

Ultrastructural and chemical characterization of the Cryogenian acritarch *Cerebrospira*

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The Cryogenian period is a time of diversification and extinction of eukaryotes [1, 2], and includes the pre-Sturtian acritarch *Cerebrospira* [3]. The vesicles are characterized by dark robust walls ornamented by cerebroid folds. Two species were previously described based on the folds' width: *C. buickii* [4] and *C. ananguae* [5]. To further characterize these acritarchs and determine their biological affinity, we analysed the ultrastructure and chemical composition of specimens from the 802±10 Ma Hussar and younger Kanpa Fm., Australia and from the ~820 Ma Svanbergfjellet Fm., Spitsbergen.

Fourteen specimens were studied under SEM for fine-scale morphological details. The morphology of the 2 *Cerebrospira* species showed a continuum suggesting they are two extreme morphotypes of a single population. Ultrastructural analyses using TEM were performed on 22 specimens and revealed a complex three-layered wall ultrastructure. No ultrastructural feature explained the distinctive folding of the walls. Infrared and Raman micro-spectroscopy were performed on 34 specimens to obtain a chemical composition of the wall biopolymer and to determine the thermal maturity. The wall biopolymer showed a highly aromatic composition and a weak to medium thermal maturity unrelated to the opacity of the specimens. Comparisons were also made with leiospheres from the same samples.

The complex morphology, ultrastructure and chemistry, combined with its large size and recalcitrant composition indicate that *Cerebrospira* was an eukaryote, taking part of the eukaryotic diversification observed prior to the onset of Snowball Earth glaciations. In the same time, the absence of significant differences between the two species plead for a taxonomic revision, *C. buickii* being the senior species.

[1] Knoll *et al.* (2006) *Philos. Trans. R. Soc. B* **361** 1023-1038 [2] Riedman *et al.* (2014) *Geology* **42** 1011-1014 [3] Grey *et al.* (2011) *Geol. Soc. of London Mem.* **36** 113-134 [4] Butterfield *et al.* (1994) *Fossils and Strata* **34** 82p [5] Cotter (1999) *Alcheringa* **23** 63-86