Fossil jellyfish from Carboniferous shales in the central USA

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Cnidarian medusae (jellyfish) have a very poor fossil record: only about a dozen well-documented deposits are known, and any new occurrence is significant. Fossil medusae occur from the Cambrian onward, and by the Carboniferous they were quite diverse. This study describes and considers the significance of a handful of remarkably preserved jellyfish from black shales of the North American midcontinent, USA. These are extremely rare fossils, with two of the three occurrences represented by a single specimen each. When considered together, they provide important information about cnidarian evolution, and about unusual taphonomic paths for the preservation of medusae. Two of the occurrences had never been previously documented; both of these fossils were in the collections of the Field Museum, Chicago. The third is a previously published slab at the Texas Memorial Museum, Austin.

One of the previously undocumented medusae is a chirodropid cubozoan (box jellyfish) from the Middle Pennsylvanian (Moscovian) Mecca Quarry Shale of Indiana. It is very similar to, and possibly conspecific with *Anthracomedusa turnbulli* Johnson and Richardson, a species already known from siderite concretions of the contemporaneous Mazon Creek Lagerstätte of Illinois. The other two occurrences, from the Upper Pennsylvanian (Kasimovian) Stark Shale, probably represent stem group Rhizostomeae. One is a slab including seven medusae from Iowa, which had been documented as *Prothysanostoma eleanorae* Ossian, whereas the other is a single medusan from Nebraska, which we refer to as *Prothysanostoma?* sp.

These fossils exhibit evidence of twisting, rupturing, and flexible deformation, while preserving delicate organs such as muscles, gonads, eyes, and tentacles. Although some tissues, like gypsum-rich rhopalia, are structures that were somewhat robust in life, others reflect preburial accentuation of tissue margins, such as tentacles that are mantled by silt and bells that were filled with quartz sand. Carbonaceous compression of soft tissue resulted from conditions where decay was delayed and scavenging inhibited, possibly through microbial activity and burial. Fossils from these deposits offer opportunities to understand how medusae change when they go through different taphonomic processes.

Anthracomedusa is remarkably similar in morphology to extant basal chirodropids, suggesting continuity of this body plan for at least 300 m.y. *Anthracomedusa* occurs in nearshore proximal-estuarine settings comparable to those of its modern counterparts, and *Prothysanostoma* and its modern allies are known from open-water settings. The preservation of jellyfish in Pennsylvanian black shales indicates that such facies may contribute significantly to the Late Paleozoic Lagerstätten record.

Atlantic Geology, 2019, Volume 55
Atlantic Geoscience Society Abstracts – 45th Colloquium & Annual General Meeting 2019
https://doi.org/10.4138/atlgeol.2019.005