SOME RECENT STUDIES OF FOSSIL PLANTS.

WHEN, many years hence, a history of the study of fossil plants during the first decade of the twentieth century is being elaborated, it will be found that two discoveries, announced in 1903 and 1906 respectively, will stand out as particularly far-reaching in their "after effects." These contributions will be found to rank in importance with any that may be cited in the whole range of the previous history of the study of palæobotany.

In 1903, Oliver and Scott showed that Lyginodendron, a well-known fern-like plant of the Carboniferous period, was in reality a seed plant. Within the next two years a number of similar discoveries were made in the case of several other genera, though since 1905 no further contributions of a like nature have been published. The identification, however, in that year of the male organs of Lyginodendron, which we owe to Dr. Kidston, completed our knowledge of that genus.

In 1906, Dr. Wieland, in his handsome volume on the "American Fossil Cycads," brought home to us, with a vividness which left little to be desired, the amphisporangiate nature of the cone of the Mesozoic genus Bennettites, or Cycadeoidea, as the Americans prefer to call it.

As Wieland himself foresaw, this discovery has thrown light on the phylogeny of the Angiosperms and Gnetales,[1] two groups hitherto of obscure affinities. These contributions have been already reviewed in NATURE[2] at some length, and it is therefore not proposed to discuss them further here.

A very extensive series, amounting to several hundreds, of memoirs, both large and small, have also been published on various palæobotanical subjects within the last ten years. The results there contained all contribute to our knowledge in one direction or another, but these directions are so varied, and often so disconnected, that it will only be possible to notice a few of them very briefly in a concise review such as the present. Further, the selection here made will be chiefly confined to those which have appeared during the last four years, and especially to those dealing with petrified material.

The true Ferns of the past have recently received considerable attention. It is now recognised that the ancient Ferns of the Palæozoic period, for which the name Primofilices has been suggested, differed in certain important respects from the Mesozoic, Tertiary, and recent Leptosporangiatæ. The latter appear to have sprung from the Primofilices, during the latter portion of the Permian period, and it would seem that, very soon after the initiation of the group, it differentiated in a fan-like manner into a number of families, many of which are still represented to-day. The Osmundaceæ, for instance, which of all the Leptosporangiate ferns stand nearest to the archaic stock, the Primofilices, were in existence in Upper Permian times.

This fact is emphasised by the recent studies of Kidston and Gwynne-Vaughan,[3] on the anatomy of a number of Osmundaceous stems from the Permian, Mesozoic, and Tertiary rocks. Three of these memoirs have appeared, and a fourth has been added since this review was written. This work is especially interesting, for not only is our knowledge of petrified plant remains from the rocks of these periods extremely scanty, but the study of the structure of these ancient representatives of the family has thrown light on the ancestral history of certain structural peculiarities met with in living ferns, especially the origin of the adaxially curved leaf trace.[4] The primitively solid, protostelic nature of the stem cylinder of the ancient Osmundaceæ is emphasised, and the evolution of the stele in this group is no longer a matter of theory, but of fact.

Our knowledge of the Primofilices has also recently advanced rapidly. A full account of this group will be found in the new edition of Scott's "Studies in Fossil Botany" (chapter ix.). Dr. Paul Bertrand, in his "Etudes sur la Fronde des Zygoptéridées," a handsomely illustrated volume published last year, has traced the course of evolution of the petiolar stele of members of this group. In this connection Mr. Gordon's paper on the structure of the stem and petiole of *Diplolabis roemeri* (Solms) from the Calciferous Sandstone of Scotland, which is shortly to appear in the Transactions of the Royal Society of Edinburgh, will be found of interest as carrying further broad conclusions of a similar, if not identical, character.

So far as the other Palæozoic groups are concerned, attention has recently been devoted almost entirely to the Lycopods. The Sigillarias, which until a short time ago remained the one important genus of the anatomy of which we knew very little, especially as regards the numerous species which possessed ribbed stems (Eu-Sigillariæ), have now been studied in detail. The structure of the stele closely resembles that of other Palæozoic Lycopods, especially Lepidophloios, the chief distinguishing features being found in the cortical tissues and leaf-bases. The anatomy of the cone scars is now known.[1] It has been found that, in certain species of ribbed Sigillariæ, the leaf-trace, when traversing the leaf-base and the lower part of the leaf, possesses a double xylem strand[2] (Fig. 2). The ribbing of the stem appears to be quite independent of the leaf-bases. The external features of three species of ribbed Sigillarias have now been correlated with their internal structure.

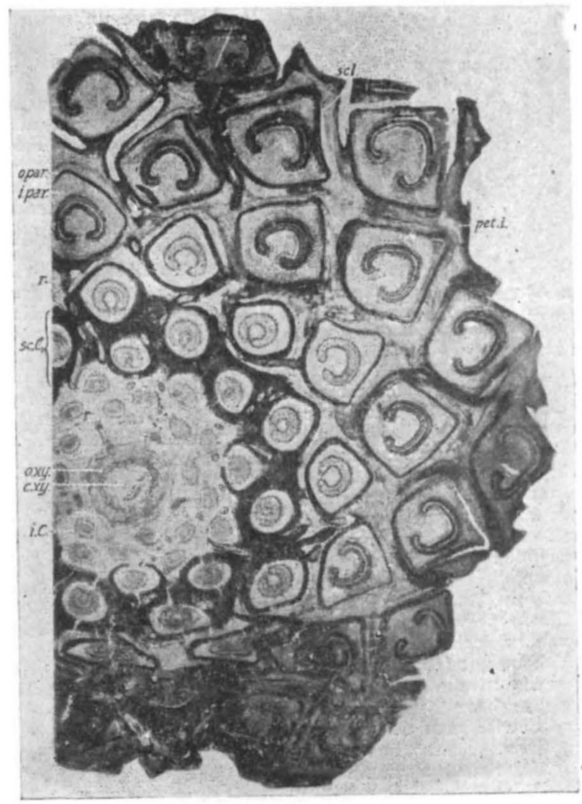

FIG. 1.—*Thamnopteris Schlechtendallii*, an Osmundaceous stem from the Upper Permian of Russia. A transverse section showing *o.xy*, outer xylem ring; *c.xy*, central xylem; *i.C*, inner cortex; *sc.C.* sclerotic outer cortex; *i.par*, inner parenchyma of petiole; *o.par*, outer parenchyma of petiole; *scl.* sclerotic ring of petiole; *r.*, root. Reduced after Kidston and Gwynne-Vaughan.

The Sigillarias, like the Lepidodendrons, were large forest trees, often 100 feet or more in height. Herbaceous members of the group appear to have been comparatively rare, and until recently have been little known. Halle[3]

[1] See Arber and Parkin, Proc. Linn. Soc. Bot., vol. xxxviii., p. 29, 1907, and Annals of Bot., vol. xxii., p. 489, 1908.

[2] See NATURE, vol. lxxi., p. 68, 1904; and p. 426, 1905; vol. lxxv., p. 329, 1907; vol. lxxvi., p. 113, 1907.

[3] Kidston and Gwynne-Vaughan, Trans. Roy. Soc., Edinburgh, vol. xlv., p. 759, 1907; vol. xlvi., pp. 213, 651, 1908–9.

[4] Gwynne-Vaughan and Kidston, Proc. Roy. Soc. Edinburgh, vol. xxviii., p. 433, 1908.

[1] Kidston, Trans. Roy. Soc. Edinburgh, vol. xli., p. 533, 1905; Proc. Roy. Soc. Edinburgh, vol. xxvii., p. 207, 1907.

[2] Arber and Thomas, Phil. Trans. Royal Soc. B, vol. cc., p. 133, 1908; Ann. of Bot., vol. xxiii., p. 513, 1909.

[3] Halle, Arkiv. för Botanik (Stockholm), vol. vii., No. 5, 1907; and *ibid.*, vol. vii., No. 7, 1908.

has, however, figured several impressions of herbaceous Lycopods from the Palæozoic and Mesozoic rocks, some of which appear to be similar in habit to the recent Lycopodium, and others to Seloginella. The latter have dimorphic leaves, and in some cases the sporangia are aggregated into stroboli, while, in at least one species, they are borne in the axils of foliage leaves, a very interesting feature in comparison with the modern Selaginellas. Zeiller, in his fine memoir, "Bassin houiller et permien de Blanzy et du Creusot" (1906), has figured, among other very interesting impressions, a Selaginellites, in which the leaves are arranged in the same manner as in the recent tetrastichous Seloginellas. The heterosporous cones contain a large number of megaspores in the megasporangia, another interesting feature unknown in the modern representatives of the group.

FIG. 2.—Tangential section through the leaf-base of *Sigillaria scutellata*, Brongn., showing the two xylem groups. After Arber and Thomas.

These specimens, however, are mere impressions. Fortunately, however, Miss Benson [1] has recently extended our knowledge of these plants by describing the anatomy and fructification of *Miadesmia membranacea*, Bertr., the first instance in which we have any information as to the structure of a *herbaceous* Palæozoic Lycopod. The fructification of this plant proves to be a primitive seed-like organ, recalling Lepidocarpon among fossils, and Isoetes among living plants.

Numerous other memoirs on Palæozoic Lycopods have also appeared, which it is impossible to discuss here. Among these may be mentioned Prof. Weiss's [2] description of a Stigmaria with centripetal wood, Mr. Watson's [3] discovery of the cone of *Bothrodendron mundum* (Will.), and Mr. David White's [4] *Archaeosigillaria primaeva*, an interesting impression from the Devonian rocks of New York State.

Although, as has been stated, no further attributions of seeds to the Palæozoic fern-like plants or Pteridospermeæ have been made during the last few years,[5] our knowledge of this group has been extended in other directions. Scott [6] has described a new stem, *Sutcliffia insignis*, Scott, a member of the Medulloseæ, characterised by concentric petiolar bundles, and a stem of very simple structure with a single main stele; a unique case of dialystely without siphonostely.

The structure of isolated seeds of pteridospermous affinity has also received attention, Scott and Maslen's [7] studies of Trigonocarpus, of which the first part has appeared, and Oliver's [8] memoir on *Physostoma elegans*, Will., being notable contributions in this direction.

Turning next to the studies of Mesozoic plants, Wieland's elucidation of the cone of Bennettites, to which we have already alluded, has been followed by the very important discoveries by Nathorst [9] of the male organs of Williamsonia, Anomozamites (now called Wielandiella), and several other genera of Triassic or Jurassic age, also belonging to the Bennettitales. Nathorst's specimens were impressions and not petrifactions, but by means of his new methods for studying carbonised impressions [1] he has been extremely successful in obtaining, from mere impressions, information which, until a few years ago, would have been regarded as quite impossible.

1 Benson, Phil. Trans. Roy. Soc. B, vol. cxcix., p. 409, 1908.
2 Weiss, Ann. of Bot., vol. xxii., p. 221, 1908.
3 Watson, Mem. and Proc. Manchester Lit. and Phil. Soc., vol. lii., No. 3, 1908.
4 White, New York State Mus. Bull. cvii., p. 327, 1907.
5 Nathorst has shown that the fructifications figured by Arber as *Carpolithus Nathorsti* (Ann. of Bot., vol. xxii., p. 57, 1908) are not seeds.
6 Scott, Trans. Linn. Soc. Lond., Ser. 2, Bot., vol. vii., p. 45, 1906.
7 Scott and Maslen, Ann. of Bot., vol. xxi., p. 89, 1907.
8 Oliver, Ann. of Bot., vol. xxiii., p. 73, 1909.
9 Nathorst, K. Svenska Vetenskap. Akad. Handl., vol. xlv., No. 4, 1909.

Nathorst finds that the flowers of Williamsonia, unlike those of Bennettites, are unisexual, a very important point. The male sporophylls (Fig. 3) were arranged in a whorl, and were fourteen or fifteen in number. They were united laterally for nearly half their length. The microsporangia were borne on the inner side of the sporophyll on segments which were somewhat divided. The male organs may be of a similar nature to the extraordinary "male-fronds" of Bennettites, but in Williamsonia they are very greatly reduced.

In Wielandiella, however, the cones are amphisporangiate, and the male sporophylls are still more reduced, and form a palisade-like ring near the base of the cone. The cone was markedly protogynous (Fig. 4).

The fact that the male sporophylls of some members of the Bennettitales have now been found, which are very much reduced as compared with those of Bennettites itself—an event which was confidently expected to occur—has an important bearing on the question of the origin of the Angiospermous stamen.[2]

Wieland [3] has also recently described a male flower of a Williamsonia, which does not, apparently, agree exactly with that discovered by Nathorst in Yorkshire last summer. On this specimen Wieland has founded a theory of the phylogeny of the Gamopetalæ, which, however, will probably not meet with general acceptance.

Mesozoic plants are now attracting a more considerable share of attention than they have in the past. The great drawback to studies of this nature has always been the absence of petrified material. Impressions alone are available, though there has been no lack of large, isolated stems or trunks of Gymnospermous or Angiospermous affinity in certain deposits belonging to this period. Such petrifactions, however, do not tell us very much, and we have hitherto failed to find plant-bearing concretions, similar to

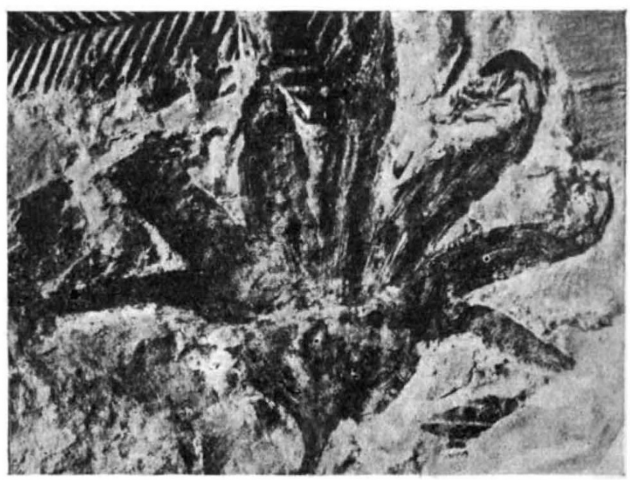

FIG. 3.—The Male Flower of *Williamsonia spectabilis*, Nathorst, from the Lower Oolite of Whitby, Yorkshire. After Nathorst.

the coal-balls of the English Carboniferous rocks, with their wealth of fragments of leaves, cones, or other organs, from which so much can be ascertained, both from an anatomical and a phylogenetic standpoint. Stopes and Fujii [4] have now, however, discovered such concretions in the Upper

1 Nathorst, Arkiv. für Botanik, vol. vii., No. 4, 1907; K. Svenska Vetenskap. Akad. Handl., vol. xliii., No. 6, 1908.
See also Bather, Geol. Mag., Dec. v., vol. iv., p. 437, 1907; vol. v., p. 454, 1908.
2 See Arber and Parkin, *ante*.
3 Wieland, Bot. Gaz., vol. xlviii., p. 427, 1909.
4 Stopes and Fujii, Phil. Trans. Roy. Soc. B, vol. cci., p. 1, 1910.

Cretaceous of Japan, which in several respects appear to be quite analogous to our English coal-balls. In their paper published a few months ago, they describe a varied series of fossil plants from these nodules, such as the sporangia of a fern of Schizæaceous affinities, a leaf, Niponophyllum, with parallel nerves, several stems and cones of Gymnosperms, especially Yezonia, a trunk in which the wood consists of thick- and thin-walled tracheids arranged on the same radii, and which is regarded as a representative of a new family of Coniferæ. Among the Angiospermous remains are woods allied to the Saururaceæ, to the Juglandaceæ, the Sabiaceæ, and Cupuliferæ. But perhaps the most interesting specimen is that discussed as being a flower of Liliaceous affinity, and termed *Cretovarium japonicum* (Fig. 5). This is regarded by the authors as the first fossil flower known in the petrified state. It is described as a trilocular ovary with axile placentation, though the ovules are absent.

FIG. 4.—The amphisporangoic cone of *Wielandiella angustifolia*, Nathorst, from the Rhætic of Sweden. (1) The axis with the "palisade-ring" of male sporophylls below. (2) The ring of male sporophylls enlarged. After Nathorst.

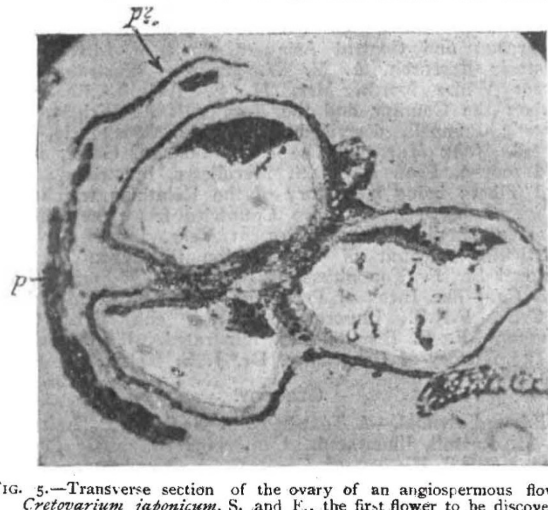

FIG. 5.—Transverse section of the ovary of an angiospermous flower *Cretovarium japonicum*, S. and F., the first flower to be discovered in the petrified state. p and p^2, perianth. After Stopes and Fujii.

Traces of a perianth (?) are seen fused to the lower part of the carpels, which were slightly inferior.

E. A. N. A.

FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE.

Edward Arnold.—The Development of British Forestry, A. C. Forbes, illustrated. *Constable and Co., Ltd.*—To Work a Grass Holding at a Living Profit and the Cheap Cottage Problem, H. B. M. Buchanan. *Duckworth and Co.*—Agricultural Bacteriology: Theoretical and Practical, Prof. J. Percival. *John Murray.*—The Feeding of Crops and Stock, A. D. Hall, F.R.S. *Kegan Paul and Co., Ltd.*—Weeds of the Farm and Garden, Prof. L. H. Pammel, illustrated; Commercial Fertilisers, Dr. L. L. Van Slyke; Field and Garden Peas, G. C. Seavey, illustrated; Profitable Stock Raising, C. A. Shamel; Profitable Poultry Production, M. G. Kains; Farm Crops, C. W. Burkett.

ANTHROPOLOGY.

Macmillan and Co., Ltd.—The Golden Bough: a Study in Magic and Religion, Dr. J. G. Frazer, third edition, in five parts: Part i., The Magic Art and the Evolution of Kings; Part ii., The Perils of the Soul and the Doctrine of Taboo; Along the Old North Trail: or Life, Legends and Religion of the Blackfeet Indians, W. McClintock, illustrated. *John Murray.*—The Castes and Tribes of Eastern India, Sir H. Risley; Shans at Home: their Customs, Habits of Life, Industries, Folk-lore, Mrs. L. Milne, with two chapters on Shan History and Literature by the Rev. W. W. Cochrane, illustrated. *Swan Sonnenschein and Co., Ltd.*—Bushman Folk-lore, L. C. Lloyd, with a preface by Dr. G. McCall Theal, illustrated; The Native Races of South Africa, the late G. W. Stow, edited by Dr. G. M. Theal, illustrated. *Watts and Co.*—History of Anthropology, Dr. A. C. Haddon, F.R.S., illustrated.

BIOLOGY.

Edward Arnold.—Hereditary Characters, C. E. Walker; Practical Photomicrography, J. E. Barnard, illustrated; A Gamekeeper's Note-book, O. Jones and M. Woodward, illustrated; Fly-leaves from a Fisherman's Diary, Capt. G. E. Sharp, illustrated. *John Bale, Sons and Danielsson, Ltd.*—A new edition of Lectures on Biology, Dr. C. Thesing, translated by W. R. Boelter. *G. Bell and Sons, Ltd.*—The Inherent Law of Life: a New Theory of Life and of Disease, F. Kleinschrod, translated and edited by L. C. Appel; A Text-book of Plant Physiology, Prof. F. W. Keeble, illustrated. *A. and C. Black.*—First Principles of Heredity, S. Herbert, illustrated. *W. Blackwood and Sons.*—The Elements of British Forestry, J. Nisbet. *Cambridge University Press.*—The Coming of Evolution, Prof. J. W. Judd, C.B., F.R.S.; Heredity, L. Doncaster; Plant-Animals, Prof. F. W. Keeble. *W. and R. Chambers, Ltd.*—Britain's Birds and their Nests, A. L. Thomson, illustrated. *J. M. Dent and Sons, Ltd.*—Physiology, Prof. Sherrington, F.R.S.; Zoology, Prof. Herdman, F.R.S.; Mendelism, Dr. Drinkwater, illustrated; The Book of the Animal Kingdom (Mammals), W. P. Westell, illustrated; Orchids for Everyone, C. H. Curtis, illustrated. *Duckworth and Co.*—Toy Dogs and their Ancestors, Hon. Mrs. N. Lytton, illustrated. *Dulau and Co., Ltd.*—The Influence of Parental Occupation and Home Conditions on the Physique of the Offspring, E. M. Elderton; On the Marriage of First Cousins, E. M. Elderton. *C. Griffin and Co., Ltd.*—New editions of Micro-organisms and Fermentation, A. Jörgensen, translated by S. H. Davies, illustrated; Open-air Studies in Botany: Sketches of British Wild Flowers in their Homes, R. Lloyd Praeger, illustrated. *Gurney and Jackson.*—A History of British Mammals, G. E. H. Barrett-Hamilton, 24 parts, illustrated. *T. C. and E. C. Jack.*—Present-day Gardening, edited by R. H. Pearson: Carnations and Pinks, T. H. Cook, J. Douglas, and J. F. M'Leod; Rhododendrons and Azaleas, W. Watson; Lilies, A. Grove; Orchids, J. O'Brien; Roses, H. E. Molyneux; and volumes on Annuals, Apples and Pears, Cucumbers, Melons, Tomatoes, &c., illustrated. *Longmans and Co.*—Lives of the Fur Folk: the Biographies of Redpad the Fox, Fluff-button the Rabbit, Grimalkin the "Gone Wild" Cat, Stubbs the Badger, M. D. Haviland, illustrated; The Essentials of Morbid Histology, Dr. A. S. Grünbaum, illustrated. *Macmillan and Co., Ltd.*—The Age of Mammals, Prof. H. F. Osborn, illustrated; Text-book of Human Physiology, Dr. L. Luciani, translated by Frances A. Welby, and edited by Dr. M. Camis, with a preface by Prof. J. N. Langley, F.R.S., illustrated, in 4 vols., vol. i. *The Methodist Publishing House.*—Sunbeam's River: a Child's Nature Story Book, N. Parsons, illustrated; In Nature's Nursery, S. N. Sedgwick, illustrated; The Boy's Book of Angling and Rambling, W. J. Claxton, illustrated. *Methuen and Co.*,