CROSSOTHECA URBANI SP. NOV., A MALE FRUCTIFICATION FROM THE PENNSYLVANIAN (DESMOINESIAN SERIES, VERDIGRIS FORMATION) OF MISSOURI, U.S.A.

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ABSTRACT

Crossotheca urbani Cridland & E. L. Darrah is described from the Verdigris Formation, Desmoinesian Series, Pennsylvanian of Missouri, U.S.A. In general aspects, this species resembles *C. sagittata* and *C. boulayi* but the laminate fertile regions of the pinnules are ovoid to oblong. Two rows of corrugated impressions on the pinnules are taken to represent sporangia. Sterile foliage is unknown. The species is known only from the holotype, a specimen preserved in an ironstone nodule, which was studied by a plastic transfer technique.

INTRODUCTION

THE genus *Crossotheca* occupies a place of special interest in paleobotany. It is a male fructification which is discovered sporadically in Pennsylvanian and Upper Carboniferous strata in the Northern Hemisphere. The genus attained its highest notoriety when specimens were attributed to that classic pteridosperm *Lyginopteris*, although this attribution has been disputed and is now generally disregarded. Another possibility is that *Crossotheca* is a fern or fern-like plant, and it may be that some species are pteridosperms while others are ferns. In these circumstances it seems worthwhile to place on record the discovery of a new specimen of *Crossotheca*, slightly different in structure to those known previously. Unfortunately, the preservation of this specimen is poor and although it has been transferred and macerated, no details of spores or cuticles have been discovered.

The specimen was collected during August 1965, from the spoil dumps of the Windsor Coal Company's abandoned strip mine approximately 2 miles northwest of Windsor, Henry County, Missouri. Plant fossils occur here in the Verdigris Formation, where they are most obvious in the abundant ironstone nodules weathering on the surfaces of the dumps. In addition plant fossils may also be obtained from a gray shale, but since a considerable amount of weathered overburden has to be removed to get at the less weathered fossil bearing shale in the dumps, these specimens are overlooked by the casual collector. Although this locality is apparently well known to local geologists and amateur collectors, the species list and discussion in Bode's (1958) work is the only publication we have discovered which mentions fossils from the vicinity of Windsor. Despite the prolific fossiliferous nature of the Verdigris Formation at this locality and the extensive collection made (more than 1,500 hand specimens were collected), the specimen of *Crossotheca* described here is unique.

TECHNIQUES

The *Crossotheca* was preserved in a broken calcareous ironstone nodule, (PL. 1, FIG. 1) of which only a portion of the counterpart was recovered (PL. 1, FIG. 2). It is represented by part of a pinna, with the pinnules preserved as delicate fragmentary carbonaceous films and the rachis of more substantial carbonaceous material. The specimen is from a fertile region of a frond but there is no way of knowing whether it is the fertile apical region of an otherwise sterile pinna or frond or if it is part of an entirely fertile organ.

The exposed surfaces of some pinnules were obscured by deposits of calcite (PL. 1, FIGS. 1, 2), which were dissolved by standing the specimen in 2 per cent hydrochloric acid for several hours. Removal of the calcite was facilitated by the gentle use of dissecting needles and a fine camel hair brush while the specimen was still immersed in the acid. The acid and fragments of material washed from the surface of the specimen were collected and processed for microfossils, but none was discovered. Subsequently, both part and counterpart were transferred, using a polyester resin (CRIDLAND & WILLIAMS, 1966). The rock adhering to the counterpart was dissolved in

48 per cent hydrofluoric acid, while that adhering to the part was dissolved in 20 per cent hydrochloric acid; a much more rapid process. After this treatment all pinnules of the part were seen to be selectively coated with a heavy deposit of iron pyrites and this was removed by immersing the transfer in 5 per cent nitric acid for several hours. As in the case of calcite adhering to the exposed surface of the specimen, removal of the pyrite from the transferred surface was facilitated mechanically. Fragments of material removed were collected and processed for microfossils, but none was discovered.

DESCRIPTION

Order-Pteridospermales (?)

Crossotheca Zeiller

Crossotheca urbani Cridland & E. L. Darrah

The pinna (Pl. 1, Fig. 3) is approximately 5 cm. long. It is evidently an apical region for it tapers, bearing secondary pinnae below but only bearing pinnules above. The secondary pinnae are arranged alternately, and the longest of them measures 18·5 mm. The rachis bearing these pinnae is almost 2 mm. wide. The pinnules have pedicels which are a little more than 1 mm. wide and vary in length from 1·5-7 mm. The laminate portions of the pinnules are elliptic to ovate and typical measurements for them are 8·5 mm.$\times$6 mm. for apical pinnules and 6 mm.$\times$4·5 mm. for pinnules lower on the pinnae. No details of venation are visible. It is most likely that the pinnules are arranged alternately, although this arrangement is obscured by the loss of pinnules, particularly from the acroscopic sides of the pinnae.

The few pinnules represented on the counterpart show no evidence of fertility, neither on the exposed surface nor on the transferred surface, and this is taken as evidence that the pinnules are represented here by impressions of the adaxial surface to which some carbonaceous material has adhered. There is no direct evidence for fertility of the part. No sporangia have been seen; no spores have been recovered. We can only point to two rows of corrugations on most pinnules, oriented at right angles to the pinnule axis, which occur in positions where sporangia might be anticipated (Pl. 1, Figs. 3, 4). We interpret these as marks left by sporangia. The preservation is such that it would be misleading to attempt more critical description or illustration of the corrugations. These corrugations are absent from apical pinnules (Pl. 1, Fig. 4).

DISCUSSION

This specimen is identified with *Crossotheca* because, in its gross aspects, and size it resembles the specimens of *C. sagittata* (Lesquereux) Sellards illustrated by W. C. Darrah (1937) and Janssen (1940). Apparently it also agrees with *C. sagittata* by possessing two rows of sporangia. There is the same general agreement with *C. boulayi* Zeiller, a species which can scarcely be differentiated from *C. sagittata* (Arnold & Steidtmann, 1937).

Both these species differ from *C. urbani* in possessing hastate pinnules (Janssen, 1940; W. C. Darrah, 1937; Arnold & Steidtmann, 1937).

Crossotheca urbani can be excluded from identification with many previously recognized species of *Crossotheca* in which the laminate portions of the fertile pinnules are significantly smaller. In some of these it is also clear that the sporangia circle the edge of the pinnule, rather than occurring in two rows. These species are: *C. aequabilis* Grand'Eury, 1890; *C. communis* Bell, 1938; *C. compacta* Bell, 1938; *C. crepini* Zeiller, 1888 (See also Round, 1922); *C. denticulata* Bell, 1938; *C. mcluckei* Andrews & Mamay, 1948; *C. nana* Round, 1922; *C. nyranensis* Nêmejc, 1937; *C. minima* Danzé, 1961; *Crossotheca* sp. Carpentier, 1927. *Crossotheca* (Kidston, 1911) probably also has small fertile pinnules, but it is described fleetingly and is poorly illustrated. Specimens of *Crossotheca* variously referred to under the names *C. hoeninghausi*, *C. schatzlarensis*, *C. hughesiana*, *C. kidstoni* and *C. communis* also have small fertile pinnules. (The nomenclature of these species is involved, see Jongmans, 1952a). *C. hughesiana*, the largest of these, may also be differentiated from *C. urbani* by its obtusely cordate fertile pinnules (Kidston, 1906). *C. trisecta* Sellards, 1902 is another species which can be excluded from comparison by virtue of its small fertile pinnules (measurements for laminate

portions are 3 mm. × 2·5 mm. to a maximum of 4 mm. × 2·5 mm.). Sellards believed that this species was unusual in having trisect fertile pinnules and occasional pinnules with even more lobes. Had we described the type specimen (no.862, Peabody Museum of Natural History, Yale University) we should have allowed for the ambiguity introduced by poor preservation and would not have talked of trisect pinnules. We regard each segment of the supposed trisect pinnules as a distinct sessile or almost sessile pinnule. In this respect, it is pertinent to point out that the insertion of pinnules illustrated by Sellards in figure 4a can be seen much more accurately and objectively than the insertion shown in his figure 4b.

It is difficult to make a precise comparison with *Crossotheca ophioglossoides* (Lesquereux) Sellards (1902), the only other specimen of *Crossotheca* known from Missouri. This is because Lesquereux (1879, PL. 48, FIG. 11; 1880, p. 329-330) provides no measurements and does not specify the magnification of his illustration. Even so, it is clear that the proportions of the pinnules are different from those in *C. urbani*. In *C. ophioglossoides* the pinnules are elliptic to oblong and they have a width/length ratio of approximately 1: 4. In *C. urbani* the pinnules are elliptic to ovate and have a width/length ratio of approximately 1:1·5.

Crossotheca (?) *gigantea* Depape & Carpentier, 1914, is known only from detached sporangia, while an illustration supposed to represent *Crossotheca* by Pepperberg (1911, PL. 9, FIG. 5) is unrecognizable.

Weissites, a genus of ferns known from fructifications which superficially resemble those of *Crossotheca* can be ruled out entirely. In *Weissites* a circular synangium covers the underside of a dangling peltate disc which has a centrally located pedicel (REMY, 1954). The type species of this genus, *W. pinnatifidus* was formerly regarded as a species of *Crossotheca*, *C. pinnatifida* (Gutbier) Potonié. It is not clear whether specimens of *C. pinnatifida* described by Jongmans (1952b) fall within Remy's conception of *Weissites*. However, the specimens are irrelevant for comparison with *C. urbani* since they are sterile and merely show pecopterid foliage.

No conclusion can be reached concerning the relationships of *C. urbani*. Many paleobotanists find it convenient to think of specimens of *Crossotheca* as the male parts of pteridosperms, but some consider them to be fern fructifications (DANZÉ, 1955). At present, no firm decision can be made. In those species where both sterile and fertile foliage of *Crossotheca* are known, there is considerable diversity in the form of the sterile foliage from species to species (ANDREWS & MAMAY, 1948). It is most likely that, in its present treatment, *Crossotheca* is a form genus rather than an organ genus. As more and better preserved specimens are discovered and studied, significant changes in taxonomy and nomenclature may be anticipated.

Crossotheca urbani, sp. nov.

Diagnosis — Pinna > 5 cm. long, bearing alternate, secondary pinnae below and pinnules above. Pinna rachis ± 2 mm. wide. Pinnules, alternate, pedicellate, pedicels ± 1 mm. wide, 1·5-7 mm. long; laminate portions elliptic to ovate, 6 mm. × 4·5 mm., bearing impressions of 2 rows of abaxial sporangia; apical pinnules larger, 8·5 × 6 mm., and sterile.

Holotype — Specimen no.1, Paleobotanical Collection, Botany Department, Washington State University.

Horizon — Verdigris Formation, Desmoinesian Series, Pennsylvanian System.

Locality — Spoil dump of abandoned strip mine (Windsor Coal Co., New Castle Coal) about 2 miles NW of Windsor, Henry County, Missouri. Center of E 1/2 Section 34, T. 44 N., R. 24 W. North of railroad track and southwest of Windsor City dump.

This species is named for Jim Urban.

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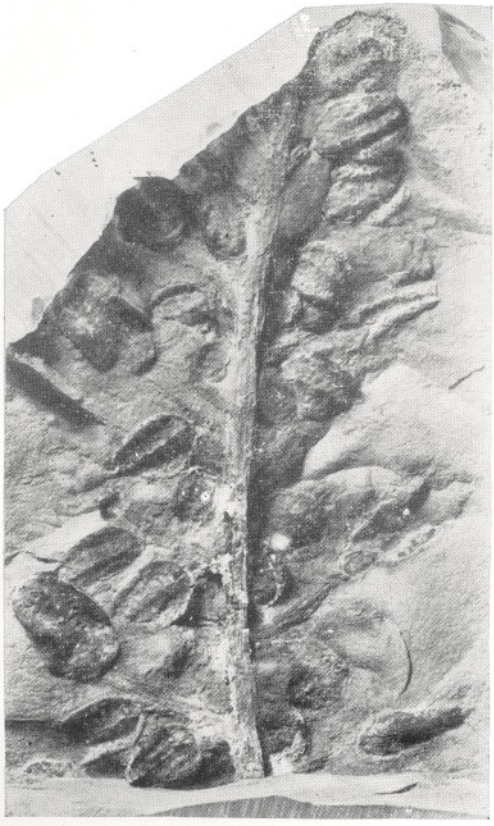
EXPLANATION OF PLATE 1

Crossotheca urbani sp. nov.

1. Part, × 1.
2. Counterpart, × 1.
3. Transferred surface of part, with encrusting pyrite removed, × 2.
4. Lower left-hand portion shown in fig. 3, enlarged, × 3.5.

1

2



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