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Three-dimensionally preserved siphuncle in an actinoceratid cephalopod from the late Katian of Bohemia

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ABSTRACT

The Ordovician to Carboniferous cephalopods of the order Actinoceratida (Teichert, 1933) are distinguished from all other cephalopods by their large siphuncles, which typically contain heavy, calcareous deposits enclosing a complex system of canals. These peculiar structures were already recognised in the 19th century, but it was only in the 20th century that they were properly described and interpreted in a more systematic manner with respect to the phylogeny and palaeoecology of the group. In the present study, we investigate a uniquely preserved actinoceratid cephalopod from the late Katian part of the Králův Dvůr Formation (Prague Basin, Central Bohemia), in order to address the magnificent works of C. Teichert, R. H. Flower, M. Wade and H. Mutvei. The specimen, tentatively assigned to the ormoceratidan genus *Adamsoceras*, consists of four isolated fragments of the siphuncle (nine siphuncular segments) and small remains of phragmocone chambers. All original calcareous parts of the conch were dissolved during diagenesis and fossilisation processes, while the spaces left by decayed soft tissues were filled with pyrite (secondarily converted into limonite). In other words, the specimen is a cast of the axial canal, radial canals and perispatium, plus some remains of phragmocone chambers. Cavities inside the cast mirror the shape of dissolved endosiphuncular deposits and ectosiphuncle; nothing is preserved of the outer shell wall and septa. The remains of phragmocone chambers are diagenetically flattened, but the siphuncle is undeformed, supposedly because it was protected against compaction by the extensive endosiphuncular deposits and possibly by the filling of the endosiphuncular canals with pyrite.

The preservation of the specimen enabled the application of the micro-CT scanning. This non-destructive method has proved invaluable for studying fossils that cannot be otherwise studied using standard oriented sectioning. It also enabled the construction of a virtual model of the specimen, which facilitated the investigation of the siphuncular structure in 3D. Preliminary results show that the endosiphuncular deposits grew unevenly, resulting in highly irregular shapes and distribution of the radial canals, and an irregularly flattened form of the central canal. The flattening of the central canal is interpreted as reflecting the dorso-ventral plane of symmetry of the siphuncle. Furthermore, the endosiphuncular structures did not form symmetrically and their appearance depends on the selected median section. This suggests that the distinction between several types of endosiphuncular systems *sensu* Teichert and Flower and the taxonomy derived from these distinctions might be, at least in some actinoceratids, artificial, resulting from studying specimens in 2D median sections.

The studied specimen represents the only unequivocal actinoceratid from the Ordovician of the high-palaeolatitude Prague Basin. Since actinoceratid cephalopods were abundant during the Ordovician mainly in low-palaeolatitude carbonate environments, the presence of this specimen in the Prague Basin supports previous indications of a faunal connection between the high and low palaeolatitudes during the late Katian age.

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