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BULLETIN OF THE TORREY BOTANICAL CLUB
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Thallites dichopleurus sp. nov. from the Middle Pennsylvanian Mazon Creek flora

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DIMICHELE, WILLIAM A., and TOM L. PHILLIPS (Botany Dept., Univ. Illinois, Urbana, Ill. 61801). *Thallites dichopleurus* sp. nov. from the middle Pennsylvanian Mazon Creek flora. Bull. Torrey Bot. Club 103: 218–222. 1976.—An impression of a dorsiventral non-vascular plant (alga or liverwort) is described from an ironstone nodule from the Francis Creek Shale Member, Carbondale Formation, middle Pennsylvanian, from the Pit 11 source of the Mazon Creek flora and fauna of Illinois. The thallus exhibits five dichotomies along a length of seven cm., a distinct midrib up to 0.5 mm wide, and a total width of 5.5–8.1 mm, with undulate margins. Lack of definitive epidermal characters places the thallus in *Thallites*, in which it is the basis of a new species, *T. dichopleurus*. This is the first report of a thalloid plant from the Mazon Creek flora, and both its morphology and depositional provenance leave open the question of algal or bryophytic affinities.

Thalloid plants have not been previously reported from the Mazon Creek flora. In fact, only two species of *Thallites* are known for the Upper Carboniferous, *T. willsii* from England and *T. lichenoides* from Canada (Walton, 1925, 1949; Matthew 1907; Lundblad 1954); the remaining species are Mesozoic in age (Jovet-Ast 1967). In erecting the genus *Thallites*, Walton (1925) provided an option for specimens for which an unequivocal affinity to neither alga nor to thalloid liverworts could be established. For strictly vegetative material, the lack of rhizoids, holdfasts, air pores or other distinctive conceptacles or cavities in the thallus necessitates emphasis on size, shape, margins, branching, midribs (if present) and surface texture—all of which are assessed without opportunity to examine variability in populations because of the rarity of well preserved specimens.

The plant that we have described herein is a significant addition as the first distinct thalloid form from what is probably the best known vascular plant compression-impression flora in the Pennsylvanian, despite the equivocal nature of the evidence as to algal or bryophytic affinities. Comparisons with other thalloid plants indicate that the plant is not referable to any established species and a new specific assignment is deemed appropriate.

Materials and methods. The ironstone concretion with the impression plant specimen, part and counterpart, was collected by Mr. Harold W. Juntunen in 1973 from a spoils pile in Pit 11 of Peabody Coal Company's Northern Illinois Mine in Essex Township, Illinois. The concretion is derived from the Francis Creek Shale Member, Carbondale Formation, and is middle Pennsylvanian in age. The type specimen bears number PP19467 and is housed in the Geology Department, Field Museum of Natural History, Chicago, Illinois.

The specimen was examined with reflected light microscopy and the latex casts, prepared according to the technique of Chaloner and Gay (1973), were examined with scanning electron microscopy. The restoration (Fig. 1) was constructed by superimposing camera lucida drawings from part and counterpart with minor additions of details after some degaging with needles.

Results. Continuity of thallus portions was established throughout most of the exposed surface, but several branches on the right half of the specimen (Figs. 1 and 2) appeared to be either overlapping branches from adjacent divisions or a double layering of the same plant material. The midrib (Figs. 3–5) and undulating margin (Figs. 1–3), although partially obscured by the fracture lines, coupled with the un-

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equal dichotomous branching (Figs. 2 and 4), constitute the most distinctive features of the plant. The angle of branching is fairly consistent at about 60°. The midrib is 0.36–0.50 mm in width with relatively little fluctuation except near apparently subapical areas (Fig. 3, upper portion). Surface patterns along the midrib are markedly elongate and narrow (Fig. 5), giving way to cells with a larger diameter in the lateral portion (Fig. 6). Although surface patterns were detected over most parts of the impression, there was no evidence of air pores, craters, reproductive structures or rhizoids.

The thallus is 7 cm long with a major initial dichotomy (Figs. 1, 2, extreme left) and all of the clear-cut dichotomies occur on the upper thallose system; one of the lateral divisions of the upper thallose system may represent an incipient dichotomy (Figs. 2A; 3, upper portion) with slightly overlapping lobes. The sharply scalloped margins in some areas represent only the angular breaks in the rock. The actual margins are thought to be more rounded, undulatory and entire. The width of the thallus portion ranges from 5.5 mm to 8.1 mm. A possible area of attachment by means of a holdfast would be on the extreme left (Figs. 1 and 2) but there is no acceptable evidence of this.

Thallites dichopleurus DiMichele and Phillips, sp. nov.

Type specimen: No. PP19467, Geology Department, Field Museum of Natural History, Chicago, Illinois (Figs. 1–6).

From: Francis Creek Shale Member, Carbondale Formation, Kewanee Group, Desmoinesian Series, (middle Pennsylvanian), Peabody Coal Company's Northern Illinois Mine, Pit 11, Essex Township.

Species name derived from *dichos* (divided) and *pleura* (rib) indicative of the dichotomously branched midrib; *Thallites* is a neuter name which has been treated as masculine by previous authors.

Diagnosis: Dorsiventral thallus, differentiated into a well developed midrib, 0.36–0.50 mm wide and laminae up to 8.1 mm wide with average width 5.5 mm; up to 7 cm in length; anisotomously dichotomous, flabellate branching at an angle of approximately 60°, irregularly spaced and unequal in growth; margin undulate, possibly slight lobing and entire; midrib of elongate, narrow cells and lamina of shorter, wider cells; no evidence of epidermal appendages or openings.

Discussion. Assignment of the fossil to the genus *Thallites* implies uncertainty with regard to its taxonomic affinities. As previously discussed this is a form genus for fossil thallophytes that have neither clear cut algal nor bryophytic affinities. *T. dichopleurus* does not fit into either

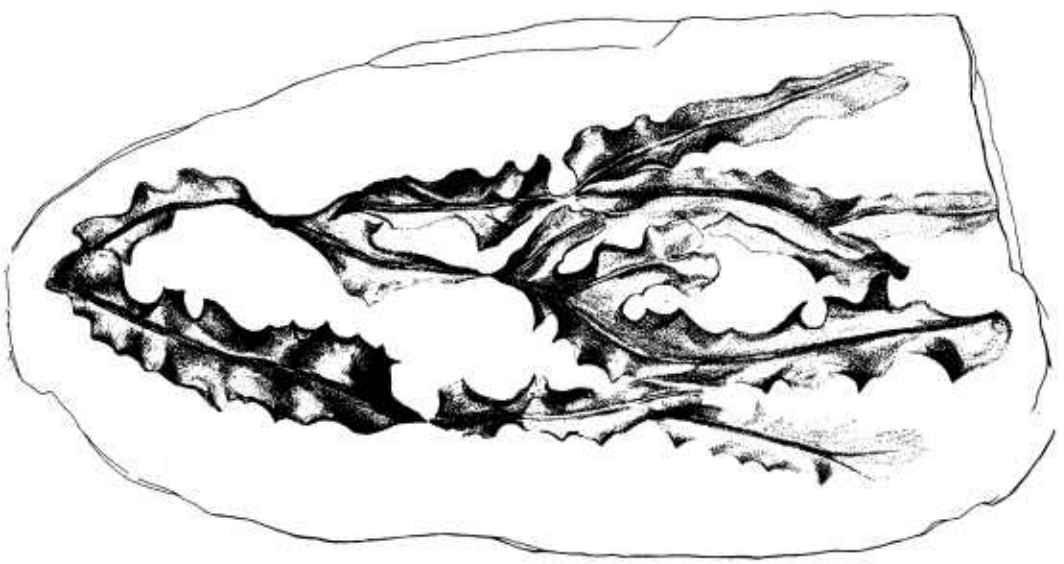
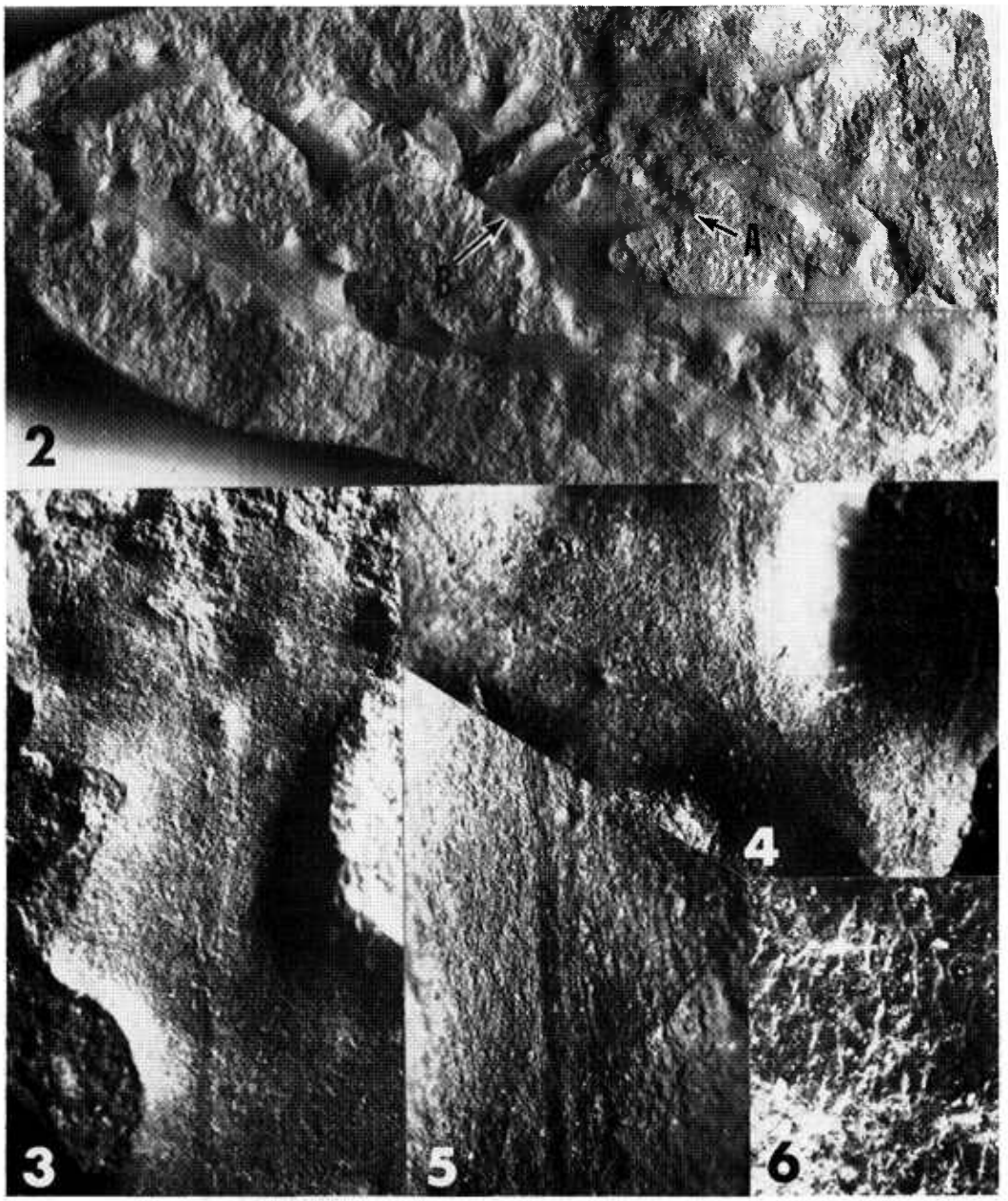


Figure 1. Reconstruction of *Thallites dichopleurus*. ×2.

group, nor does it resemble, in detail, any other members of *Thallites*. Due to the nature of the genus, most members are quite different whereas those that are similar differ often by only one or two characters of a very few used to delimit the species (see Jovet-Ast, 1967).

Within the genus *Thallites* there are only two Paleozoic members, both Upper Carboniferous: *Thallites willsii* Walton



Figures 2–6. Light and scanning electron micrographs of the impression of *Thallites dichopleurus*, Middle Pennsylvanian, Illinois.—Fig. 2. Dichotomously branched thallus with incomplete ruffled margin; A enlarged in Fig. 3. B enlarged in Fig. 4, ×2.—Fig. 3. Lobed, possibly apical portion of thallus (A in Fig. 2), ×8.—Fig. 4. Dichotomous segment of thallus showing midribs (B in Fig. 2), ×8.—Fig. 5. Striated midrib, ×15. Fig. 6. Cellular pattern of lamina surface from latex peel, SEM ×80.

(1949) and *Thallites lichenoides* (Matthew) Lundblad (1954). These differ from *T. dichopleurus* in that *T. willsii* has no midrib and is smaller than our specimen, its maximum width being 1.4 mm, averaging 0.9 mm., while *T. lichenoides* differs in growth pattern, exhibiting crowded radial growth with frequent flabellate branching.

Other Paleozoic thalloid plants with similar growth form include those whose affinities are more clearly with the thalloid liverworts. *Hepaticites langii* Walton (1925) and cf. *Hepaticites* sp. (Walton 1949) have no well developed midrib, the latter exhibiting a radial pattern of growth. *Hepaticites lobatus* Walton (1925) does have a midrib but it is poorly developed. The thallus of this species is narrow and deeply lobed. *Hepaticites metzgerioides* Walton (1928), which has been described in greater detail by Oshurkova (1965), has a well developed midrib of up to 1 mm wide. It branches dichotomously with the lobes diverging at an angle of 120°. The margin is not lobed and is not undulate. *Hepaticites devonicus* Hueber (1961) is quite distinct, being composed of two separate portions. It averages 0.56 mm in width with a midrib that is relatively large in relation to the thallus at 0.22 mm. This species has been assigned to *Pallaviciniites*; see Schuster 1966, p. 352, Jovet-Ast 1967, p. 54.

Thalloid plant fossils are much more abundant in the Mesozoic. Among those in the genus *Thallites* there are several species that are similar to *T. dichopleurus* but they can be differentiated in detail as follows: *T. yabei* (Kryshtofovich) Harris (1942) is described as branching by equal dichotomy, the margin being only slightly undulate and not markedly lobed. It is approximately 1.2 cm in total width. The midrib is up to 1 mm wide (Kryshtofovich, 1929). *T. blairmorensis* (Berry) Lundblad (1954) and *T. sewardii* (Berry) Lundblad (1954) are branched by equal dichotomy of between 35° and 45°. The margins are but slightly undulate and not lobed. The only major difference between these two species appears to be size, the former being 6 to 10 mm and greater in width, the latter 2 to 3 mm in width (Berry 1920; 1929). *T. lichenoides* (Matthew) Lundblad (1954) exhibits crowded radial growth, dichotomies being frequent and unequal. There are disk-like structures present on the surface of the thallus. *T. polydichotomous* Prynada (1938) is similar in width to our specimen, 5–6 mm; however it does not have a well developed midrib and the margin is neither undulatory nor lobed. *T. uralensis* Kryshtofovich and Prynada (1933) is distinct in that the thallus constricts sharply after branching. It has a large midrib area, up to 1.10 mm, in a thallus of 3.75 mm maximum width. *T. zeilleri* (Seward) Harris (1942) is similar to *T. uralensis* in having a large midrib. Seward (1894) shows a thallus of 3 mm width with a midrib approximately one fourth the width of the entire thallus. *T. erectus* (Leekenby) Walton (1925) was originally described as an alga (Leekenby 1864). It has numerous secondary veins spreading from a central midrib. Dichotomies are very irregular in occurrence and unequal.

One of the difficulties in making species comparisons at this generalized level is the necessary reliance on vegetative characteristics without any known range of variation from a number of specimens. It is noted that many such characteristics may not be considered significant when working with living plants, but these are the limitations of dealing with fossil plants, particularly impressions.

There is a distinct possibility that *Thallites dichopleurus* was an alga, both from general morphology and from the likely depositional environment associated with its particular area of discovery in Pit 11. Shabica (1970) has interpreted this environment as that of an inter-distributary bay. Such an environment is associated with deltaic sedimentation and may have local development of fresh, brackish and marine areas. It can be subjected to influx of material from associated marine areas as well as crevass splays and floods resulting in large sediment influx from distributary channels. This particular locality is unlike most Mazon Creek sites, having a higher concentration of marine animals rather than terrestrial ones. Animals and plants have equal representation (Johnson and Richardson 1966).

Fritsch (1959), in a discussion of the ecology of the Fucales, describes several salt marsh forms of these brown algae that undergo morphological and physiological changes brought about by living unattached and reproducing asexually. Many are reduced vegetative forms lacking air bladders

and reproductive structures. They live in bottom sediments entangled in one another or on salt marsh plants. Such an interpretation of *Thallites dichopleurus* may be suggested. The presence of midribs in algae is limited to a few red algae and to the brown algae, particularly the Fucales. The midrib and flabellate dichotomies of *T. dichopleurus* indicate such a possible interpretation.

Conclusion. *Thallites dichoplcurus* is either an alga or a thalloid liverwort on the basis of its vegetative morphology. In either case, it is the first thalloid nonvascular plant to be reported from the Mazon Creek flora. If it were an alga, it would most closely parallel the Fucales, perhaps as an unattached thallus in a salt marsh habitat. If it were an hepatic, the Metzgeriales would be the closest in comparable morphology. Transport into the environment of deposition would then be most likely.

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