

III.—On the Fructification of two Coal-measure Ferns.

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[Plate I.]

CROSSOTHECA, Zeiller, 1883.

Crossothea, Zeiller, Ann. d. Sc. Nat. 6^e sér. Bot. vol. xvi. p. 180; id.

Flore foss. d. bassin houil. d. Valenciennes, p. 33, fig. 21.

Sorotheca, Stur, Zur Morph. u. Syst. d. Culm- u. Carbon-Farne, p. 175;

id. Carbon-Flora, i. p. 273.

Sorocladus, Lesquereux (in part), Coal Flora, vol. i. p. 327.

Description.—Fertile and barren pinnules dissimilar, the fertile pinnules having the limb much reduced. Sporangia exannulate, tapering to a point at the apex, contiguous, more or less united among themselves, and suspended like a fringe from the margin of the fertile pinnule.

Remarks.—This genus has been described and illustrated by Zeiller in the Ann. d. Sc. Nat. (l. c.) and in his 'Flore foss. d. bassin houil. d. Valenciennes.' In this latter work he gives additional and fuller figures of *Crossothea Crepini*, Zeiller †, the type of the genus, and also figures a second species, *Crossothea Boulayi*, Zeiller ‡.

The name of *Sorotheca* has been applied to the same plants by Stur; but his paper containing the description of his genus did not appear till some months after the issue of that in which Zeiller's genus *Crossothea* was defined.

Probably *Sorocladus sagittatus*, Lesqx. §, is referable to *Crossothea*; but *Sorocladus*, Lesquereux, has been employed by him merely as a genus in which to place "fructifications of ferns in separate branches and of unknown attribution" without any attempt at a definition, and, in fact, it embraces fructifications belonging to ferns of very different generic affinity.

The sporangia of *Crossothea* are linear, the base being slightly broader than the tapered apex. They are unprovided with an annulus, and the walls are composed of cells elongated in the direction of their axis. The sporangia are placed close together, and it is difficult to determine whether they are free or united to each other. According to Zeiller

* Communicated by the Author, having been read before the Royal Physical Society of Edinburgh, April 18, 1888.

† *Loc. cit.* p. 112, pl. xiii. figs. 1-3.

‡ *Loc. cit.* p. 115, pl. iv. fig. 4.

§ Coal Flora, vol. i. p. 329, pl. xlvi. figs. 10 and 10 b, vol. iii. p. 762, pl. C. figs. 4-5.

they appear to be united in pairs or perhaps in fours at the extremities of veins which are given off from a swelling of the pedicel that terminates in a thickening in the centre of the fertile pinnule.

It should be mentioned that what are here treated as exannulate sporangia are regarded by Stur as portions of an indusium which has burst at maturity into valves. This view, however, appears to be entirely at variance with the structure of the organs under consideration.

Among fossil genera *Crossothea* approaches most closely to *Calymmatotheca*; but in the latter genus the sporangia are not attached around the margin of a prominent disk, nor are they so fully united to each other. In *Calymmatotheca* the branches bearing them are also entirely deprived of foliage-pinnules, and ramify by a series of dichotomies; and, as far as observation has shown, the fruiting pinnæ are only borne at the base of the frond.

Crossothea fimbriata, Kidston, n. s.
(Pl. I. figs. 1-8.)

Description.—Frond tripinnate, pinnæ deltoid, subalternate. Fertile and barren pinnæ dissimilar. Fertile pinnules simple, with the limb much modified; sporangia exannulate, linear, numerous, united to each other and suspended from a central disk, which is borne at the summit of a slender pedicel. Barren pinnules divided into from two to seven single-veined, simple or bifid, linear segments, according to their position on the pinna.

Remarks.—The specimens of *Crossothea fimbriata* which I have the pleasure of describing were communicated to me by Mr. William Hemingway, to whom my thanks are due for the opportunity of examining this interesting addition to the Coal-measure flora of Britain.

Figs. 1-3 show portions of what are probably primary pinnæ; at the right of the pinna in fig. 1 is a small fragment of a rachis, to which probably the fruiting pinna was attached.

The sporangia are borne as a fringe at the margin of what appears to have been an oval disk. This disk and, more particularly, the sporangia appear to have possessed a considerable thickness of tissue, which contrasts markedly with the delicate structure of the barren pinnules. The sporangia are converted into a bright, brittle, carbonaceous substance, so that in splitting the stone in almost all cases they are more or less fractured; and, further, in no case where they are at all well preserved have I been able to discover a complete

fruiting pinnule, one half of each pinnule having apparently adhered to each side of the matrix when the stone was split. Thus there is only one half of the disk with its surrounding fringe of sporangia shown respectively on the fossils and their counterparts.

Figs. 4 and 5 represent each two fruiting pinnules, magnified six and a half times. These figures are drawn under the microscope with the camera lucida, and every endeavour has been taken to avoid any "restoration;" so that those who cannot see the originals may form their own conclusions from the drawings.

Fig. 4 is an enlargement of the two fruiting pinnules marked *a* in fig. 1. Both these pinnules, as already mentioned, are split through the middle, so that only half the disk and its fringe of sporangia are shown. The sporangia appear to have depended almost at right angles from the margin of the supporting disk. In no case did I see any trace of a thickened vein in the disk-like portion of the pinnule like that figured and described by Zeiller (see fig. 9).

Owing to the fruiting pinnules being split in two—and this arises evidently from the comparatively thick mass of coaly matter into which they have been converted—the pinnules have the appearance of being attached to the pedicels by their centre, within the fringe of sporangia; but in reality I believe the pedicels are attached to the outside edge of the fruiting pinnules, like a leaf to its stalk, and that the pedicel is bent into a knee, which causes the pinnule to assume a horizontal position. The apparent *peltate* attachment of the fruiting pinnules to the pedicels is therefore probably caused by the pinnule *lying upon* the pedicel and concealing the upper part of it.

Fig. 5 exhibits very much the same characters as fig. 4.

Fig. 6 shows four sporangia, enlarged eighteen times. The form of the sporangia is better shown here than in the previous figures. This figure is part of the fruiting pinnule marked *b* in fig. 1. The sporangia are linear and apparently blunt-pointed, as shown by that to the left; the other three are probably broken over at their apices. They all show, especially those to the left, an apparent basal contraction which ends in a short pedicel. The sporangia are clearly united to each other and only free at the apex. For the purpose of comparison I have given a copy of a fruiting pinnule of *Crossothea Crepini*, as figured by Zeiller (fig. 9).

The barren pinnules of *Crossothea fimbriata* are of very delicate texture, and though they frequently occur on the same slabs as the fruiting specimens they are seldom well

preserved. Two fragments are shown in figs. 7 and 8. Barren pinnæ have been observed attached to the same rachis as the fruiting pinnæ, and in one case one of these fruiting pinnæ has a few barren pinnules interspersed with the fruiting ones.

Crossotheca fimbriata in the barren condition seems undistinguishable from *Calymmatotheca schatzlarensis*, Stur*. The figures given by Stur are somewhat indistinct, especially that showing the fruit of his fern (fig. 2), from which really nothing can be learnt of the form and structure of the fructification. In his description he refers to the imperfect preservation of the fruit of his specimen, but among other remarks mentions that the fruit contains four or five sporangia (valves (Klappen) of an indusium according to Stur), which are directed downwards and only free at their upper part, that the upward directed portion of the fructification to which the supporting stalk is attached is convex, and that the fruit is 2-3 millim. long and 1.2-1.4 millim. broad. Notwithstanding the somewhat imperfect condition in which the fruit is said to be, a very distinct woodcut of the same is given on p. 238, fig. 40. Accepting, then, this figure and description as correct, *Crossotheca fimbriata* is essentially distinct from *Calymmatotheca schatzlarensis*, Stur. In *Crossotheca fimbriata* the *synangia* are broader than long, having a breadth of from 3-4 millim. and a length of about 2 millim. in the compressed condition. Again, in *Crossotheca fimbriata* the sporangia are numerous, narrow, oblong, or linear, and are united to each other throughout almost the whole of their length. The fructification of the two species is therefore altogether dissimilar. It is possible that the specimens examined by Dr. Stur were not so fully developed as those figured by me, for on some of the small slabs from Yorkshire, on which the fruit appears to be younger and scarcely so well preserved as in the specimens I have figured, the entire synangium is oval and but little broader than long, and in this condition it has a much closer approach in general appearance to fig. 40 given by Stur on p. 238 of his 'Carbon-Flora' than to those given on my plate.

The affinities of *Crossotheca fimbriata* are clearly *Marattiaceous*. In the union of the sporangia to each other, their attachment to an oval (or circular) disk, and in their forming a cup-like synangium, they have a considerable similarity to the synangia of *Kaulfussia*, Blume; but in *Kaulfussia* the synangia are scattered on the back of the frond, not on portions of the frond specially metamorphosed for fructification.

* Carbon-Flora, i. p. 265, pl. xxxviii. figs. 1, 2 (1885).

Localities.—Monkton Colliery, near Barnsley, and East Gawber Colliery, Barnsley, Yorkshire.

Horizon.—Middle Coal-measures; Shale over "Barnsley Thick Coal."

CYCLOTHECA, Kidston, n. g.

Description.—Sporangia small, free, sessile, circular, exanulate, and arranged in two parallel rows.

Remarks.—In structure the individual sporangia approach closely to those of *Myriothea*, Zeiller *, but in *Myriothea* the sporangia are oval and cover the whole of the lower surface of the pinnules.

In *Renaultia*, to which *Cyclothea* has also some affinity in the structure of the sporangia, the sporangia are situated at the extremities of the veins either singly or in groups of from two to five. *Cyclothea* differs from both these genera in the sporangia being circular and arranged in two parallel rows—probably one row was situated on each side of the midrib of the fruiting pinnule.

Cyclothea belongs to the Marattiaceæ, and is more closely related by the structure of its sporangia to *Angiopteris* than to any other recent genus.

Cyclothea biseriata, Kidston, n. s.
(Pl. I. figs. 10–12.)

Description.—Characters of genus. The sporangia measure .50 millim. in diameter, and their walls are composed of small cells not elongated more in one direction than the other.

Remarks.—This species is founded on a single specimen which was collected by Mr. P. Jack near Baillieston. Fig. 10 shows the fossil, natural size. It consists of several pinnæ lying on each side of the rachis, of which a small fragment is shown towards the centre of the figure. With the exception of this fragment of rachis there is nothing preserved in the fossil but the parallel rows of sporangia. These are well preserved and shown at fig. 11, magnified six and a half times. At fig. 12 are given four sporangia, magnified twenty times. Although no trace of a midrib is shown, one probably lay between the parallel rows of sporangia.

The small specimens originally figured by Lesquereux as *Staphylopteris asteroides* † probably belong to the genus *Cyclothea*.

* Ann. d. Sc. Nat. 6^e sér. vol. xvi. Bot. p. 186, pl. ix. figs. 18–20; also Flore foss. du bassin houil. d. Valenciennes, p. 32, fig. 19.

† Rep. Geol. Survey of Illin. vol. iv. pl. xiv. figs. 8–10.

It is impossible to say to which fern the Baillieston fructification belongs. As the fruiting portion of ferns often assumes an outline so entirely different from that of the barren condition, I refrain from any suggestion upon this point.

Locality.—Ellismuir, Baillieston, Lanarkshire.

Horizon.—Lower Coal-measures: shales above the "Kil-longue" Coal.

Note.—Since this paper was put into type I have been favoured by my friend, M. Crépin, Director of the State Botanical Gardens, Brussels, with two fruiting specimens of *Calymmatotheca schatzlarensis*, Stur, from one of the original localities—Charbonnage de l'Agrappe, Frameries (Fosse Grand Trait), Belgium. With these I have compared the Yorkshire examples, and find that the plant I had named *Crossotheca fimbriata* is the *Calymmatotheca schatzlarensis*, Stur. The woodcut given by Stur of the fruit of his fern (*l. c.* p. 238, fig. 40) is therefore quite misleading, and does not at all represent the fruit of the plant from the same locality which has been forwarded to me by Mons. Crépin under Stur's name. In fact the description Stur gives of his admittedly badly preserved fruit leads one to inquire whence the evidence has come for the creation of his fig. 40.

The fossil remains, however, in the genus *Crossotheca*, but under the name of *Crossotheca schatzlarensis*, Stur, sp.

Stirling,
June 6, 1888.

EXPLANATION OF PLATE I.

Crossotheca fimbriata, Kidston.

Figs. 1–3. Fruiting pinnæ.

Figs. 4 & 5. Synangia, enlarged $6\frac{1}{2}$ times.

Fig. 6. Portion of a synangium, enlarged 18 times.

Figs. 7 & 8. Fragments of barren pinnæ.

Crossotheca Crepini, Zeiller.

Fig. 9. Fruiting pinnule, enlarged 5 times (after Zeiller).

Cyclothea biseriata, Kidston.

Fig. 10. Specimen, natural size.

Fig. 11. Sporangia, enlarged $6\frac{1}{2}$ times.

Fig. 12. Sporangia, enlarged 20 times.



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