenopteris. Similarly, in many parts of India, Glossopteris has been found in extraordinary abundance in the same company with which it occurs in Australia. In South Africa an identical flora is met with which extends to the Argentine and to other regions of South America. A few members of this southern flora have been recorded from Borneo, and the genus Glossopteris is said to occur in New Zealand, but the latter statement has been called in question and requires confirmation. It is clear that from South America, through South Africa and India to Australia, there existed a vegetation of uniform character which flourished over a vast southern continent at approximately the same period as that which, in the northern hemisphere and in China, witnessed the growth of the forests the trees of which formed the source of our coal-supply.

Since attention was drawn by Dr. Blanford and other writers to the facts of plant-distribution revealed by a study of the later Palæozoic floras, it has been generally admitted that during the Permo-Carboniferous era there existed two fairly well-marked botanical provinces. The more familiar and far richer flora occupied a province stretching from the western States of North America across Europe into China and reaching as far as the Zambesi; the other province was occupied by a less varied assemblage of plants, characterised by the abundance of Glossopteris, Gangamopteris, Neuropteridium, Noeggerathiopsis, Schizoneura, and other genera, stretching from South America through India to Australia.

Two questions at once suggest themselves: first, were these two botanical provinces defined by well-marked boundaries, or did they dovetail into one another at certain points? Secondly, is there any probable explanation of this difference between northern and southern floras, a feature not shown either by the preceding Devonian and Lower Carboniferous or by the succeeding Lower Mesozoic floras?

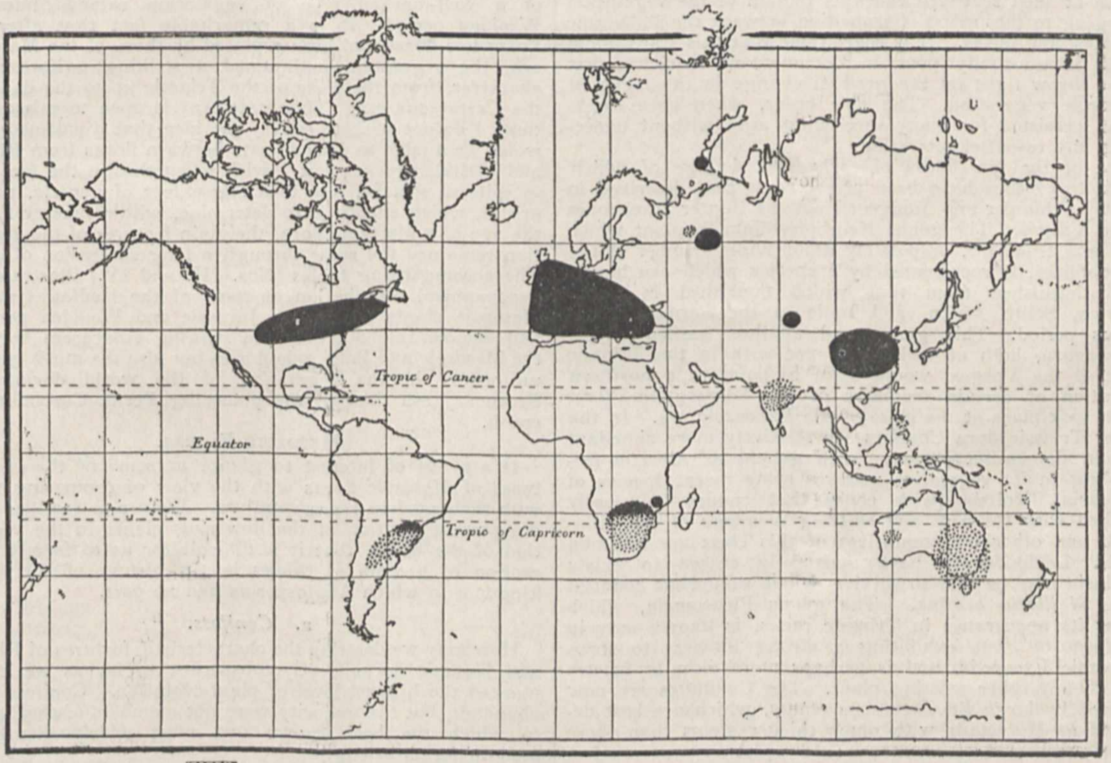
In Brazil, Prof. Zeiller has recorded the occurrence of a flora including Lepidophloios, a well-known European member of the Lycopods, associated with such characteristic southern types as Gangamopteris and Noeggerathiopsis. Similarly from the Transvaal a European species of Sigillaria, with a Lepidodendroid plant, and another northern genus, Psygmophyllum, have been found in beds containing Glossopteris, Gangamopteris, Noeggerathiopsis, Neuropteridium, and other members of the so-called Glossopteris flora. In India, the Glossopteris flora exhibits an entire absence of Lepidodendron, Calamites, Sigillaria, and other common northern genera, while Sphenophyllum is represented by a single species. The Australian Permo-Carboniferous flora is also characterised by the absence of the great majority of the northern types. Until a few years ago the genus Glossopteris had not been discovered in Europe, but in 1897 Prof. Amalitzky recorded the occurrence of this genus in association with Gangamopteris in Permian strata in northern Russia.

We see, then, that in Brazil and South Africa the Glossopteris flora and the northern flora overlapped, but the former was the dominant partner. On the other hand, in rocks belonging to a somewhat higher horizon in Russia, we meet with a northern extension of the Glossopteris flora. Map II. serves better than a detailed description to illustrate the geographical distribution of these two types of vegetation in the Permo-Carboniferous era.

There is little doubt that the differences between the flora of the southern continent, that existed towards the close of the Carboniferous and during the succeeding Permian period, and that which flourished farther north have in some respects been exaggerated; geographical separation has played too conspicuous a part in influencing botanical nomenclature. Granting the existence of identical genera or representative types, there remains a striking difference between the two provinces into which the Permo-Carboniferous vegetation was divided. As regards an explanation of this fact, we can only hazard a guess; as Dr. Blanford and others have pointed out, there is a probable solution to hand. Briefly stated, the Upper Palæozoic plant-bearing strata of India, South America, Australia, and South Africa are in close association with boulder-beds of considerable extent. In some places, as for example in India and Australia, the boulder-beds rest on rocks bearing unmistakable signs of the grinding action of ice. There can be no reasonable doubt that the huge continental area of which India, South Africa, parts of South America, and Australia remain as comparatively insignificant remnants, was exposed to climatal conditions favourable to the accumulation of snow and to the formation of glaciers. One possible explanation, therefore, of the existence of a distinct vegetation in the southern area is that the climate was such as to render impossible the existence of those coal-forest plants that exhibited so vigorous a development in northern latitudes. There is, moreover, another consideration, and that is the effect on the vegetation of an enormous continental mass; in North America and Europe it is probable that the forests grew on low-lying land penetrated by lagoons and in part submerged under shallow brackish water, a disposition of land and sea very different from that in the so-called Gondwana Land of the South. Possibly the apparently uniform vegetation of the Devonian and Lower Carboniferous period was unable, through stress of climatal conditions, to prolong its existence in the southern area, while in the north it continued to flourish, and as the evolution of new types proceeded in rapid succession it was not slow to colonise new areas stretching in South America and South Africa to the confines of the Glossopteris flora.

There seems good reason for assuming that the Glossopteris flora originated in the South and before the close of the Permian period, as well as in the succeeding Triassic era, pushed northward over a portion of the area previously occupied by the northern flora. This northward extension

MAP II.—Permo-Carboniferous Floras.



= *Glossopteris* (Southern Flora).
= Northern Flora.

is shown by the existence of Glossopteris in Upper Permian rocks of Russia, by the occurrence of several southern types in plant-bearing beds of the Altai mountains, and by the existence in Western Europe during the early stages of the Triassic era of such southern genera as Neuropteridium and Schizoneura.

Triassic, Jurassic, and Wealden Floras.

It is unfortunate that the records of plant-life towards the close of the Palæozoic and during the succeeding Triassic period are very fragmentary; the documents are few in number, and instead of the fairly continuous chapters in which the records of the Coal age have been preserved, we have to be content with a few blurred pages. During the Triassic period the vegetation of the world gradually changed its character; the balance of power was shifted from the Vascular Cryptogams, the dominant group of the Palæozoic era, to the Gymnosperms. It is not until we pass up the geologic series as far as the Rhætic formation, that we come to palæobotanical records at all comparable in their completeness with those of the Permo-Carboniferous era; but before considering the Rhætic vegetation we must glance at such scattered relics as remain of the vegetation belonging to the period of transition between the Palæozoic and Mesozoic facies. It is regrettable that this transitional period is unusually poor in documentary evidence that might throw light on the gradual change in the facies of Palæozoic vegetation. The new order, when once established, persisted for many succeeding ages without undergoing any essential alteration.

One of the few floras of early Triassic age of which satisfactory relics have been preserved is that described in 1844 by Schimper and Mougeot from the Bunter Sandstones of the Vosges. The genus Neuropteridium, a plant which may be a true fern, or possibly a surviving member of the Cycadofilices, is represented by a species which can hardly be distinguished from that which flourished in South America, South Africa, and India in the Permo-Carboniferous period. This genus and another southern type, Schizoneura, both of which are met with in the Triassic rocks of the Vosges, would seem to point to a northern migration of certain members of the Glossopteris flora, which took place at the close of the Palæozoic era. In the Lower Triassic flora Conifers are relatively more abundant than in the earlier periods; such genera as Albertia (resembling in its vegetative features some recent species of Araucaria), Voltzia (with cones that cannot be closely matched with those of any existing members of the Coniferæ), and other representatives of this class are common fossils. Lepidodendra have apparently ceased to exist; Sigillaria may be said to survive in one somewhat doubtful form, *Sigillaria oculina*. The genus Pleuromeia, which makes its appearance in Triassic rocks, is known only in the form of casts exhibiting a strong likeness to some Palæozoic Lycopods, and is perhaps more akin to Isoetes than to any other existing plant. The Calamites are now replaced by large Equisetaceous plants, which are best described as Horsetails with much thicker stems than those of their modern descendants.

From Recoaro in Northern Italy some of the Vosges genera have been recorded, and a few other European localities have furnished similar relics of a Triassic vegetation. Passing to the peninsula of India, we find the genus Glossopteris abundantly represented in strata which there is good reason for regarding as homotaxial with the European Trias, and the occurrence in the same beds of some other genera of Permo-Carboniferous age shows that the change in the character of the southern vegetation at the close of the Palæozoic era was much more gradual than in the north.

The comparative abundance of plant remains in the northern hemisphere in rocks belonging to the Rhætic formation, a series of sediments so named from their development in the Rhætian Alps, is in welcome contrast to the paucity of the records from the underlying Triassic strata. From Virginia and adjacent districts in the United States a rich flora has been described, which by some authors is assigned to the Keuper or Upper Triassic series, while others class it as Rhætic. A similar assemblage of plants is known also from the Lettenkohle beds of Austria which, as Stur has shown, clearly belong to the same period of vegetation as the American flora. We need not, however, concern ourselves with discussions as to the precise stratigraphical position of these American and European plant-beds, but may conveniently group together floras of Upper Triassic and Rhætic age since they exhibit but minor differences from one another. Plants of Upper Triassic or Rhætic age are known from Scania and Franconia in Europe, Virginia and elsewhere in North America, Honduras, Tonkin, Australia, South Africa, Chili, and other parts of the world.

The geographical distribution of plants of approximately Rhætic age is shown in the following table, No. II., on p. 563, which demonstrates an almost world-wide range of a vegetation of uniform character. The character of the plant-world is entirely different from that which we have described in speaking of the Palæozoic floras. Gymnosperms have ousted Vascular Cryptogams from their position of superiority; ferns, indeed, are still very abundant, but they have undergone many and striking changes, notably in the much smaller representation of the Marattiaceæ. The Palæozoic Lycopods and Calamites have gone, and in their place we have a wealth of Cycadean and Coniferous types. As we ascend to the Jurassic plant-beds the change in the vegetation is comparatively slight, and the same persistence of a well-marked type of vegetation extends into the Wealden period. It is a remarkable fact that after the Palæozoic floras had been replaced by those of the Mesozoic era, the vegetation maintained a striking uniformity of character, from the close of the Triassic up to the dawn of the Cretaceous era. This statement is open to misconception; I do not wish to convey the idea that a palæobotanist would be unable to discriminate between floras from Rhætic and Wealden rocks; but I wish to emphasise the fact that in spite of specific, and to a less extent of generic, peculiarities, which enable us to determine, within narrow limits, the age of a Mesozoic flora, the main features of the vegetation remained the same through a long succession of ages. The accompanying tables (Nos. III. and IV.) illustrate the geographical distribution of some of the leading types of Mesozoic plants during the Jurassic and Wealden periods, and demonstrate not only the striking differences between the Mesozoic and Palæozoic floras, but also the much greater uniformity in the vegetation of the world during the Secondary era than in the preceding Permo-Carboniferous epoch.

MESOZOIC FLORAS.

It may be of interest to glance at some of the leading types of Mesozoic floras with the view of comparing them with their modern representatives. We are so familiar with the present position of the flowering plants in the vegetation of the world, that it is difficult for us to form a conception of a state of things in the history of the plant-kingdom in which Angiosperms had no part.

a. *Conifers.*

How may we describe the characteristic features of Rhætic and Jurassic floras? Gymnosperms, so far as we know, marked the highest level of plant-evolution. Conifers were abundant, but the majority were not members of that group to which the best known and most widely distributed modern forms belong.

A comparison of fossil and recent conifers is rendered difficult by the lack of satisfactory evidence as to the systematic position of many of the commoner types met with in Mesozoic rocks. There are, however, certain broad generalisations which we are justified in making; such genera as the Pines, Firs, Larches, and other members of the Abietineæ appear to have occupied a subordinate position during the Triassic and Jurassic eras; it is among the relics of Wealden and Lower Cretaceous floras that cones and vegetative shoots like those of recent Pines occur for the first time in a position of importance. There are several Mesozoic Conifers to which such artificial designations as Pagiophyllum, Brachyphyllum, and others have been assigned, which cannot be referred with certainty to a particular section of the Coniferæ; these forms, however, exhibit distinct indications of a close relationship with the Araucarieæ, represented in modern floras by Araucaria and Agathis. The abundance of cones in Jurassic strata showing the characteristic features of those of recent species of Araucaria affords trustworthy evidence as to the antiquity of the Araucarieæ and demonstrates their wide geographical distribution during the Mesozoic era. At the present day the Araucarieæ comprise the two genera Araucaria and

II. *Rhaetic Floras.—Geographical Distribution of a few Characteristic Types.*

Characteristic Types	Arctic						N. Temperate			N. Sub-tropical				Tropical			S Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7		9	10	11	12	13	14	15	16	17	18	19	20	21	22
EQUISETALES																						
Equisetites Muensteri ... / *Equisetites arenaceus* ... }		×					×	×		×	×					×						
Schizoneura								×			×	×				×		×				
Phyllotheca											×								×		×	
FILICALES																						
Clathropteris ... ... / *Dictyophyllum* ... ... }							×	×			×	×				×			×			
Laccopteris								×											×			
Todites		×					×	×			×	×				×			×		×	
Taeniopteris							×	×		×	×					×		×	×			
Thinnfeldia								×								×	×	×	×		×	
Sagenopteris							×	×											×		×	
CYCADOPHYTA																						
Cycadites							×	×								×						
Podozamites		×					×	×			×					×						
Otozamites								×		×	×			×		×						
Anomozamites								×			×			×		×						
Pterophyllum		×					×	×			×			×		×			×		×	
GINKGOALES																						
Baiera ... ... / *Ginkgo* ... ... }		×					×	×			×							×	×		×	

III. *Jurassic Floras.—Geographical Distribution of Characteristic Types.*

Characteristic Types	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EQUISETALES																						
Equisetites								×					×		×	×			×			
LYCOPODIALES																						
Lycopodites								×					×			×			×			
FILICALES																						
Cladophlebis denticulata							×	×	×	×			×			×			×			×
Coniopteris						×	×	×	×			×	×			×			×			
Dictyophyllum								×	×								×					
Klukia								×					×		×							
Laccopteris								×											×			
Matonidium							×	×														
Taeniopteris								×		×		×	×			×			×			×
Todites							×	×	×			×	×									
CYCADOPHYTA																						
Nilssonia						×		×	×			×	×			×						
Otozamites								×								×	×					
Podozamites						×	×	×	×	×		×	×			×			×			
Williamsonia							×	×				×				×						
GINKGOALES																						
Baiera / *Ginkgo* }					×	×	×	×	×	×		×	×						×			
CONIFERALES																						
Araucarites								×								×			×			
Pagiophyllum							×	×		×		×			×	×						
Brachyphyllum								×							×	×	×		×			

IV. *Wealden Floras.—Geographical Distribution of Characteristic Types.*

Characteristic Types	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EQUISETALES																						
Equisetites							×	×					×									
FILICALES																						
Onychiopsis		×					×	×					×					×	×			
Matonidium							×	×														
Cladophlebis		×					×	×					×					×	×			
Sphenopteris							×	×										×				
Weichselia							×	×					×									×
Taeniopteris		×		×			×	×										×				
Laccopteris								×														
Gleichenites			×					×														
GINKGOALES																						
Baiera } *Ginkgo* }		×		×	×		×	×														
CONIFERALES																						
Sphenolepidium		×					×	×														
Araucarites							×	×														
Pinites			×					×														
CYCADOPHYTA																						
Nilssonia								×					×					×				
Otozamites		×						×														
Zamites							×	×					×					×				
Bennettites							×	×														

Agathis, the former including ten species occurring in South America and Australia, and the latter comprising four species which flourish in the Malay Archipelago, New Zealand, the Philippines, North-East Australia, and elsewhere. Sir William Thiselton-Dyer pointed out, in a lecture on plant-distribution, delivered in 1878, that the genus Araucaria appears to have been extinct in a wild state north of the Equator since the Jurassic epoch. Additional confirmation of the important status of this section of the Coniferæ is afforded by the abundance of petrified wood exhibiting Araucarian features, in both Jurassic and Wealden rocks. There is good reason to believe that the well-known Whitby jet was formed by the alteration of blocks of Araucarian wood drifted from forest-clad slopes overlooking a Jurassic estuary that occupied the site of the moors and headlands of North-East Yorkshire. Among familiar Jurassic genera, mention must be made of the genus Brachyphyllum, including species referred by some authors to Athrotaxites, represented by fragments of leafy twigs and branches bearing a striking resemblance to those of the isolated Tasmanian genus Athrotaxis. Omitting further reference to the various indications afforded by a study of Mesozoic Conifers as to the former extension of many of the more isolated recent types, we may present in a tabular form an epitome of the past and present range of the Araucarieæ:—

b. *Cycads.*

One of the most striking features of the Mesozoic vegetation is the abundance and wide distribution of Cycadean plants. To-day the Cycads or Sago-Palms are represented by ten genera and about eighty species; they are plants which occupy a subordinate position in modern floras, and occur for the most part as solitary types in tropical latitudes, never growing together in sufficiently large numbers to constitute a dominant feature in the vegetation. Cycads have long attracted attention as exhibiting morphological features of considerable interest. During the last few years the work of Ikeno, Webber, and Lang has shown us that the pollen of Cycas, Zamia, Stangeria, and probably of the other recent genera, produce spirally ciliated motile spermatozoids, the type of male cell previously regarded as constituting one of the well-defined distinctions between the Vascular Cryptogams and the Seed-bearing plants. The study of Palæozoic plants has done even more to break down the artificial barrier between Cycads and Vascular Cryptogams, by demonstrating beyond all reasonable doubt that our modern Cycads represent a small group of survivals descended from ancestors common to themselves and the ferns. Cycadean plants must have been among the commonest members of Mesozoic floras. Before the end of the Palæozoic era there existed plants bearing pinnate fronds similar to those of recent species of Cycadaceæ, and

Geographical Distribution of Past and Present ARAUCARIEÆ.

Araucarieæ	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Araucarites [Rhætic → Cretaceous]							×	×								×	×	×	×			
Araucaria 10 species																	×		×			
Agathis 4 species																×			×			×

in succeeding ages the group rapidly increased in number and variety until, in the Jurassic and the early Cretaceous periods, the Cycads asserted their superiority as the leading type of vegetation. The majority of Mesozoic Cycadean fronds are assigned to artificial or form-genera as an indication of our ignorance of their reproductive organs, or of the anatomical structure of their stems. As Prof. Nathorst has recently suggested, it is convenient to speak of these Cycadean remains as belonging to the group Cycadophyta. On the other hand, we find numerous petrified stems bearing well-preserved reproductive organs which enable us to compare the extinct with the existing species. We are in possession of enough facts to justify the statement that the majority of Mesozoic Cycads bore reproductive organs which differed in important morphological characters from those of existing forms. The researches of Williamson, Carruthers, Solms-Laubach, Lignier, and others, have revealed the existence of a large group of Cycadean plants—known as the Bennettiteæ—almost identical in habit with modern sago-palms, but distinguished by the complexity of their reproductive shoots. The Bennettiteæ, originally founded on a petrified stem discovered more than fifty years ago in the Isle of Wight, and represented by another fossil which Carruthers made the type of a new genus, Williamsonia, in 1870, possessed a thick stem, clothed with an armour of persistent leaf-bases and bearing a crown of pinnate fronds, as in most modern Cycads; but their flowers, which were borne on lateral shoots, were more highly specialised than those of the true Cycads. While most of the Mesozoic Cycads were no doubt members of the Bennettiteæ, others appear to have possessed reproductive organs like those of recent species. The Bennettiteæ belong to that vast army of plants that succumbed in the struggle for existence æons before the dawn of the Recent period. The other section of the Cycadophyta, the Cycadaceæ, still lingers on as one of the select band the present insignificance of which constitutes a badge of ancient lineage, and a faint reflection of past supremacy.

The wealth of Cycadean vegetation during the latter part of the Jurassic and the earlier stages of the Cretaceous periods is admirably illustrated by the discovery in the Black Hills of North America, and in other districts of the United States of hundreds of silicified trunks of Cycadean plants. The first discovery of petrified Cycadean stems in America was made by Tyson in 1859, who found two specimens in the Potomac beds of Maryland; since then more than 700 trunks, remnants of a vast Cycadean forest, have been obtained from the Black Hills alone. The investigations of Mr. Wieland, of Yale, who has been engaged for some time on the examination of this rich material, have already revealed the fact that in some of the Bennettiteæ the male and female organs were borne in a single flower, the female portion having a structure identical with that previously described from European stems, while the male flowers bear a close resemblance to the fertile fronds of a Marattiaceous fern. We have watched the progress of Mr. Wieland's researches with keen interest and look forward to further important developments. With some of us, indeed, the feelings of the ideal student of science are in danger of being overshadowed by a sensation akin to envy and a desire to invade American territory.

c. *Ginkgoales.*

Before leaving the Gymnosperms a word must be said about another section—the Ginkgoales—represented by the Maidenhair-tree of China and Japan. *Ginkgo* (or *Salisburia*) *biloba* has almost, if not quite, ceased to exist in an absolutely wild state, but as a cultivated tree it has now become familiar both in America and Europe. The living Maidenhair-tree is in truth an anachronism, a solitary remnant that brings us into touch with a vanished world and appears as an alien among its modern associates. The abundance of fossil leaves, like those of *Ginkgo biloba*, and of other slightly different forms referred to the genus Baiera, associated not infrequently with remains of male and female flowers, demonstrates the ubiquitous character of the Ginkgoales during the Rhætic, Jurassic, and Wealden periods. In the Jurassic shales of the Yorkshire Coast, Ginkgo and Baiera leaves occur in plenty, some of them practically identical with those of the existing species. The abundance of fossil Ginkgoales in other parts of the world—in Australia, South Africa, South America, China, Japan, North America, Greenland, Franz Josef's Land, Siberia, and throughout Europe—demonstrates the former vigour of this class of plants of which but one member survives. This type of Gymnosperm is distinctly foreshadowed in the Palæozoic vegetation, and as recently as the Eocene period a species of Ginkgo, indistinguishable in the form of its leaves from the living Maidenhair-tree, flourished in Western Scotland.

The accompanying table of distribution shows how extensive was the range of the Ginkgoales in the Mesozoic era—both geographically and stratigraphically.

Geographical Distribution of the GINKGOALES.

Ginkgoales	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Ginkgo } *Baiera* } [Rhætic → Cretaceous]		×		×	×		×	×	×			×	×			×		×	×		×	
Ginkgo biloba												×	×									

d. *Ferns.*

Although many of the Mesozoic ferns are preserved only in the form of sterile fronds and are of little botanical interest, several examples of fertile leaves are known which it is possible to compare with modern types. The Polypodiaceæ, representing the dominant family of recent ferns, are met with in nearly all parts of the world and possess the attributes of a group of plants at the zenith of its prosperity. We may confidently state that so far as the somewhat meagre evidence allows us to form an opinion, this family occupied a subordinate position in the composition of Mesozoic floras. Polypodiaceous sporangia have been met with in Palæozoic rocks, and their existence during the Mesozoic period is not merely a justifiable assumption, but is demonstrated by the occurrence of undoubted species of Polypodiaceæ. It seems clear, however, that this family did not attain to a position of importance until the Mesozoic vegetation gave place to that which characterises the present period. The Osmundaceæ are now represented by five species of Todea and four of Osmunda; *Todea barbara* occurs in South Africa, Australia, Tasmania, and New Zealand, the other species are all filmy ferns and occur in New Zealand, New South Wales, New Caledonia, Samoa, and in a few other southern regions. The genus Osmunda has a wider range, occurring in Europe, Asia, North America, India, Japan, Southern China, Java, South Africa, and other parts of the world. During the Rhætic and Jurassic periods the Osmundaceæ flourished over the greater part of Europe; their remains have been recorded from England, Germany, Scandinavia, Russia, Poland, Siberia, and Greenland, also from North America, Persia, and China.

Similarly the Schizæaceæ, a family now represented by a few genera in India, North America, South America, Africa, Australia, Japan, China, and elsewhere, were among the more abundant ferns in the Jurassic vegetation. The Cyatheaceæ, a family that is now for the most part confined to the tropics, constituted another vigorous and widely spread section in the Jurassic period; we find them in Jurassic rocks of Victoria, as well as in several regions in Europe, North America, and the Arctic regions.

The fertile fronds of many of the fossil Cyatheaceæ bear a striking resemblance to that isolated survivor of the family in Juan Fernandez—*Thyrsopteris elegans*. It is true that a considerable number of ferns of Jurassic and Wealden age have been described by the generic name Thyrsopteris without any adequate reason; but, neglecting all doubtful forms, there remain several types represented in the Jurassic flora of Siberia, England, and other parts of the world, which enable us to refer them with confidence to the Cyatheaceæ and to compare them more particularly with the sole existing species of Thyrsopteris. The Gleicheniaceæ, at present characteristic of tropical and southern countries, were undoubtedly abundant in the northern hemisphere in early Cretaceous days; abundant traces of this family are recorded from Greenland as well as from more southern European latitudes.

One of the most striking facts afforded by a study of the Mesozoic fern vegetation is the former extension and vigorous development of two families, the Dipteridinæ and Matonineæ, which are now confined to a few tropical regions and represented by six species. The tall graceful fronds of *Matonia pectinata*, forming miniature forests on the slopes of Mount Ophir and other districts in the Malay Peninsula in association with *Dipteris conjugata* and *Dipteris Lobbiana*, represent a phase of Mesozoic life which survives—

"Like a dim picture of the drowned past."

The fertile fragment of a frond of Matonidium exposed by a stroke of the hammer in a piece of iron-stained limestone picked up on the beach at Haiburn Wyke (a few miles north of Scarborough), is hardly distinguishable from a pinna of the Malayan *Matonia pectinata*. Rhætic and Jurassic ferns referred to the genus Laccopteris afford other examples of the abundance of the Matonineæ in the northern hemisphere during the earlier part of the Mesozoic era.

The modern genus Dipteris, with its four species occurring in India, the Malayan region, Formosa, Fiji, and New Caledonia, stands apart from the great majority of Polypodiaceous ferns, and is now placed in a separate family—the Dipteridinæ. Like Matonia it is essentially an ancient and moribund type with hosts of ancestors included in such Rhætic and Jurassic genera as Dictyophyllum, Camptopteris, and others which must have been among the most conspicuous and vigorous members of the Mesozoic vegetation. The appended table illustrates in a concise form the former extension of the Matonineæ and Dipteridinæ:—

geological history written in the rocks that constitute the Wealden series of Britain exposed in the Sussex cliffs and in the Weald district of south-east England. According to the geologist's reckoning, the Cretaceous period is of comparatively modern date; it occupies a position near the summit of a long succession of ages representing an amount of time beyond the power of imagination to conceive. On the other hand, to quote from Huxley's lecture on a piece of chalk, "not one of the present great physical features of the globe was in existence. . . . Our great mountain-ranges, Pyrenees, Alps, Himalayas, Andes, have all been upheaved since the chalk was deposited, and the Cretaceous sea flowed over the sites of Sinai and Ararat." This Cretaceous epoch, so recent geologically if measured by the standard of the antiquity of the everlasting hills, has a remoteness beyond our power to appreciate.

One interesting fact as regards the composition of the Jurassic Flora is the absence of any plants that can reasonably be identified as Angiosperms. In the Wealden flora of England no vestige of an Angiosperm has been found; this statement holds good also as regards Wealden floras in most other regions of the world. On the other hand, as soon as we ascend to strata of slightly more recent age we are confronted with a new element in the vegetation, which with amazing rapidity assumes the leading *rôle*. It is impossible to say with confidence at what precise period of geological history the Angiosperms appeared. When the rocks that now form the undulating country of the Weald were being accumulated as river-borne sediments on the floor of an estuary, this crowning act in the drama of plant evolution was probably being enacted.

"Nothing," wrote Darwin to Sir Joseph Hooker in 1881, "is more extraordinary in the history of the vegetable kingdom, as it seems to me, than the apparently very sudden or abrupt development of the higher plants. I have sometimes speculated whether there did not exist somewhere during long ages an extremely isolated continent, perhaps near the South Pole." We date the appearance of a new product of evolution from the age of the strata in which it first occurs; but this may well be a misleading criterion: all that we can say is that at a particular period certain new types of organisms are brought within our ken.

To quote Darwin again: "We continually forget how large the world is, compared with the area over which our geological formations have been carefully examined; we forget that groups of species may somewhere have long existed, and have slowly multiplied, before they invaded the ancient archipelagoes of Europe and the United States. We do not make due allowance for the intervals of time

Geographical Distribution of the Matonineae and Dipteridinae.

Matonineæ and Dipteridinæ	Arctic						N. Temperate			N. Sub-tropical				Tropical			S. Sub-tropical			S. Temperate		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
MATONINEÆ																						
Matonidium ... ... } *Laccopteris* ... ... } [Rhætic → Cretaceous]		×		×				×			×								×			
Matonia 2 species																×						
DIPTERIDINÆ																						
Dictyophyllum ... ... } *Camptopteris*, &c. ... ... } [Rhætic → Wealden]							×	×			×	×				×	×		×			
Dipteris 4 species																×						

Could we but question these survivors from the past, we should hear a tragic story of hopeless struggle against stronger competitors, and learn the history of their gradual migration from an ancient northern home to regions at the other end of the world.

e. *Flowering Plants.*

Our retrospect of the march of plant-life has so far extended to the dawn of the Cretaceous period, a chapter in

which have elapsed between our consecutive formations, longer, perhaps, in many cases than the time required for the accumulation of each formation."

On another occasion Darwin wrote to his friend Hooker: "The rapid development, as far as we can judge, of all the higher plants within recent geological times is an abominable mystery." Such evidence as we possess, meagre as it admittedly is, shows that "this overshadowing type of plant-life" no sooner appeared than it asserted itself with extraordinary vigour and created a revolution in the plant-world. Let us glance for a moment at the facts to be gleaned from an examination of the records of this critical period in the history of vegetation.

I have already pointed out that we have as yet recognised no Angiosperms in the Wealden floras of England, Spitzbergen, Germany, France, Austria, Belgium, Russia, and Japan; but from plant-bearing rocks of Portugal, regarded as homotaxial with those which British geologists speak of as Wealden, the late Marquis of Saporta named a fragment of a leaf *Alismacites primaevus*, a determination that, while possibly correct, cannot be accepted as conclusive testimony. In Virginia and Maryland there occurs a thick series of strata known as the Potomac formation from which a rich harvest of plant-remains has been obtained. Prof. Lester Ward has recently shown that under this title are included several floras, some of which are undoubtedly homotaxial with the Wealden of Europe, while others represent the vegetation of a later phase of the Cretaceous era. From the older Potomac beds a few leaves have been assigned to Dicotyledons and referred to such genera as Ficophyllum, Myrica, Proteæphyllum, and others. Some of these may well be small fronds of ferns with venation characters like those of the Elk's Horn fern (Platycerium), while others, though presenting a close resemblance to Dicotyledonous leaves, afford insufficient data for accurate generic identification. In dealing with fossil leaves of the dicotyledonous type, we must not forget that the recent genus Gnetum—a gymnosperm of the section Gnetales—possesses leaves that may be said to be indistinguishable in form and venation from those of certain Dicotyledons. Before the close of the Potomac period these few fragmentary relics of possible Dicotyledons are replaced by a comparative abundance of specimens which must be accepted as undoubted Angiosperms. Previous to the discovery of the supposed Angiosperms in Wealden strata of Portugal and North America, the earliest record of an Angiosperm was represented by Heer's *Populus primaeva* from Northern Greenland. This name was applied to a fragmentary specimen which may be a true dicotyledonous leaf. In 1897 Dr. White, of the Geological Survey of the United States, stated that additional examples of dicotyledonous leaves had been obtained during the visit of the Peary Arctic expedition to the well-known locality in Greenland where Heer's *Populus primaeva* was discovered in the so-called Kome series. From strata known as the Atane beds, which rest on the Kome series, unmistakable Angiosperms have been collected in abundance.

Another indication of the sudden increase in the number of dicotyledons is furnished by the Dakota flora of the United States—in age somewhat more recent than the older Potomac beds. In these plant-beds it is stated that Angiosperms constitute two-thirds of the vegetation.

We may sum up the whole matter in a few words. There is some evidence of the existence of Angiosperms before the close of the Wealden period. It may be added that the Stonesfield Slate of England (a formation of approximately the same age as the Inferior Oolite plant-beds of Yorkshire) has afforded a single specimen of a leaf which in form and venation has as much claim to be referred to the dicotyledons as many of the leaves from Wealden rocks. These earliest records are, however, unsatisfactory, and the names assigned to them are often misleading. As soon as we ascend a stage higher in the geological series, not only do the Angiosperms at once become abundant, but the whole facies of the vegetation undergoes a striking change. The Gymnosperms, especially the Cycads, are ousted from a supremacy maintained through countless ages, and the vegetation becomes essentially modern. Many of the earlier angiospermous plants may be referred to existing genera and present no features of special interest from a phylogenetic standpoint.

One of our most pressing needs is a thoroughly critical revision of the late Cretaceous and earlier Tertiary floras, with the object both of determining the systematic position of the older Angiosperms and of mapping out with greater accuracy the geographical distribution of the floras of the world in post-Wealden periods. This is a task which is sometimes said to be impossible or hardly worth the attempt; the available evidence is indeed meagre, and much of it has been treated with more respect than it deserves, but it is at least a praiseworthy aim, not to say a duty, to take stock of our material and to compile lists of plants that may bear the scrutiny of experienced systematists. We are profoundly ignorant of the means by which Nature produced this new creation; we can only emphasise the fact that in the early days of the Cretaceous era a new type was evolved which no sooner appeared than it swept all before it and by its overmastering superiority converted the past into the present.

Conclusion.

In conclusion, I would urge the importance of taking stock of our accumulated facts, and of so recording our observations that they may be safely laid under contribution as aids to broad generalisations. Detailed descriptions and the enumeration of small collections are a necessity, but there is danger of the student neglecting the application of his results to problems of far-reaching import. We may borrow a saying of a great artist in regard to attention to detail—"I see it, but I prefer to construct the synthesis."

There is no more fascinating task than to follow the onward march of the plant-world from one stage to another and to watch the fortunes of the advancing army. We see from time to time war-worn veterans dropping from the ranks and note the constant addition of recruits, some of whom march but a short distance and fall by the way; while others, better equipped, rise to a position of importance.

At long intervals the formation is altered and the constitution of the advancing and increasing host is suddenly changed; familiar leaders are superseded by new-comers who mark their advent by drastic reorganisation. To change the metaphor, we may compare the stages of plant-evolution to the records of changing architectural styles represented in Gothic buildings. The simple Norman arch and massive pier are replaced, with apparent suddenness, by the pointed arch and detached shafts of the thirteenth century; the latter style, which marked an architectural phase characterised by local variations subordinated to a uniformity in essential features, was replaced by one in which simplicity was superseded by elaboration, and new elements were added leading to greater complexity and a modification of plan. Similarly the Palæozoic facies of vegetation passes with almost startling suddenness into that which monopolised the world in the Mesozoic era, and was in turn superseded by the more highly elaborated and less homogeneous vegetation of the Cretaceous and Tertiary periods. In taking a superficial view of architectural styles we are apt to lose sight of the signs of gradual transition by which one period passes into the next; so, too, in our retrospect of the changing scenes which mark the progress of plant-evolution, we easily overlook the introduction of new types and the gradual substitution of new for old. The invention of a new principle in the construction of buildings is soon followed by its wide adoption; new conceptions become stereotyped, and in a comparatively few years the whole style is altered. As a new and successful type of plant-architecture is produced it rapidly comes into prominence and acts as the most potent factor in changing the facies of a flora. Making due allowances for the imperfection of the Geological record, we cannot escape from the conclusion, which is by no means opposed to our ideas of the operation of the laws governing evolutionary forces, that the state of equilibrium in the vegetable kingdom was rudely shaken during two revolutionary periods. The earlier transitional period occurred when Conifers and Cycads became firmly established, while for the second revolution the introduction of the Angiospermous type was mainly responsible. As in the half-effaced documents accessible to the student of architecture "the pedigrees of English Gothic can still be recovered," so also we are able to trace in the registers imprinted on the rocks the genealogies of existing botanical types.

In the course of this address I have given but scant attention to the lessons we have learnt and are still to learn as to the family-history of plants. As Prof. Coulter says: "The most difficult as well as the most fascinating problem in connection with any group is its phylogeny. The data upon which we base opinions concerning phylogeny are never sufficient, but such opinions usually stimulate research and are necessary to progress."

We who attempt to read the records of the rocks may be tempted to magnify the importance of the work, but I do not hesitate to add that botanists as a whole have but half realised the fact that the study of living plants alone supplies but a portion of the evidence bearing on problems of plant-evolution. To ignore the facts that may be gleaned from the investigation of extinct types is like attempting to draw up a genealogy by merely questioning an individual without consulting the documentary evidence of registers and other chronicles.

Each successive stage through which the organic world has passed contains some relics of a preceding age; in comparing the chalk with the calcareous ooze now accumulating on the bed of the Atlantic, Carpenter expressed the partial agreement between the two deposits by saying that we are still living in the Cretaceous period. Dr. Moore's recent researches, demonstrating a striking resemblance between many of the molluscs of Lake Tanganyika and fossils preserved in the sediments of Jurassic seas, led him to describe some constituents of the fauna of this inland lake as so many "lingering shadows of the past," while Tanganyika itself is a dwindled remnant of a Mesozoic sea. Similarly our modern vegetation differs enormously from that of the Mesozoic era, yet in the sago-palms of the Tropics and in species of Malayan ferns we recognise proofs of the continuity of plant-types through successive ages. One stage is superseded by another, but some characteristic elements of each period persist into the next, carrying on the traditions of the past and demonstrating the futility of our system of classification, a system in which we express the limitations of our knowledge, as we suit our convenience, by dividing into periods the history of geological and organic evolution.

"It is only our ignorance that fixes a limit, as the mist gathered round the mountain's brow makes us fancy we are treading the edge of the universe."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IN connection with the Technical Education Board of the London County Council, a course of ten free lectures to teachers on "Animal Life in a Freshwater Aquarium" will be given by Dr. A. C. Haddon, F.R.S., at the Horniman Museum on Saturday mornings, at 11.30, from October 10 to December 12. Tickets of admission may be obtained from the Clerk of the London County Council, County Hall, Spring Gardens, S.W.

A COURSE of eight lectures on "The Relation of the Composition of the Plant to the Soil in which it Grows" will be given at the Chelsea Physic Garden by Mr. A. D. Hall (director of the Rothamsted Experimental Station) on Tuesdays from October 13 to December 8, in connection with the University of London. The lectures are addressed to advanced students. Two courses of lectures on advanced physiology will be given at the university during the present session. Commencing on October 16, Dr. F. W. Mott, F.R.S., will lecture on "The Structure and Function of the Cerebral Cortex," and on October 20 Dr. Buckmaster will lecture on "The Blood." On October 13 Dr. A. D. Waller will lecture on "The Anæsthetic Action of Chloroform and Ether." Admission to the lectures is by ticket, to be obtained from the Academic Registrar.

THE Act of Parliament under which the University College of Liverpool, hitherto associated with Owens College, Manchester, and Yorkshire College, Leeds, in Victoria University, begins its independent existence as the University of Liverpool, came into operation on October 1. This charter, which was obtained last July, provides that all the courses shall be open to women. Lord Derby is the first Chancellor and Principal Dale the Vice-Chancellor, and the university possesses a strong staff. Chairs have recently been endowed in tropical medicine, biochemistry, and electrotechnics, besides additions to other teaching resources. It is anticipated that the existence of the new university will greatly stimulate the work in the secondary a well as other schools.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 28.—M. Albert Gaudry in the chair.—The myelocytes of the olfactory bulb, by M. Johannes **Chatin.**—Remarks by M. Alfred **Picard** on the "Rapport général administratif et technique sur l'Exposition universelle internationale de 1900."—On a combination of aluminium sulphate with sulphuric acid, by M. E. **Baud.** By the action of sulphuric acid upon bauxite, aluminium hydrate, or aluminium sulphate, a compound possessing the composition $Al_2O_3.4SO_3.4H_2O$, is formed, which dissolves very slowly in cold water. It is analogous to the ferrisulphuric acid of M. Recoura.—On the nitrosite of pulegone, by M. P. **Genvresse.** Pulegone, dissolved in petroleum ether, and saturated with either nitrogen peroxide or nitrous fumes from starch and nitric acid, gives a nitrosite, $C_{10}H_{16}.N_2O_3$, the properties of which are described.—On the production of sulphuretted hydrogen by extracts of organs and albumenoid materials in general, by M. Emm. **Pozzi-Escot.** Yeast extract, treated with sulphur, gives rise to a considerable quantity of sulphuretted hydrogen; if the extract is boiled for a short time before adding sulphur, no sulphuretted hydrogen is evolved. From this it is concluded that the reaction is of a diastatic nature.—On the phagocytic resorption of unutilised genital products in *Echinocardium cordatum*, by MM. Maurice **Caullery** and Michel **Siedlecki.**—On the formation of the egg and the multiplication of an antipode in Juncus and Luzula, by M. Marcellin **Laurent.**—The morphological variation in the leaves of the vine following grafting, by M. A. **Jurie.** The experiments described show the great variability of certain morphological characters in the leaf of the vine under the influence of grafting.—On the relations between the structure of the French and Swiss Alps, by M. **Kilian.**

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