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Edited by:  
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## A large branched *Arthrodendron* species (Foraminifera) from the Ropianka Beds (Senonian-Paleocene) of the Polish Carpathians

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### ABSTRACT

A complete specimen of *Arthrodendron* is described from deep-sea flysch of the Ropianka Beds (Magura Unit) at Wola Brzezińska in the Polish Carpathians. The specimen was originally described by Książkiewicz (1977) as *Chondrites flexilis*, but it likely constitutes a new species belonging to the genus *Arthrodendron* Ulrich, 1904. *Arthrodendron* is a larger agglutinated foraminifer showing regular, tubular chambers that may branch dichotomously. The organism evidently lived as epibenthos on the muddy sea floor. Because of their branching morphology and comparatively large dimensions, larger complete specimens of *Arthrodendron* have previously been confused with algae and trace fossils. Care should be taken in such cases to resolve the agglutinated wall and chambers of this deep-water agglutinated foraminifer. Some species of *Arthrodendron* display superficial similarities to some modern komokiaceans, especially to *Septuma*. Further investigations are needed for clarification of their taxonomic affinities.

### INTRODUCTION

Large branched agglutinated foraminifers are rarely the focus of research by foraminiferal specialists, especially by those dealing with their fossil record. Commonly, these fossils are noticed by researchers analysing bedding surfaces for different purposes, and are usually ignored. In our view, these larger deep-sea protozoans deserve more attention as an important component of the benthic community. Because of their unusual morphology, it is not uncommon that they are mistaken for trace fossils, even by experienced ichnologists. Książkiewicz (1977, p. 79, pl. 4, fig. 10), the author of a remarkable monograph on trace fossils, described and illustrated such a branched foraminifer as *Chondrites flexilis* Fischer-Ooster, 1858. The specimen was collected from the deep-sea flysch deposits of the Ropianka Beds (Senonian-Paleocene) in the Magura Nappe. This specimen was reinterpreted as a “large protist” by Uchman (1998, p. 123, fig. 20). Its spectacular morphology attracts attention and requires further analysis and taxonomic treatment. The main aim of this paper is to document its morphology and its taxonomic position with respect to other known species of the genus.

### MATERIAL

The foraminifer, originally described as *Chondrites flexilis* Fischer-Ooster, 1858 by Książkiewicz (1977,

p. 79, pl. 4, fig. 10) is housed as specimen UJTF1031 in the Geological Museum in the Institute of Geological Sciences, Jagiellonian University. According to the label and original description, it is derived from the Ropianka Beds (Senonian-Paleocene) in the northern part of the Magura Nappe at Wola Brzezińska. This is a hamlet between the villages of Przyszowa and Trzetrzewina, west of Nowy Sącz. A more detailed localization is not given. The specimen is a 2-3 cm thick sandstone slab with partly natural, slightly abraded edges, which suggest that the slab was collected in the river or stream bed. The only river at Wola Brzezińska is the Suchy Potok stream, along which the Ropianka Beds of the Długołęki-Wola Brzezińska-Litacza anticline elevation are exposed (Oszczypko, 1973). The lithology consists of thin-bedded flysch with an intercalation of red shales (N. Oszczypko, personal communication, 2009).

The sandstone is dark grey, very fine-grained, calcareous, with fine muscovite flakes, cross cut by very thin calcite veins. The slab is uneven, up to 18 mm thick. Its upper part shows indistinct bioturbational structures. The lower surface is lightly undulated, and beside the large, branched foraminifer, contains small, gently sloped oval or elongate corrugations that can be interpreted as infillings of small scourings, but without any clear linear arrangement. The slab shows fine ripple cross lamination.

## TAXONOMY

Class FORAMINIFERA d'Orbigny, 1826  
 Subclass TEXTULARIA Mikhalevich, 1980  
 Order LITUOLIDA Lankester, 1885  
 Suborder HORMOSININA Mikhalevich, 1980  
 Superfamily HORMOSINACEA Haeckel, 1894  
 Family ASCHEMOCELLIDAE Vialov, 1966  
 Genus *Arthrodendron* Ulrich, 1904

**Diagnosis.** Branched chains of large chambers with an imperforate agglutinated wall that lacks biogenic barite crystals (Kaminski *et al.*, 2008).

**Remarks.** *Arthrodendron* [= *Aschemocella* Vialov, 1966] differs from other hormosinaceans in its large dimensions and in having a branching septate test. The test consists of many chambers in a meandering series that may branch from a central area. These tubular chambers may branch further. The species of *Arthrodendron* are distinguished by the predominant chamber shape.

### *Arthrodendron* sp.

Plate 1, figs 1-2

**Description.** The *Arthrodendron* specimen is a horizontal dendritic form, which occupies a sub-circular area 80-82 mm wide. The test is grey in colour, 0.9–1 mm wide. It is incompletely preserved along the branches. The test is compressed. Its edges are elevated in respect to the axial part, and they are elevated slightly above the sole. The wide axial part is depressed below the sole by a fraction of millimetre. The test expands from a centre along a slightly winding course and branches dichotomously at an acute angle. Second- to fifth-order branches occur. They are more frequent in the peripheral part of the specimen. The higher order branches are 4-9 mm long. Non-branched segments are 8-17 mm long. The branches converge to the centre, but the exact junction point is abraded away. The tips of the branches are broadly rounded and apparently closed, without any visible apertures.

The test is approximately 50  $\mu\text{m}$  thick, but has been compacted. The wall is built of mostly silt-size agglutinated grains, held together by a cementing substance (probably silica) that does not react with HCl. In the places when the test is partly removed, the interior of test can be seen. It is corrugated and is infilled with black bituminous material.

**Remarks.** We do not describe this specimen as a new species because we cannot be certain of its type level or the type locality, as the specimen is only known as a single individual collected from a stream bed. Fragments of a thin-walled *Arthrodendron* species with tubular chambers were described by Grzybowski (1898) as *Hyperammina subnodosiformis* but the fragmentary specimens preserved in the Grzybowski

Collection differ in their smaller dimensions, thinner wall, and more irregular chamber shape (Kaminski & Geroch, 1993). The type species, *Arthrodendron diffusum*, which Ulrich (1904) described from the Upper Cretaceous flysch of Kodiak Island, Alaska, differs in having more clearly defined, oval chambers.

## DISCUSSION

Because of their large size and branched morphology, *Arthrodendron* and similar foraminifers are easily mistaken for trace fossils, and because they occur along with trace fossils, they were often described together even after their foraminiferal nature was established. Such was the case with this specimen that Książkiewicz (1977) originally illustrated as a species of *Chondrites*.

Despite the fact that the regular branched morphology can suggest the trace fossil *Chondrites*, the presence of a chambered test with a layered agglutinated wall is the substantial difference from these trace fossils, which does not display this feature. Many trace fossils have a constructed wall (e.g., Bromley, 1996) but the conduit (lumen) bounded by the wall is continuous, without strong constrictions, to allow passage of the organism's body. The test wall is similar to other large agglutinated foraminifera, such as *Nothia* (= *Dendrophrya robusta* of Grzybowski, 1898) or *Arthrodendron* Ulrich, 1904 (Kaminski *et al.*, 2008, Kaminski *et al.*, 2010). *Arthrodendron* sp. was an epibenthic organism living in a prone position on a muddy seafloor. It displays superficial similarities to some modern komokiaceans, especially to the genus *Septuma*, but differs in its much larger dimensions. Moreover, the wall of *Septuma* and other komokiaceans is flexible, thin, and argillaceous, whereas in *Arthrodendron* the wall is thick and composed of well-sorted, silt-sized quartz grains. The septa of *Septuma* are formed by simple invaginations of the inner organic layer, defining pseudochambers, whereas *Arthrodendron* possesses true overlapping chambers. Today the primary habitat of the komokiaceans is different from that of *Arthrodendron*. Komokiaceans are most common on the oligotrophic abyssal plains, whereas *Arthrodendron* is typical of the more eutrophic flysch basins.

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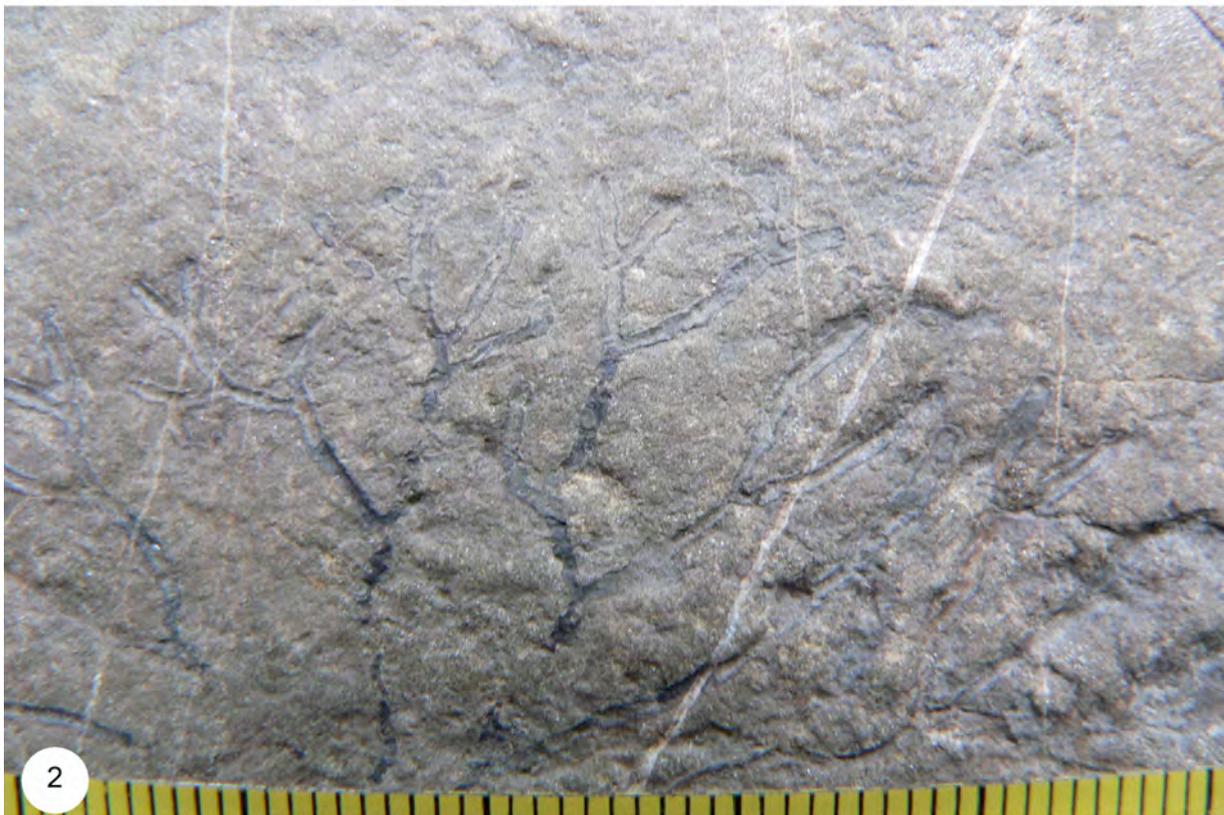
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**Plate 1.** 1. Axial view of the complete specimen of *Arthrodendron* sp. 2. Detail of peripheral part of the specimen, showing details of the terminal branches and rounded tips. Ruler for scale.