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A rare double skeleton of the silicoflagellate *Corbisema*

KEVIN McCARTNEY[1,*], DAVID M. HARWOOD[2] & JAKUB WITKOWSKI[3]
[1]Department of Environmental Studies, University of Maine at Presque Isle, Presque Isle, ME 04769, USA
[2]Department of Geosciences, University of Nebraska-Lincoln, Lincoln, NE 68588-0340, USA
[3]Department of Historical and Regional Geology, Faculty of Geology, University of Warsaw, ul. Zwirki i Wigury 93, 02-089 Warsaw, Poland and Paleoceanology Unit, Faculty of Earth Sciences, University of Szczecin ul. Mickiewicza 18, 70-383 Szczecin, Poland
[*]Corresponding author (e-mail: kevin.mccartney@umpi.edu)

INTRODUCTION

Silicoflagellates are usually associated with simple skeletons made of a domal latticework of rod-shaped elements, known as the apical structure, which is attached to a polygonal basal ring. Silicoflagellate reproduction is poorly understood (Moestrup & Thomsen, 1990) but they are known to divide mitotically associated with the construction of a double skeleton. Such double skeletons connected at the abapical face of the basal ring are observed from Recent and fossil material. Double skeletons of *Dictyocha* and *Distephanus* noted in Cenozoic sediments (Dumitrică, 1973, pl. 4, fig. 8; Boney, 1976) show basal rings positioned with their corners in close proximity. Ling & Takahashi (1985, pl. 1, fig. 5) and Takahashi *et al*. (2009, pl. 2, figs 3, 5) illustrate *Distephanus* with the spines of the two skeletons in exact alignment with one another.

Recent work in a Campanian sequence of strata near Horton River, District of Mackenzie in the Northwest Territories, Canada (McCartney *et al*., in press) identified a rare double skeleton of *Corbisema archangelskiana* (Schulz, 1928). The discovery was made in sample C-8590 in a slide prepared in 1994 for diatom study (Tapia & Harwood, 2002) and is associated with a flora of Late Cretaceous silicoflagellates from the *Cornua trifurcata* Zone of Early Campanian age (McCartney *et al*., in press). The two paired specimens are joined at the abapical faces. The apical structure of the lower skeleton is intact but that of the higher element is lost, otherwise the shape, size and structures are the same. The double skeleton is contained within a piece of original sediment, which explains the intact preservation of the pair. Other *Corbisema archangelskiana* are common in this sample, with 189 specimens observed in two slides (20 × 40 mm cover slips). The chance settling of one skeleton so precisely upon the other is considered a very unlikely event.

The occurrence is unusual. To our knowledge, this is the only example of a *Corbisema* double skeleton to have been photographed and the specimens preserved and connected in a host of matrix sediment. This specimen is especially interesting because the corners of each basal ring are aligned with the strut attachments – rather than the corners – of the sibling skeleton. The effect is a 'Star of David' configuration (Fig. 1a), with each skeleton rotated 1/6 of a turn with respect to the other. Known examples in other genera (e.g. *Naviculopsis* (Schulz, 1928), *Dictyocha* (Dumitrică, 1973), *Distephanus* (Takahashi *et al*., 2009)) do not exhibit such twisting of the alignments of the basal corners with respect to one another.

Two other illustrations of double skeletons of *Corbisema* are known in the literature, both by Schulz (1928, figs 27, 75). The two skeletons of each of these illustrated pairs are of a configuration similar to that found in this study, with corners offset rather than aligned. Neither specimen is identified precisely in terms of locality or age, though Schulz does say, in the English summary at the end of the article, that both are from the 'chalk', meaning the Cretaceous. Figure 75 of Schulz (1928; shown here as Fig. 1b) depicts *Corbisema inermis* using modern taxonomic usage, with one corner aligned with the strut attachment, and

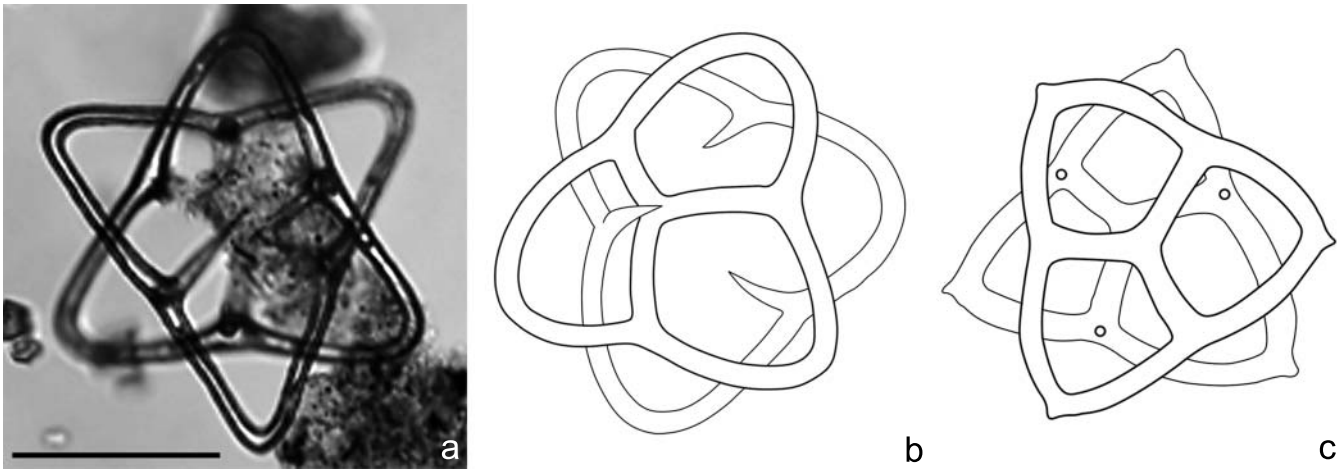

Fig. 1. (**a**) Double skeleton of *Corbisema archangelskiana* (Schulz, 1928), sample C-8595, Horton River, Canada; scale bar 50 μm. (**b**, **c**) Redrawn figures from Schulz (1928), showing double skeleton of (**b**) '*D. triacantha* var. *inermis*' (his figure 75; now *Corbisema inermis*) and (**c**) '*D. triacantha* var. *apiculata*' (his figure 27; now *Corbisema apiculata*).

the remaining corners orientated slightly away from that position. The other figure of Schulz (1928; shown here as Fig. 1c) is *Corbisema apiculata* (Lemmermann) and shows a similar configuration.

CONCLUSIONS

Paired skeletons are an early feature of silicoflagellates, and preliminary evidence that Cretaceous *Corbisema* had corners of each skeleton aligned between the corners of the sibling member of a double skeleton pair. The observation that *Corbisema* double skeletons are of a configuration different from Cenozoic genera raises some outstanding questions. Did all *Corbisema* double skeletons produce the 'Star of David' configuration? Did other Cretaceous genera, such as *Cornua*, also exhibit rotation of each skeleton with respect to the sibling in a double pair? If it is determined that *Corbisema* and other early silicoflagellate genera had skeletons rotated with respect to the sibling skeleton in a pair, then how and when did Cenozoic silicoflagellates, such as *Dictyocha* and *Distephanus*, change to a double skeleton configuration with aligned corners? Further study of Cretaceous silicoflagellates will shed light on these questions.

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