An aberrant bi-apical Follicucullus (Albaillellaria) from the late Guadalupian (Middle Permian), with the possible oldest evidence of double malformation in radiolarians

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Abstract: An aberrant bi-apical Follicucullus specimen (Albaillellaria, Radiolaria) has been discovered from an upper Guadalupian (Middle Permian) chert block of the Kamiaso Unit of the Mino terrane, central Japan. If this specimen was formed with double malformation, it would be the oldest record of this phenomenon in radiolarians and the first record of its kind in Albaillellaria.

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Conjoined radiolarians, in which two or more individuals are joined together, are of particular interest as evidence of binary fission (e.g. Anderson & Gupta 1998), although double malformation essentially forms during skeletogenesis. Radiolarians represent significantly different ecology and physio-ecology in different taxonomic orders (Suzuki & Not 2015), but conjoined specimens have been widely recognized in various radiolarian orders such as Collodaria (Sugiyama 1992; Anderson & Gupta 1998), Entactinaria (Dumitrica 2013), Nassellaria (Takahashi & Honjo 1981; De Wever 1985; Dumitrica 2013) and Spumellaria (Itaki & Bjørklund 2007; Dumitrica 2013). These data strongly suggest that conjoined specimens could have appeared in other orders such as Albaillellaria.

Conjoined radiolarians rarely occurred in the Mesozoic (e.g. Dumitrica 2013) and Cenozoic (e.g. Itaki & Bjørklund 2007) and no confirmed conjoined specimens have yet been found from the Palaeozoic (Dumitrica 2013). De Wever (1985) illustrated several aberrant conjoined specimens as Siamese radiolarians from the Silurian, but these specimens, according to Dumitrica (2013), are probably bryozoan colonies.

We have discovered an aberrant bi-apical specimen of the Permian radiolarian genus Follicucullus. If this specimen formed as a result of a double malformation, it is not only the oldest record of this phenomenon in radiolarians, but may also be the first record of conjoining in the Order Albaillellaria.

Material and bi-apical Follicucullus

A Capitanian (late Guadalupian, Middle Permian) age radiolarian assemblage including Follicucullus charveti Caridroit & De Wever and F. porrectus Rudenko has been obtained from a chert block (sample IT15102608) within conglomerates of the Kamiaso Unit of the Mino terrane at Awano in the Mino–Hichiso area, Gifu Prefecture, central Japan, near the locality of sample KY2014061107 of Ito et al. (2016). For detailed geological information of this area, see Ito et al. (2016).

The assemblage includes a single Follicucullus specimen with a bifurcated test on part of its pseudothorax (Fig. 1a). The right part is a typical Follicucullus test, whereas the left part is a thin cylinder of some organism (Fig. 1b). The base of this cylinder coalesces with the typical Follicucullus test, although this part is probably cracked (Fig. 1c).

Implications

Follicucullus belongs to the Order Albaillellaria, which is characterized by a triangular framework (De Wever et al. 2001). This framework is formed by three intersecting bars in order to restrict the shell morphology of late Palaeozoic Albaillellaria. The
fission is the oldest certain record of its kind in radiolarians (Fig. 2).

One concern, however, is that the left cylinder appears to belong to an unknown species. This form may have deformed to some extent, but diagenetic or an amalgamated siliceous fragment resulting from diagenesis. This specimen may have deformed to some extent, but diagenetic or an amalgamated siliceous fragment resulting from diagenesis.

Assuming that this form is a double malformation, the thin cylinder is regarded as *F. porrectus*. The shell size of the right test (96 μm wide and 298 μm high) unquestionably falls in the size range of *F. porrectus* in terms of width (78 – 135 μm; average: 99 ± 12 μm) and height (231 – 341 μm; average: 284 ± 28 μm) (Fig. 3), indicating that the specimen is in the fully grown stage. The conjoined phenomenon in the fully grown stage of radiolarians can be observed in both Mesozoic and Cenozoic Nassellaria individuals that formed in a similar manner (De Wever 1985, for the Mesozoic; Takahashi & Honjo 1981, for the Cenozoic). The assumption that the findings were caused by a double malformation is one of the most plausible interpretations.

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**References**


