18. *On the* OCCURRENCE *of* *DICTYOZAMITES* *in* ENGLAND, *with* REMARKS *on* EUROPEAN *and* EASTERN MESOZOIC FLORAS.

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[PLATE XV.]

AMONG several species of Inferior-Oolite plants recently collected by the Rev. John Hawell, M.A., F.G.S., and sent to me for examination, I found a few fragments of *Dictyozamites*, a genus of especial interest from the point of view of the geographical distribution of Mesozoic plants. Mr. Hawell obtained the plants from a bed of ironstone on the northern face of the Upleatham outlier, near Marske-by-the-Sea, in Yorkshire; most of the material was dug out from an old heap of refuse thrown aside during boring operations, but the plant-bed was also investigated *in situ*.[1]

The locality is mentioned on the 6-inch Ordnance Survey-maps as Marske Quarry; it is situated 1 mile directly south of Marske, and about 500 feet above sea-level. This plant-bed occurs low down in the Estuarine Series, and is probably of Lower Estuarine age; but in the neighbourhood of Marske, Mr. Hawell informs me, there is apparently no distinct line of division between the Lower and the Middle Estuarine Series.[2]

The generic name *Dictyozamites* was proposed by Oldham in 1862[3] for some pinnate fronds discovered in strata of laminated clay, converted by igneous agency into a porcellanous rock, at the eastern end of the Puchwara Pass in the Rajmahal Hills. The fragments represented in figs. 5–8 (Pl. XV) were drawn from a piece of this rock in the British Museum (Natural History) Collection.[4] Morris, as joint author with Oldham of the first volume of the 'Fossil Flora of India,' referred the specimens to Gutbier's genus *Dictyopteris*, a term applied to certain Palæozoic species agreeing in all respects, except in the reticulate venation of the pinnules, with the well-known genus *Neuropteris*. Presl's generic term *Linopteris*[5] has been substituted by some authors for *Dictyopteris*. Morris instituted the species *Dictyopteris falcata* for the Rajmahal plant, describing certain specimens as *D. falcata*, var. *obtusifolia*.[6] The name *Dictyopteris* expressed Morris's view that the leaves were those

[1] Mr. Hawell kindly supplied me with this information, and I am indebted to him for generously allowing me to describe the specimens which form the subject of this communication.

[2] For the geological structure of this part of Yorkshire, see Fox-Strangways (92). [Numerals in parentheses throughout this paper refer to the Bibliography on p. 230.]

[3] Oldham & Morris (63) p. 38.

[4] Specimen No. 52546.

[5] For a figure of *Linopteris*, see Zeiller (00) p. 108.

[6] Oldham & Morris (63) pl. xxiv, fig. 2.

of a fern, an opinion shared by Zigno, to whom specimens were sent for examination. The view usually held that *Neuropteris* is a genus of Ferns has not as yet been demonstrated by the evidence of satisfactory fertile fronds, and we should probably better express the botanical position of this provisional genus by including it as a member of that important Palæozoic class the Cycadofilices, than by retaining it among the Ferns. Oldham, on the other hand, was of opinion that the plants referred to *Dictyopteris* were probably Cycads, and to give expression to this view he proposed the name *Dictyozamites* for the fragments of Indian leaves which bore the closest resemblance, except in the venation of the leaflets, to the genus *Otozamites*, adding the following diagnosis :—'Pinnis multinervis; basi subauriculatis; nervis dichotomis reticulatis.'[1]

In an earlier paper, Oldham[2] mentioned the occurrence of *Dictyopteris*, but without any discussion as to the probable nature of the leaves referred to this 'peculiar genus.'

In 1877 Feistmantel[3] described additional specimens from Amrapara and Golapili[4] and substituted the name *Dictyozamites indicus* for Morris's *Dictyopteris falcata*, including the forms originally separated as the variety *obtusifolia*. While Feistmantel was no doubt well advised in including the various forms under one designation, there was no need to discard Morris's specific name *falcata*. In justification of this change Feistmantel pointed out that the specific name *indicus* was appropriate as denoting that *Dictyozamites* is an Indian type,—a reason, in any case inadequate, which subsequent discoveries have rendered misleading. Another argument was that Morris's term implied that the falcate form of the pinnæ was a specific character, whereas for some specimens the descriptive epithet *falcata* was inaccurate.[5]

In 1876 Feistmantel published a paper in the 'Palæontographica'—'Ueber die Indischen Cycadeengattungen *Ptilophyllum*, Morr., & *Dictyozamites*, Oldh.,'[6] in which *Dictyozamites indicus* is thus defined :—

'Fronde simplici, elongata; foliolis alternantibus; aut brevioribus et obtusioribus, aut longioribus apicemque versus incurvatis vel falcatis; solum media parte basis insertis aut sessilibus—aut paulo pedunculatis—angulis basalibus distincte auriculatis; uno foliolo terminante. Nervis crebris, media basi eggredientibus, marginem versus irradiantibus—areolas formantibus. Areolis mediis elongatis subparallelis—areolis apicem marginemque versus brevioribus —polygonalibus.'

The pinnæ shown in figs. 5–8 (Pl. XV) are identical with the smaller forms of *Dictyozamites* as figured by Feistmantel from the Sripermatur Series[7] in the neighbourhood of Madras, which may be included stratigraphically in the Rajmahal Group.[8] The longest

[1] Oldham & Morris (63) p. 40.
[2] Oldham (60) p. 320.
[3] Feistmantel (77) pp. 69, 70 & pl. xlvi, figs. 7–8.
[4] Feistmantel (77[2]) p. 18 & pl. ii, figs. 5–6.
[5] Feistmantel (76) pp. 19 & 20.
[6] *Ibid.* p. 18.
[7] Feistmantel (76) pl. vi, figs. 4 & 5.
[8] R. D. Oldham's edition of Medlicott & Blanford (93) p. 182.

pinna is slightly over 2 centimetres in length and has a breadth of 4 millimetres; the veins, not always accurately represented in Feistmantel's plates, are clearly defined. Most of the leaflets are imperfect, but in a few cases (Pl. XV, fig. 6) one is able to see that they were attached to the rachis by a small portion of the lamina occupying an approximately-median position on the basal end; the edges of the base are very slightly lobed.

On the same porcellanous slab numerous fragments of other fronds occur, which I am unable to distinguish from *Williamsonia pecten*.

The next contribution to our knowledge of Oldham's genus was made by Dr. Yokoyama,[1] who recorded the occurrence of the Indian type at Ozo in the Province of Koga and at Ushimari in the Province of Hida in Central Japan. Most of the Japanese specimens are referred to a variety of the Rajmahal type—*Dictyozamites indicus*, var. *distans*; but a new species was instituted by Yokoyama, under the name *D. grossinervis*, for a form of pinna characterized by a coarser form of reticulation.

In 1889 Prof. Nathorst published a paper 'Sur la Présence du Genre *Dictyozamites*, Oldham, dans les Couches jurassiques de Bornholm.'[2] The specimens, collected by Herre A. F. Carlson in 1885, in the neighbourhood of Hasle in Bornholm, were named by Prof. Nathorst *Dictyozamites Johnstrupi*. This species agrees in the habit of the frond with the Indian form, but differs slightly in the shape of the pinnæ and in their manner of attachment to the rachis of the frond. Mr. Hawell's discovery at Marske affords proof of the occurrence of Oldham's genus in a second European region of rocks, of approximately the same geological age as those of Bornholm.

Distribution of the Genus *Dictyozamites* in the Jurassic Period.

Dictyozamites falcatus (Morr.)	Rajmahal Series of India.
Dictyozamites falcatus (Morr.), var *distans*, Yok.	Central Japan.
Dictyozamites falcatus (Morr.), var. *grossinervis*, Yok.[3]	Central Japan.
Dictyozamites Johnstrupi, Nath.	Bornholm.
Dictyozamites Hawelli, sp. nov.	England (Marske, E. Yorks).

In the absence of reproductive organs it is impossible to speak with confidence as to the affinity of the genus. It has long been customary to include fossil fronds, which agree in their pinnate method of branching and in the form and arrangement of the pinnæ with the leaves of modern Cycads, in the class Cycadales. The monotypic Australian genus *Bowenia* is the only existing Cycad in

[1] Yokoyama (90) pp. 53, 55, pl. vii, fig. 10, pl. x, figs. 4–10, & pl. xi, fig. 5.

[2] Nathorst (89).

[3] I have reduced Dr. Yokoyama's species *D. grossinervis* to the rank of a variety, as the small fragments with the coarser type of venation seem to me to be more appropriately distinguished by the term *grossinervis*, used as the designation of a variety, than as defining a distinct species.

which the fronds are bipinnate. In some instances we possess information as to the nature of the stems which bore the fronds, and we are familiar with various types of Cycadean inflorescences. The genus *Williamsonia* is represented by the Jurassic species *W. gigas* (L. & H.) and *W. pecten* (Phill.), characterized by pinnate fronds closely resembling those of certain forms of modern Cycads; in the case of the former species we have some evidence as to the nature of the stem, which in external form was practically identical with the stems of *Macrozamia* or *Encephalartos* among existing genera.[1] I have elsewhere[2] shown that Williamson's opinion, expressed in his important memoir published in 1870,[3] as to the organic connection between the fronds originally named *Zamia gigas*, L. & H., and the peculiar reproductive shoots named by Carruthers *Williamsonia*,[4] is confirmed by the evidence of specimens in the Yates Collection in the Paris Natural History Museum.

It seems clear that the smaller form of *Williamsonia*, figured by Leckenby in 1864,[5] represents a reproductive organ of the plant which bore fronds previously known as *Pterophyllum pecten*, L. & H., and now referred to the genus *Williamsonia*.

Prof. Nathorst has clearly demonstrated an organic connection between a third type of *Williamsonia*, *W. angustifolia*, Nath., and leaves formerly placed in the genus *Anomozamites*.[6]

We have therefore sufficient evidence to justify the opinion, founded at first on the external resemblance of vegetative structures, that certain of the Cycad-like fronds of Mesozoic age have their nearest living representatives in the Cycadaceæ. On the other hand, there are numerous forms of pinnate leaves which we are as yet unable to associate with either stems or reproductive organs, but which it is reasonable to regard as fronds of Cycadean plants. Prof. Nathorst has recently suggested the term Cycadophyta[7] as a convenient designation for fossil Cycadean plants known only as isolated leaves. The morphology of the flowers of some of the Mesozoic Cycads differs in so marked a manner from those of recent forms, that it has been necessary to place them in a separate division—the Bennettitales—of which the English species *Bennettites Gibsonianus*, Carr.,[8] represents the typical example.

No specimens of the English *Williamsonia* have so far been discovered of which it is possible to make an anatomical examination; but it is clear that the type of reproductive shoot represented by Mr. Carruthers's genus is very closely allied to, if not generically identical with, *Bennettites*.[9] Other fossil reproductive organs are known which present a sufficiently close agreement with those of modern Cycads to warrant their inclusion with them in a separate

[1] Seward (00[3]) p. 179.
[2] Seward (97) p. 274.
[3] Williamson (70).
[4] Carruthers (70).
[5] Leckenby (64) [*Palæozamia pecten*] pl. ix, fig. 4 *a*.
[6] Nathorst (80) & (02) pp. 9 *et seqq.*
[7] Nathorst (02) p. 3.
[8] Carruthers (70); Solms-Laubach (90). For an account of the male organs of *Bennettites*, see Wieland (99) (99[2]) & (01).
[9] Seward (95) pp. 146 *et seqq.*

division, the Cycadales. We may, therefore, as Prof. Nathorst has suggested, employ the term Cycadophyta as a group-name for Cycadean plants, comprising the two subdivisions Cycadales and Bennettitales, the distinguishing characters of which are furnished by the reproductive structures. In dealing with the numerous fossil leaves which are in all probability Cycadean, but cannot, through lack of evidence, be referred to one or other of the two subdivisions, we can best express our opinion as to their probable taxonomic position, and at the same time our ignorance as to their precise affinity, by speaking of them as members of the Cycadophyta.

CYCADOPHYTA, Nathorst.

[Kongl. Svensk. Vetenskaps-Akad. Handl. vol. xxxvi, no. 4, p. 3.]

Genus DICTYOZAMITES, Oldham.

[Mem. Geol. Surv. India, Pal. Indica, ser. 2, vol. i, p. 40.]

Fronds pinnate, similar in habit to those of *Otozamites*; pinnæ sessile, or with a very short stalk, disposed in two alternate rows, and attached to the rachis either by the middle or by the lower half of the base. The basal free portion of the pinnæ is usually slightly auriculate. The central portion of the lamina of the pinnæ is occupied by veins which follow a longitudinal and approximately-parallel course, and are connected one with the other by oblique anastomoses; the veins of the median region give off branches which curve obliquely upward and downward to the margin of the leaflet, and by repeated cross-connections with one another divide the lamina into numerous polygonal meshes or reticula.

Stems and flowers unknown.

DICTYOZAMITES HAWELLI, sp. nov. (Pl XV, figs. 1–4.)

Fronds pinnate; pinnæ crowded, sessile, in two alternating rows, attached by a small portion of the lamina slightly below the middle of the base to the upper face of the rachis. The pinnæ are broadly linear in shape, and taper gradually to a bluntly rounded apex; the upper margin of the base is slightly auriculate, the lower margin rounded or very slightly auriculate.

Veins numerous; those in the median region are approximately parallel to the edges of the pinna, and from them branches are given off which pass obliquely upward and downward towards the margin of the lamina.

The material from Marske consists of small and imperfect pieces of fronds, but is sufficient to form the type of a distinct species, distinguished from *Dictyozamites falcatus* (Morr.) by the relatively greater breadth of the segments, their more linear instead of a falcate form, and by the attachment to the rachis being slightly below the middle of the pinna-base. From the Japanese type *D. Hawelli* differs in the more crowded arrangement of the segments and in their blunter apices

Dictyozamites Johnstrupi is characterized by the more strongly-curved pinnæ, with more sharply-pointed apices, and by their manner of attachment to the rachis.

Pl. XV, fig. 1. This specimen shows clearly the crowded arrangement of the pinnæ, and their manner of attachment to the axis of the frond. The upper face of the rachis is hidden by the bases of the pinnæ, as in the frond of *Otozamites*. The upper edge of the pinna-base is distinctly auriculate, while the lower edge appears to be merely rounded or very slightly lobed. The most complete pinna is 3 centimetres long and 11 millimetres broad; in the venation-characters the species agrees with the other types of the genus.

Fig. 2. This drawing gives an end-view of the lowest pinna of the specimen represented in fig. 1, and shows the small and narrow oval area *a* by which the leaflet was attached to the surface of the rachis *r*, agreeing in this respect with the method of articulation of the pinnæ of *Encephalartos* and certain other recent Cycads. The scar or attachment-area, *a*, is situated slightly below the middle of the pinna-base.

Fig. 3. In this fragment the venation is shown with great clearness; the most complete pinna has a length of 3·8 centimetres, tapering gradually towards the bluntly rounded apex.

Fig. 4. This enlarged drawing of a portion of one of the pinnæ shown in fig. 3 illustrates the characteristic venation of the genus.

DICTYOZAMITES FALCATUS (Morr.). (Pl. XV, figs. 5–8.)

Fig. 5 represents a portion of a frond, drawn three times natural size, showing the form and manner of attachment of the bases of the pinnæ.

Figs. 6 & 7 illustrate the short, broad, and slightly-falcate form of the pinnæ of a small type of the Indian species. Fig. 7 is drawn natural size.

Fig. 8. A single pinna enlarged to show the venation, which agrees closely with that of *Dictyozamites Hawelli*.

COMPARISON OF THE JAPANESE, INDIAN, BORNHOLM, AND ENGLISH MESOZOIC FLORAS.

It is of interest to compare the Mesozoic floras of Japan, India, Bornholm, and England, in each of which *Dictyozamites* is represented. The resemblance of one flora to another is usually obscured by the use of different generic or specific names for plants, which are either identical, or represent closely-allied members of the same family. This diversity in nomenclature is, to some extent, the result of geographical separation; an author naturally hesitates to assign the same specific name to plants from India and Europe unless the evidence as to identity is convincing. On the other hand, wide separation in space has often been allowed to exercise a misleading influence in the determination of species. Another

reason for the use of different names for plants, which are either specifically identical or very closely allied, is to be found in the individual preferences of authors in the choice of possible generic designations for a particular plant.

In order to obtain a clear idea of the botanical relationship of one flora to another it is essential to devise some method by which distinctions, either imaginary or exaggerated, between plants recorded by different writers under distinct names may be eliminated. As a standard of comparison we may take a list of the plants described from the Inferior-Oolite rocks of Yorkshire, and by adopting an uniform system of nomenclature, and regarding as representative species types that are either specifically identical or distinguished by characters that, so far as we can judge, are not of generic rank, we shall be in a better position to furnish an answer to the question—how closely do the widely separated floras of Japan and Western Europe resemble or differ from one another?

In the following lists (pp. 224–26) I have therefore made use of specific names in a wide sense. In taking considerable liberties with the nomenclature of other authors, I do not necessarily mean to express disagreement with them as regards their interpretation of affinity, but my aim is to avoid the danger of allowing slight differences—whether of specific rank or not—to obscure the broad relationships of floras. The method of comparison is adopted primarily for the purpose of instituting a botanical comparison, rather than with the view of expressing an opinion as to relative age or stratigraphical position. The data on which the lists are founded have been supplied by the works of Geyler,[1] Yokoyama,[2] and Nathorst[3] in the case of the flora of Japan, but the flora with with which we are more especially concerned is that described by Dr. Yokoyama in his earlier paper of 1886; by Oldham & Morris[4] and by Feistmantel[5] for the Indian species; and by Bartholin,[6] Möller,[7] and Hjorth[8] for Bornholm.

The welcome memoir by Dr. Möller on the flora of Bornholm deals only with the Pteridophyta, but we may look forward to a completion of his valuable investigations at an early date. [Since this paper on *Dictyozamites* was read, Dr. Möller's second memoir on the Bornholm Flora has been published; see Möller (03) in the Bibliography, p. 231.]

In order to avoid misunderstanding, the names employed by the authors of the floras of Japan, India, and Bornholm are added in square brackets in cases where their nomenclature or determination does not agree with that which I have adopted. The initial letters Y, F, N, B, and M (Yokoyama, Feistmantel, Nathorst, Bartholin, and Möller), placed after the specific names in the last three columns, serve as a guide to the 'Floras' from which the species are quoted.

[1] Geyler (77).
[2] Yokoyama (90) & (95).
[3] Nathorst (90).
[4] Oldham & Morris (63).
[5] Feistmantel (77) & (77[2]).
[6] Bartholin (92) & (94).
[7] Möller (02).
[8] Hjorth (99).

England.	Japan.	India.	Bornholm.
Equisetales.			
Equisetites columnaris, Brongn.	The equisetaceous plant named by Dr. Yokoyama *Equisetum ushimarense* agrees closely with the European Wealden species *Equisetites Burchardti*, Dunk.[1]	Cf. *Equisetites rajmahalensis*. F.	Cf. *Equisetites columnaris*. [*Equisetum Muensteri* and *E.* cf. *Lyelli*. M.] The stems of *Equisetites* figured by Bartholin and Möller bear a resemblance to the smaller forms of *E. columnaris*.
Lycopodiales.			
Lycopodites falcatus, L. & H.	Cf. *Lycopodites* sp. (The fragments figured by Prof. Nathorst[2] appear to be too small to identify with any certainty.)	*Lycopodites falcatus*. [*Cheirolepis gracilis*. F.]	*L. falcatus*. M.
Filicales.			
Matonidium Gœpperti (Ett.).			
Laccopteris polypodioides (Brongn.).	.....	.....	*Laccopteris polypodioides*. M.
L. Woodwardi (Leck.)...	.....	.....	*L. Woodwardi*. [*Microdictyon Woodwardi*. M.]
Todites Williamsoni (Brongn.).	Cf. *Todites Williamsoni*. [*Asplenium whitbiense* (Brongn.). Y.]		
Coniopteris hymenophylloides (Brongn.).	? *Coniopteris hymenophylloides*. [*Dicksonia nephrocarpa*. Y.]	*Coniopteris hymenophylloides*. [*Hymenophyllites Buburyanus*. F.; *Sphenopteris arguta*. F.]	*Coniopteris hymenophylloides*. [*Sphenopteris hymenophylloides* and *Dicksonia Pingelii*. M.]
C. quinqueloba (Phill.).			
C. arguta (L. & H.).....	*Cladophlebis Dunkeri* (Schimp.). (This Wealden type[3] is hardly distinguishable from *C. arguta*.) [*Pecopteris exilis*. Y.; *P. Geyleriana*. N.]	Cf. *Cladophlebis arguta*. [*Pecopteris lobata*. F.]	Cf. *Cladophlebis arguta*. [*Thaumatopteris gracilis*. M.]
Dictyophyllum rugosum, L. & H.	.....	.....	*Dictyophyllum rugosum*. [*D. Muensteri*; *D. acutilobum*; *D. Nilssonia*. M.]
Klukia exilis (Phill.).			
Ruffordia Gœpperti (Dunk.).			
Cladophlebis denticulata (Brongn.).	Cf. *Cladophlebis denticulata*. [*Asplenium distans*. Y.] [*Cladophlebis* sp. N.]	*Cladophlebis denticulata* [*Alethopteris indica*. F.] [*Asplenites macrocarpus*. F.]	Cf. *Cl. denticulata*. [*Cl. nebbensis*. M.]
Cl. lobifolia (Phill.).....	.....	.....	*Cladophlebis lobifolia*. [*Dicksonia lobifolia*. M.]
Sphenopteris princeps, Presl.	.....	.....	*Sphenopteris princeps*. [*Acrostichides princeps*. M.]

[1] Seward (94) p. 29.
[2] Nathorst (90) pl. ii, fig. 3.
[3] Seward (94) p. 100 & pl. vii, fig. 3.

ENGLAND.	JAPAN.	INDIA.	BORNHOLM.
FILICALES (*cont.*).			
Sphenopteris Williamsoni, Brongn.			
Sph. Murrayana (Brongn.)			
Tæniopteris vittata (Brongn.).	.....	Cf. *Tæniopteris vittata.* [*Angiopteridium ensis.* F.]	Cf. *Tæniopteris vittata.* [*T. tenuinervis*, Brauns. M (*pars*).]
T. major, L. & H.	.....	Cf. *Tæniopteris major.* [*Macrotæniopteris crassinervis* and *M. ovata.* F.]	Cf. *Tæniopteris major.* [*T. tenuinervis.* M (*pars*).]
Sagenopteris Phillipsi (Brongn.).	.....	.....	*Sagenopteris Phillipsi.* M.
Pachypteris lanceolata (Brongn.).	.....	Cf. *Pachypteris lanceolata.* [*Dichopteris ellorensis.* F.]	*Pachypteris lanceolata.* [*Cycadopteris heterophylla.* M.]
CYCADOPHYTA.			
Williamsonia gigas (L. & H.).	.....	Cf. *Williamsonia gigas.*	
W. pecten (Phill.)	.....	*W. pecten.* [*Ptilophyllum acutifolium, Pt. cutchense*, and cf. *Otozamites acutifolius.* F.]	
Anomozamites Nilssoni (Phill.).	.....	.....	Cf. *Anomozamites Nilssoni.* [? *Nilssonia Muensteri*, Schimp. B (*pars*).]
	Nilssonia, cf. *schaumburgensis* (Dunk.). (Probably identical with Dunker's Wealden species.[1])		
Otozamites Beani (L. & H.).	.....	.....	Cf. *Otozamites Beani.* [*O. obtusus.* B.]
O. Bunburyanus, Zigno.			
O. graphicus (Leck. *ex* Bean MS.).			
O. acuminatus (L. & H.).			
O. parallelus, Phill. ...	.....	*Otozamites parallelus.* F. [Cf. also *O. Oldhami.* F.]	
O. obtusus (L. & H.), var. *ooliticus.*			
O. Feistmanteli, Zigno.	.....	Cf. *O. Feistmanteli.* [*O. benhalensis* and *O. abbreviatus.* F.]	Cf. *O. Feistmanteli.* [*O. Reglei.* B.]
Nilssonia compta (Phill.)	.....	Cf. *Nilssonia compta.* [*Pterophyllum princeps.* F.]	Cf. *Nilssonia compta.* [*N. polymorpha*, Schenk. B (*pars*).]
N. mediana (Leck. *ex* Bean MS.).	.....	? Cf. *Nilssonia mediana.* [*Pterophyllum Carterianum* & *Pt. propinquum.* F.]	
N. tenuinervis, Nath.	Cf. *N. tenuinervis.* [*Nilssonia orientalis*, Heer. Y.]	.....	*Nilssonia tenuinervis.* [*N. polymorpha.* B (*pars*).]

[1] Seward (95) p. 53.

England.	Japan.	India.	Bornholm.
Cycadophyta (*cont.*).			
Ctenis falcata (L. & H.).	.....	.....	Cf. *Ctenis falcata*. [*Ctenis Nathorsti*. M.]
Ptilozamites Leckenbyi (Leck. *ex* Bean MS.).			
Dioonites Nathorsti, Sew.	.....	Cf. *Dioonites Nathorsti*. *Zamites proximus*. F.]	Cf. *Dioonites Nathorsti*. [? *Pterophyllum Braunianum*, Gœpp. B (*pars*).]
Podozamites lanceolatus (L. & H.).	*Podozamites lanceolatus*. Y.		
Ginkgoales.			
Ginkgo digitata (Brongn.).	*Ginkgo digitata*. Y. A species named by Dr. Yokoyama *Ginkgodium Nathorsti*, an abundant Japanese type, probably a member of the Ginkgoales, is not represented in the Yorkshire flora.	.....	*Ginkgo digitata*. B.
G. whitbiensis, Nath.			
Baiera gracilis, Bunb.			
B. Lindleyana (Schimp.).			
B. Phillipsi, Nath.			
Beania gracilis, Carr.			
Czekanowskia Murrayana (L. & H.).	.....	.....	*Czekanowskia Murrayana*. [*Cz. rigida*. B.]
Coniferales.			
Araucarites Phillipsi, Carr.	.....	Cf. *Araucarites Phillipsi*. [*A. cutchensis*. F.]	
Pagiophyllum Williamsoni (Brongn.).	.....	Cf. *Pagiophyllum Williamsoni*. [*Cheirolepis*, cf. *Muensteri*. F.]	Cf. *Pagiophyllum Williamsoni*. [*P. peregrinum*. B.]
Cheirolepis setosus (Phill.).			
Brachyphyllum mamillare, Brongn.	.....	Cf. *Brachyphyllum mamillare*. [*Echinostrobus indicus*, *E. rajmahalensis*, &c. F.]	
Taxites zamioides (Leck. *ex* Bean MS.).	.....	*Taxites zamioides*. [*T. planus*. F.]	

Japan.

In has been pointed out in a previous publication that several of the Mesozoic species described by Geyler,[1] Yokoyama,[2] and Nathorst[3] are probably identical with European Wealden species. The flora including *Dictyozamites*, with which we are chiefly concerned, is referred by Dr. Yokoyama to the Bathonian stage of the Inferior

[1] Geyler (77).
[2] Yokoyama (90) & (95).
[3] Nathorst (90).

Oolite; the plants described by Prof. Nathorst and in a later paper [1] by Dr. Yokoyama were obtained from different localities, and probably belong to an uppermost Jurassic and Lower Cretaceous horizon. As regards the later floras, which contain several Wealden species, it is of interest to note the absence of *Weichselia Mantelli* (Brongn.), a species abundantly represented in the Wealden vegetation of Europe.[2]

India.

The Rajmahal Series of India, with which alone we are immediately concerned, contains, as Feistmantel pointed out, several forms which bear a close resemblance to types of Rhætic age, and there can be little doubt that this flora should be referred to a somewhat lower horizon than the Inferior-Oolite flora of England. In spite of its slightly more ancient facies, the Indian flora, as a whole, exhibits a close agreement in its composition with that of Yorkshire.

In the foregoing lists I have substituted the generic name *Williamsonia* for certain pinnate fronds from the Rajmahal Series, which it has been the general custom to include in Morris's genus *Ptilophyllum*. The use of the latter term, as one denoting Cycadean fronds peculiar to Indian floras and distinguished, by the manner of attachment and arrangement of the pinnæ, from European leaves of similar habit, has been one cause of exaggerating the differences between Indian and Western floras. Feistmantel, in his paper of 1876,[3] speaks of *Ptilophyllum*, like *Dictyozamites*, as an Indian genus, and the practice has been to regard species so named as essentially distinct from European types. In the British Museum Catalogue published in 1900,[4] I expressed the view that there is no difference, between the abundant fronds from the Inferior Oolite of Yorkshire formerly known as *Pterophyllum pecten*, L. & H., and certain Indian species referred to *Ptilophyllum*. This conclusion is based on the examination of several specimens of the Indian fronds and their comparison with the English forms. *Ptilophyllum cutchense* and *Pt. acutifolium* of Feistmantel appear to me, not merely generically but specifically, identical with the English species, and this opinion derives support from the association of both the Indian and English leaves with specimens of reproductive structures of the *Williamsonia*-type. There is no need to recapitulate the facts bearing on the probable connection between the small form of *Williamsonia*, named by Prof. Nathorst *W. Leckenbyi*,[5] and the fronds of *Pterophyllum pecten*, L. & H.; a conclusion arrived at by Mr. Carruthers in 1870,[6] and adopted by several authors. This question, as well as a fuller comparison of the Indian and European

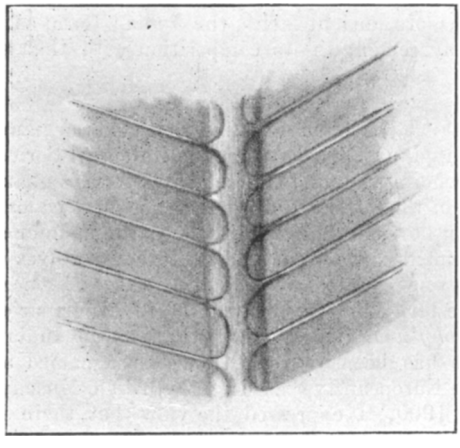
[1] Yokoyama (95).
[2] Seward (94) & (00[2]).
[3] Feistmantel (76) p. 5.
[4] Seward (00[3]) p. 192.
[5] Nathorst (80).
[6] Carruthers (70) p. 694.

fronds, is dealt with more fully in my Jurassic Catalogues, from which one sentence may be quoted :—

'A careful examination of Morris's type-specimen of *Ptilophyllum cutchense* (in the Museum of the Geological Society of London), and of several other Indian specimens in the British Museum, has convinced me that a generic separation of the Indian and European fossils serves to mislead, and indicates a distinction which does not exist.'[1]

Morris's type-specimen is represented in the accompanying figure, approximately three times the natural size. As regards the arrangement of the pinnæ and the form of their bases, the specimen presents the closest agreement with *Williamsonia pecten*. In some fronds of *W. pecten* the pinnæ have broader bases, with the upper edge more or less auriculate ; a similar variation is seen also in the Indian fronds.[2] The following definition of *Ptilophyllum* as given by Morris contains nothing that is not equally applicable to the fronds of *Williamsonia pecten* :—

Ptilophyllum cutchense of Morris [=*? Williamsonia pecten* (L. & H.)]. (× 3.)



Type-specimen.
(Geological Society's Museum, No. 9941.)

'Fronds pinnate, pinnæ closely approximated, linear, lanceolate, more or less elongate, imbricate at the base, attached obliquely ; base semicircular or rounded ; veins equal, slender, parallel.'[3]

Bornholm.

The flora described by Bartholin, and more recently by Dr. Möller, includes several English types from Inferior-Oolite rocks, but the occurrence of other forms identical with, and closely allied to, Liassic and Rhætic species leads me to assign it to a somewhat lower horizon than that of the Yorkshire plant-beds.

The foregoing lists do not include any of the extra-British plants which cannot be closely matched by species from the Yorkshire strata as tabulated in the first column. If we examine the complete lists of Japanese, Indian, and Bornholm plants, disregarding such

[1] Seward (00[3]) p. 193.
[2] See Feistmantel (76) pls. i–iv, and Seward (00[3]) pl. iii & text-figs. 31–34.
[3] Morris (40) expl. of pl. xxi.

species as are founded on inadequate evidence, with a view to discover the chief distinguishing features which they exhibit, as compared with the Jurassic vegetation of England, we find very little indication of any but minor differences. The Bornholm flora is essentially of the same general botanical type as that of Yorkshire, the chief distinguishing features being due to the greater resemblance, as regards certain types, to such Rhætic floras as those of Franconia [1] and Scania [2]; but these differences are rather of the nature of the relative representation of particular families, than of a kind that one would expect to find had the vegetation of the two regions flourished under different conditions. Taking the two European floras together, and contrasting them with those of Japan and India, we note the prominence of the Matonineæ [3] (*Matonidium*, *Laccopteris*) and the Dipteridinæ,[4] *Dictyophyllum* and *Protorhipis* [5] (including species of *Hausmannia* of Möller), as contrasted with the apparent absence of these families of Ferns in the Eastern floras. Similarly the Ginkgoales [6] are not represented by any species which we can assign with confidence to either *Ginkgo* or *Baiera* in the Indian flora. One of the genera recorded from India, and not represented in the floras of Yorkshire or Bornholm, is *Cycadites*, but the Rajmahal forms of this genus may well be identical with a European species, *Cycadites rectangularis*, which occurs in the Liassic strata of England and in the Rhætic flora of Franconia.

In all the floras Cycadean plants play an important part. With regard to *Williamsonia* we have proof of its occurrence, in both India and Western Europe, supplied by the presence of reproductive organs; but the other Cycadophyta common to the different regions are represented almost solely by vegetative fragments.

A striking agreement, as regards the Ferns represented in the Eastern and Western floras, is clearly brought out in the foregoing lists. The Conifers of India and England agree in including representatives of *Araucarites*, but for the rest a comparison as regards family or generic identity is almost impossible in the absence of well-preserved cones. Such vegetative specimens as occur in the four floras appear to be of similar type, and we are justified in the conclusion that there is no evidence of any striking contrast between the Coniferæ of the East and the West. The character of the vegetation of the world from the Upper Triassic Period to the Wealden seems to have been remarkably uniform and constant in its main features. On a future occasion I hope to discuss in greater detail the distribution and composition of the various floras of Mesozoic type. The marked contrast exhibited by the Palæozoic vegetation on the one hand, and the Tertiary vegetation (including that of the greater part of the Cretaceous Era) on the other, to that which flourished through the whole Jurassic Era is a striking fact, well worthy of more critical and extensive consideration than it has so far received.

[1] Schenk (67).
[2] Nathorst (78) (78[2]) & (78[3]).
[3] Seward (99).
[4] See also Zeiller (97).
[5] Seward & Dale (01).
[6] Seward & Gowan (00).

Conclusion.

The main object of this paper is to record the occurrence in the Jurassic plant-beds of Yorkshire of a genus previously supposed to be confined to Japan, India, and Bornholm. A comparison of the Lower Jurassic flora from the Rajmahal Series of India with European floras reveals a greater similarity between the vegetation of Eastern and Western regions during part, at least, of the Mesozoic Era than is usually admitted. The differences between Mesozoic floras of approximately the same geological age are for the most part few and unimportant, when we consider their wide geographical separation.

Equisetaceous plants are practically ubiquitous; several ferns of apparently the same species occur in the far East and in Western Europe; Cycadaceous plants are represented by cosmopolitan types, and the same may be said of the genus *Araucarites* and other members of the Coniferæ. The most noteworthy exceptions are afforded by the Mesozoic representatives of the two isolated recent ferns *Matonia*[1] and *Dipteris*[2]; these two families—each with a surviving genus—played a conspicuous part in the vegetation of the Rhætic and succeeding Jurassic periods in Europe and, to a less extent, in North America, but we have no satisfactory records of their existence in India or Japan. A similar state of things is illustrated by the Ginkgoales, the class of which the maidenhair tree of China and Japan (*Ginkgo biloba*[3]) forms the solitary survivor; the abundance of both *Ginkgo* and *Baiera* in Europe is in striking contrast to their almost complete absence in India.

Bibliography.

Bartholin, C. T. (92). 'Nogle i den bornholmske Juraformation forekommende Planteforsteninger.' Botan. Tidsskr. Botan. Foren. Kjœbenhavn, vol. xviii, p. 12. 1892.
—— (94). *Ibid.* vol. xix, p. 87. 1894.
Carruthers, W. (70). 'On Fossil Cycadean Stems from the Secondary Rocks of Britain.' Trans. Linn. Soc. vol. xxvi, p. 675. 1870.
Feistmantel, O. (76). 'Ueber die Indischen Cycadeengattungen *Ptilophyllum*, Morr., und *Dictyozamites*, Oldh.' Palæontographica, Suppl. iii. 1876.
—— (77). 'Jurassic (Liassic) Flora of the Rajmahal Group in the Rajmahal Hills.' Mem. Geol. Surv. India, Pal. Indica, ser. 2, vol. i, pt. 2. 1877.
—— (77[2]). 'Jurassic (Liassic) Flora of the Rajmahal Group from Golapili (near Ellore), S. Godavari District.' *Ibid.* pt. 3. 1877.
Fox-Strangways, C. (92). 'The Jurassic Rocks of Britain. Vol. I. Yorkshire.' Mem. Geol. Surv. 1892.
Geyler, H. T. (77). 'Ueber fossile Pflanzen aus der Juraformation Japans.' Palæontographica, vol. xxiv, p. 221. 1877.
Hjorth, A. (99). 'Vellengsbyleret og dets Flora.' Danmarks Geol. Undersögelse, ser. 2, No. 10, p. 61. 1899.
Medlicott, H. B., & Blanford, W. T. (93). 'Manual of the Geology of India.' 2nd edit., by R. D. Oldham. Calcutta, 1893.
Leckenby, J. (64). 'On the Sandstones & Shales of the Oolites of Scarborough,

[1] Seward (99).
[2] Seward & Dale (01).
[3] Seward & Gowan (00).

with Descriptions of some New Species of Fossil Plants.' Quart. Journ. Geol. Soc. vol. xx, p. 74. 1864.
MÖLLER, H. (02). 'Bidrag till Bornholms Fossila Flora. Pteridofyter.' Kongl. Fysiogr. Sällsk. Handl. vol. xiii. Lund, 1902.
—— (03). 'Bidrag till Bornholms Fossila Flora (Rhät och Lias)—Gymnospermer.' Kongl. Svensk. Vetenskaps-Akad. Handl. vol. xxxvi, No. 6. 1903.
MORRIS, J. (40). 'Memoir to illustrate a Geological Map of Cutch.' (Grant, C. W.) Trans. Geol. Soc. ser. 2, vol. v, pt. ii, p. 289. 1840.
NATHORST, A. G. (78). 'Om Floran i Skånes Kolförande Bildningar. I. Floran vid Bjuf.' Sver. Geol. Undersökn. ser. C, No. 27. 1878.
—— (78²). 'Beiträge zur fossilen Flora Schwedens. Ueber einige rhätische Pflanzen von Pålsjö in Schonen.' 4to, Stuttgart, 1878.
—— (78³). 'Om Floran i Skånes Kolförande Bildningar. Floran vid Höganäs och Helsingborg.' Sver. Geol. Undersökn. ser. C, No. 29. 1878.
—— (80). 'Några Anmärkningar om *Williamsonia*, Carruthers.' Öfvers. k. Vetenskaps-Akad. Förhandl. No. 9, p. 33. 1880.
—— (88). 'Nya Anmärkningar om *Williamsonia*.' *Ibid.* No. 6, p. 359. 1888.
—— (89). 'Sur la Présence du Genre *Dictyozamites*, Oldham, dans les Couches jurassiques de Bornholm.' Overs. kongl. dansk. Vidensk. Selsk. Forhandl. p. 96. 1889.
—— (90). 'Beiträge zur Mesozoischen Flora Japans.' Denkschr. k. Akad. Wissensch. Wien, vol. lvii, p. 43. 1890.
—— (02). 'Beiträge zur Kenntniss einiger mesozoischen Cycadophyten.' Kongl. Svensk. Vetenskaps-Akad. Handl. vol. xxxvi, No. 4. 1902.
OLDHAM, T. (60). 'On the Geological Relations, & probable Geological Age, of the several Systems of Rocks in Central India & Bengal.' Mem. Geol. Surv. India, vol. ii, p. 299. 1860.
OLDHAM, T., & MORRIS, J. (63). 'Fossil Flora of the Rajmahal Series in the Rajmahal Hills.' Mem. Geol. Surv. India, Pal. Indica, ser. 2, vol. i, pt. i. 1863.
SCHENK, A. (67). 'Die fossile Flora der Grenzschichten des Keupers und Lias Frankens.' Wiesbaden, 1865–67.
SEWARD, A. C. (94). 'Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Nat. Hist.). The Wealden Flora, pt. i. 1894.
—— (95). Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Nat. Hist.). The Wealden Flora, pt. ii—Gymnospermæ. 1895.
—— (97). 'On the Leaves of *Bennettites*.' Proc. Phil. Soc. Cambridge, vol. ix, p. 273. 1897.
—— (99). 'On the Structure & Affinities of *Matonia pectinata*, R. Br., with Notes on the Geological History of the Matonineæ.' Phil. Trans. Roy. Soc. vol. cxci, B, p. 171. 1899.
—— (00). 'Notes on some Jurassic Plants in the Manchester Museum.' Mem. & Proc. Manch. Lit. & Phil. Soc. vol. xliv, No. 8, p. 1. 1900.
—— (00²). 'La Flore Wealdienne de Bernissart.' Mém. Mus. Roy. d'Hist. Nat. Belg. vol. i. 1900.
—— (00³). 'Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Nat. Hist.). Part III. The Jurassic Flora. I.' 1900.
SEWARD, A. C., & DALE, E. (01). 'On the Structure & Affinities of *Dipteris*, with Notes on the Geological History of the Dipteridinæ.' Phil. Trans. Roy. Soc. vol. cxciv, B, p. 487. 1901.
SEWARD, A. C., & GOWAN, J. (00). 'The Maidenhair Tree (*Ginkgo biloba*, L.).' Annals Bot. vol. xiv, p. 109. 1900.
SOLMS-LAUBACH, H. GRAF ZU (90). 'Ueber die Fructification von *Bennettites Gibsonianus*, Carr.' Botan. Zeitung, vol. xlviii, p. 789. 1890. [Translation in Annals of Botany, vol. v, p. 419. 1890–91.]
WIELAND, G. R. (99). 'A Study of some American Fossil Cycads.' Pt. i. Amer. Journ. Sci. ser. 4, vol. vii, p. 219. 1899.
—— (99²). Pt. ii. *Ibid.* p. 305. 1899.
—— (01). Pt. iv. *Ibid.* ser. 4, vol. xi, p. 423. 1901.
WILLIAMSON, W. C. (70). 'Contributions towards the History of *Zamia gigas*, Lindl. & Hutt.' Trans. Linn. Soc. vol. xxvi, p. 663. 1870.
YOKOYAMA, M. (90). 'Jurassic Plants from Kaga, Hida, & Echizen.' Journ. Coll. Sci. Imp. Univ. Japan, vol. iii, p. 1. 1890.
—— (95). 'Mesozoic Plants from Kōzuke, Kii, Awa, & Tosa.' *Ibid.* vol. vii, p. 20. 1895.
ZEILLER, R. (97). 'Revue des Travaux de Paléontologie Végétale publiés dans le cours des années 1893–1896.' Rev. Gén. Bot. vol. ix, p. 324. 1897.
—— (00). 'Eléments de Paléobotanique.' Paris, 1900.

EXPLANATION OF PLATE XV.

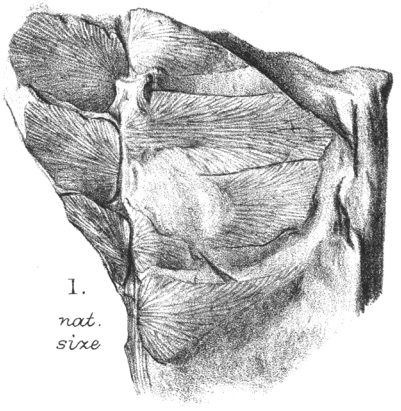
Fig. 1. *Dictyozamites Hawelli*, sp. nov. Natural size.
2. *D. Hawelli*. Base of the lowest pinna shown in fig. 1: a = surface by which the pinna was attached to the rachis; r = rachis of frond. Enlarged three times natural size.
3. *D. Hawelli*. Natural size.
4. *D. Hawelli*. Portion of one of the pinnæ shown in fig. 3. Enlarged twice natural size.
5. *D. falcatus* (Morr.). × 3.
6. *D. falcatus* (Morr.). × 3.
7. *D. falcatus* (Morr.). The portion shown in fig. 6 represented natural size.
8. *D. falcatus* (Morr.). Single pinna, showing venation. × 3.

[The specimens of *D. Hawelli* are from Mr. Hawell's collection, and are to be deposited in the British Museum (Nat. Hist.); the drawings of *D. falcatus* were made from specimen No. 52546 in that Museum.]

Discussion.

The President spoke of the geological interest of this paper, as giving a fresh example of a fact familiar to many palæontologists who had devoted themselves to a single and well-defined group of fossils, namely, the close similarity of the collective forms belonging to that group occurring on about the same geological horizon in different regions of the globe. It was often a grave difficulty to decide whether the minor dissimilarities were of sufficient importance to warrant the present distinctions in nomenclature. The resemblances and differences no doubt both existed, and neither should be ignored; but in most cases, as shown by the Author in the present instance, the resemblances were of the higher systematic consequence. The great similarity between the Mesozoic vegetation of the Eastern and Western regions pointed out by the Author was of extreme interest; and when one bore in mind the great contrast between the Permo-Carboniferous flora and the Mesozoic flora of the Northern Hemisphere, and the fact that the *Glossopteris*-flora had already appeared in the Southern Hemisphere in later Permo-Carboniferous times, the Author's views seemed to have a high theoretical significance.

Dr. Blanford remarked that the paper was of great interest, and expressed gratitude to the Author for light thrown on an important portion of the world's history. The history of the genus *Dictyozamites* commenced in India. Some impressions of leaves in the Rajmahal Beds—shales interstratified with doleritic lava-flows—were at first referred to a fern, *Dictyopteris*, but subsequently were recognized as belonging to a Cycad and renamed *Dictyozamites*. The discovery of the same genus in the various regions recorded by the Author tended to link together the scattered occurrences of the Jurassic flora in the Northern Hemisphere. But this flora—or, rather, the Mesozoic flora as a whole, as defined by the Author—appeared to have been of worldwide distribution, and, with the possible exception of a Devonian flora, to have been the earliest that was known to have been generally distributed. Representatives of it had been found in South Africa and Australia, and recently



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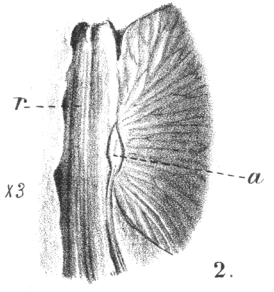

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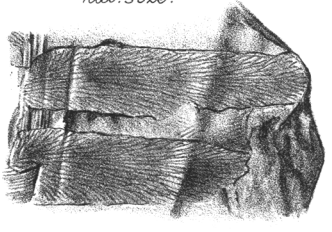

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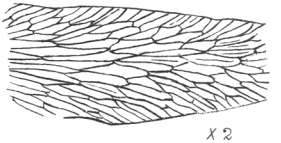

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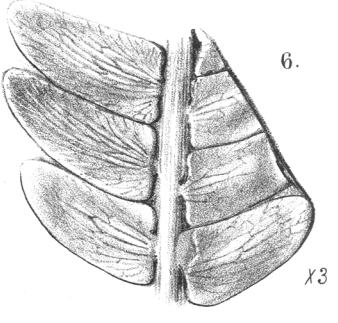

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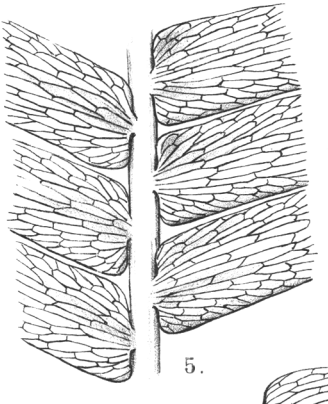

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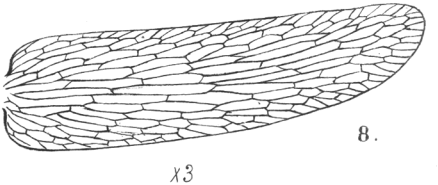

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X3

G.M.Woodward lith. Mintern Bros. imp.

DICTYOZAMITES.

large collections belonging to it, made in Argentina, had been described by Dr. Kurtz and Dr. Bodenbender. Nor was this the only interesting fact about the plant-life of Mesozoic times. In Upper Palæozoic days two very distinct floras co-existed: the Northern or *Lepidodendron*- and *Sigillaria*-flora of the British Coal-Measures, and the Southern or *Glossopteris*-flora of Australia, India, South Africa, and South America. Some slight intermixture of the floras existed in the two last-named areas; none had been detected in Australia or India. But the earliest Mesozoic flora of Europe, the Triassic, which differed completely from the Permian, contained several forms characteristic of the *Glossopteris*-flora, and very probably might have been derived from the latter. The Mesozoic flora, as the Author had pointed out, prevailed up to the earlier part of the Cretaceous Period, but was replaced in Upper Cretaceous times by the modern flora, abounding in Angiosperms; and this flora had continued down to the present day. The Mesozoic flora was perhaps derived from the Southern Hemisphere; but the origin of the Tertiary and recent flora was still one of the puzzles of Geology.