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SHORT COMMUNICATION

A new species of *Conchicolites* (Cornulitida, Tentaculita) from the Wenlock of Gotland, Sweden

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Abstract. A new cornulitid species, *Conchicolites crispisulcans* sp. nov., is described from the Wenlock of Gotland, Sweden. The undulating edge of *C. crispisulcans* sp. nov. peristomes is unique among the species of *Conchicolites*. This undulating peristome edge may reflect the position of setae at the tube aperture. The presence of the undulating peristome edge supports the hypothesis that cornulitids had setae and were probably related to brachiopods.

Key words: tubeworms, tentaculitoids, cornulitids, Silurian, Baltica.

INTRODUCTION

Cornulitids belong to encrusting tentaculitoid tubeworms and are presumably ancestors of free-living tentaculitids (Vinn & Mutvei 2009). They have a stratigraphic range from the Middle Ordovician to the Late Carboniferous (Vinn 2010). Cornulitid tubeworms are found only in normal marine sediments (Vinn 2010), and in this respect they differ from their descendants, microconchids, which lived in waters of various salinities (e.g., Zatoń et al. 2012, 2013). Cornulitid tubeworms are especially common in shallow marine sediments (e.g., Richards 1974; Zatoń & Borszcz 2013). Cornulitids as hard substrate encrusters are palaeoecologically important because they generally retain their original position on the substrate after fossilization (Taylor & Wilson 2003). They had a diverse palaeoecology, being either solitary encrusters, gregarious aggregates, free-living varieties or symbiotic endobionts. Some cornulitids were even parasitic (Vinn 2010).

The biological affinities of cornulitids have been debated since their discovery in the early 19th century. They have been affiliated with various groups of invertebrates, such as sponges (stromatoporoids), cnidarians, fusulines, bryozoans, annelids and molluscs. However, most likely they belong to the Lophothrochozoa according to a recent study by Vinn & Zatoń (2012). They possibly represent stem-group phoronids (Taylor et al. 2010).

Four genera of cornulitids have been assigned to Cornulitidae: *Cornulites* Schlotheim, 1820, *Conchicolites* Nicholson, 1872a, *Cornulitella* (Nicholson 1872b) and *Kolihaia* Prantl, 1944 (Fisher 1962). The taxonomy of Wenlock cornulitids of Gotland (Sweden) is poorly studied, mostly due to their minor stratigraphical importance.

The aim of the paper is to: (1) systematically describe a new species of cornulitids from the Wenlock of Gotland, (2) discuss the function of the unique undulating edge of the peristome in *Conchicolites crispisulcans* sp. nov.

MATERIAL AND METHODS

The specimens have been recovered from the uppermost part of the Mulde Brick-clay Member of the Halla Formation, exposed in the cliff at the Blåhäll 1 locality in western Gotland, Sweden (Fig. 1; Laufeld 1974). The Silurian succession of Gotland developed in an epeiric basin stretching on the shelf of the East European Craton and located near the palaeoequator during the mid- to late Silurian (Calner et al. 2004). The interval exposed in Blåhäll 1 belongs to the *Ozarkodina bohemica longa* and, in its uppermost part, *Kockelella ortus absidata* conodont zones, indicating Homerian (Wenlock, middle Silurian) age (Calner et al., 2000). The Mulde Brick-clay Member is developed as marls and marly lime-

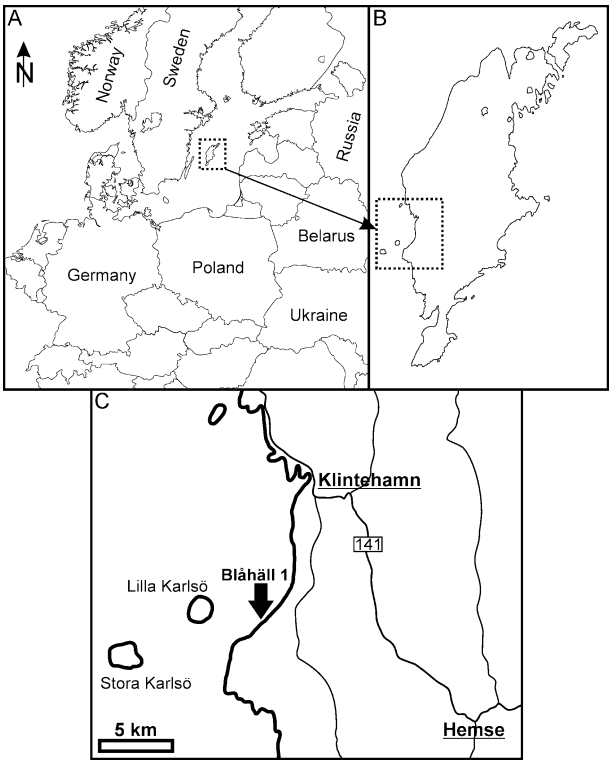

Fig. 1. Location of the sample that yielded *Conchicolites crispisulcans* sp. nov. All maps are own compilations based on Google Earth. **A**. Political map showing the position of Gotland. **B**. Gotland outline; the dashed line shows the location of the close-up map in C. **C**. Position of the Blåhäll 1 locality.

stones terminating in a halysitid-heliolitid biostrome. Based on regional topography and the rich benthic and pelagic faunal association comprising brachiopods, trilobites, tentaculitoids, scolecodont-bearing polychaetes, graptolites, chitinozoans and abundant sclerobionts, it is interpreted as having been deposited in a low-energy proximal shelf environment below the photic zone (Calner et al., 2000; Jarochowska et al. 2013).

A 2-kg sample was disintegrated using the surfactant Rewoquat according to the method of Jarochowska et al. (2013). After 10 days of disintegration, the Rewoquat was decanted, and the residue was soaked with water and wet-sieved on the following day. *Conchicolites crispisulcans* sp. nov. specimens were hand-picked from the >1 mm fraction. One specimen was sputter-coated with gold and documented under scanning electron microscope (TESCAN Vega\\xmu).

The specimens studied here are housed in the Museum of Geology (Natural History Museum), University of Tartu (TUG). The systematic palaeontology was written by O. Vinn.

SYSTEMATIC PALAEONTOLOGY

Phylum *incertae sedis*
Class TENTACULITIDA Bouček, 1964
Order CORNULITIDA Bouček, 1964
Family CORNULITIDAE Fisher, 1962
Genus *Conchicolites* Nicholson, 1872a

Type species. *Conchicolites gregarius* Nicholson, 1872a.

Conchicolites crispisulcans sp. nov.
Figures 2, 3A–C

Material. Six specimens (holotype TUG 1675-1, paratypes TUG 1675-2, TUG 1675-3, TUG 1675-4, TUG 1675-5, TUG 1675-6), free tube parts only.

Locality. Blåhäll 1 locality, Gotland, Sweden.

Stratigraphy. The uppermost part of the Mulde Brick-clay Member of the Halla Formation, Homerian, Wenlock, Silurian.

Etymology. After the Latin word for wavy (i.e. *crispisulcans*), referring to the undulating edge of peristomes of the new species.

Diagnosis. Conical straight free tube parts with well-developed transverse ornamentation in form of peristomes with the regularly undulating edge.

Description. Slightly conical straight free tube parts have well-developed transverse ornamentation in the form of former peristomes. The tube divergence angle is 6 to 7 degrees. The maximal diameter of tubes varies

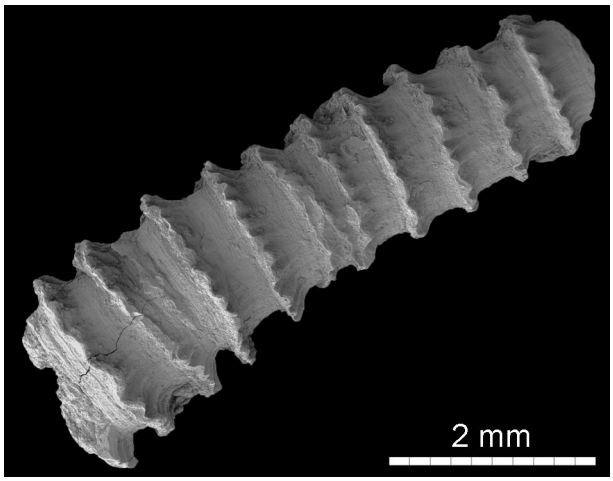

Fig. 2. *Conchicolites crispisulcans* sp. nov. (holotype TUG 1675-1) from the Mulde Brick-clay Member of the Halla Formation, Homerian of Gotland. SEM photo.

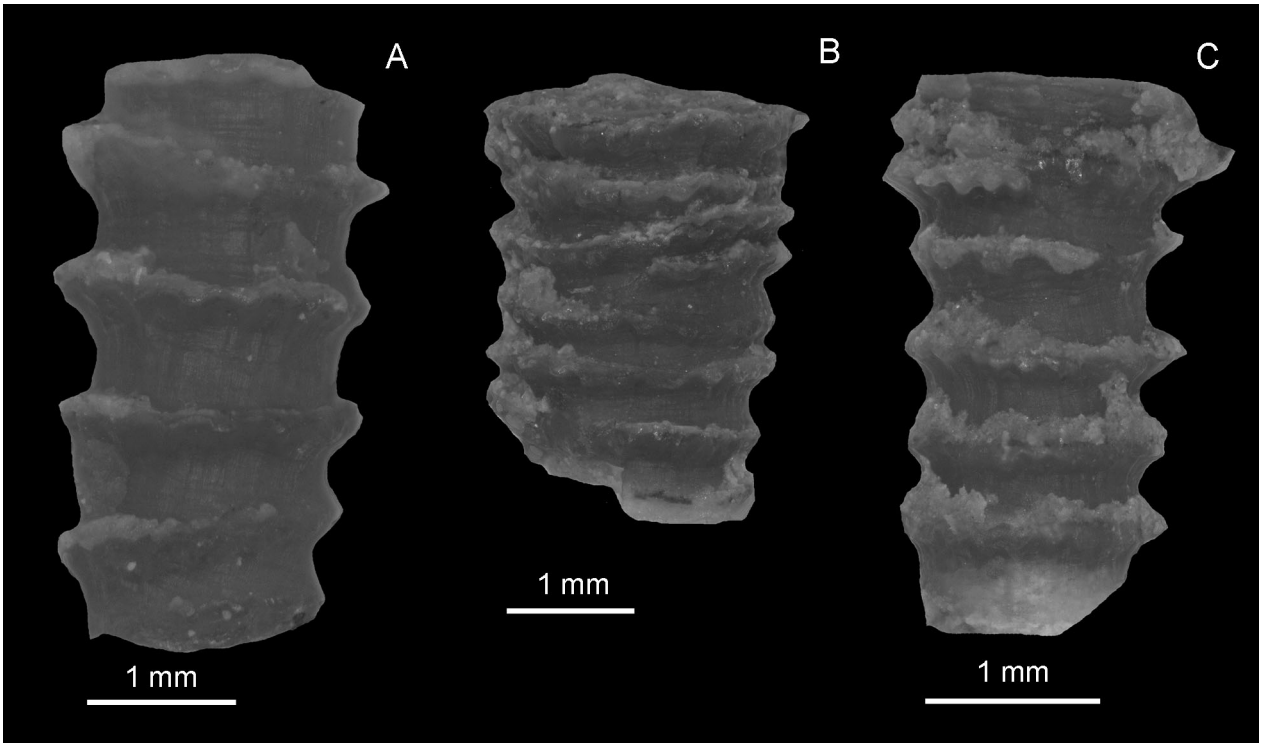

Fig. 3. A–C. *Conchicolites crispisulcans* sp. nov. from the Mulde Brick-clay Member of the Halla Formation, Homerian of Gotland. A, paratype TUG 1675-2; B, paratype TUG 1675-3; C, paratype TUG 1675-4. Light microscope photos.

from 1.3 to 2.3 mm (mean = 1.8 mm, sd = 0.41, n = 6). The interval between peristomes ranges from 0.3 to 0.8 mm (mean = 0.56 mm, sd = 0.17, n = 15). The distance between peristomes does not increase notably with the tube diameter. Tubes with a smaller diameter can have more widely spaced peristomes. The interval of peristomes is slightly variable within a single specimen, but more variable between different specimens. The edge of all peristomes is regularly undulating. The tube wall below the undulation can be slightly elevated and form a weakly developed costa-like structure. The undulations are 0.10 to 0.18 mm wide. The tube wall is covered with fine weakly developed regular perpendicular growth lines, up to 3 lines per 0.1 mm. Fine weakly developed longitudinal striae can occur at some places below the peristomes, up to 3 striae per 0.1 mm.

Comparison. This new species is assigned to *Conchicolites* because of its small size, peristome-shaped perpendicular ornamentation and the lack of regular well-developed longitudinal striae. In general, striae are not a good character for distinguishing cornulitids on the genus level. However, well-developed striae do not occur in *Conchicolites*, but are usually present in *Cornulites*. *Conchicolites crispisulcans* sp. nov. somewhat resembles *Conchicolites gregarius* Nicholson, 1872a (pp. 204–205, fig. 2a, b) and *Conchicolites corrugatus* Nicholson 1872b (pp. 55–56, pl. 4, fig. 2) in its small size but differs in having better developed peristomes with an undulating edge. The new species has well-developed peristomes, making it somewhat similar to *Conchicolites* sp. 1 (Vinn & Wilson 2013, fig. 13, pp. 365–366), but differs from *Conchicolites* sp. 1 in having undulating edges of the peristomes. Another species from the Silurian of Baltica, *Conchicolites* sp. 2 (Vinn & Wilson 2013, fig. 14, pp. 366–367), resembles *C. crispisulcans* sp. nov. in its small angle of tube divergence, but differs by less developed and non-undulating peristomes.

DISCUSSION

Peristomes with the undulating edge

Vinn & Mutvei (2005) hypothesized that cornulitids may have had setae similar to their possible relatives, brachiopods. This hypothesis was based on the presence of costae in *Cornulites* that are somewhat similar to those of brachiopods. It is possible that cornulitid

costae housed setae similarly to brachiopods. Thus, the undulating edge of the peristomes in *C. crispisulcans* sp. nov. may reflect the position of setae at the tube aperture. Setae were possibly located in the curved niches at the peristome edge. The presence of undulating peristomes in *C. crispisulcans* sp. nov. fits well with the hypothesis that cornulitids possessed setae and were lophophorates related to brachiopods.

Perpendicular ornamentation in *Conchicolites*

Conchicolites tubes have a relatively variable morphology. The perpendicular ornamentation of most of the species is composed of well-developed fine perpendicular ridges (O. Vinn, pers. obs.). Sometimes like in *Conchicolites* sp. 1 the perpendicular ornamentation is extremely well developed in the form of peristomes. The edges of peristomes can form spines like in *Conchicolites* sp. from Gotland (Vinn & Mutvei 2005), but usually the edge of peristomes and perpendicular ridges are smooth. The undulating edge of *C. crispisulcans* sp. nov. peristomes is unique among the species of *Conchicolites*.

Long free tube parts

Long free tube parts can be an adaptation to life in relatively fast sedimentation or in conditions of restricted available substrate (Vinn 2010). The available hard substrate can be restricted due to space competition by other encrusters or because only limited substrates were available in the biotope. Long free tube parts are also common in case of aggregative growth in *Cornulites* Schlotheim, 1820 (Vinn 2010) and in *Septalites* (Vinn 2005). The aggregations occur in *Conchicolites gregarius* Nicholson, 1872a and are also possible in *Conchicolites crispisulcans* sp. nov.

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Uus *Conchicolites*'e (Cornulitida, Tentaculita) liik Gotlandi Wenlockist

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Uus kornulitiidi liik *Conchicolites crispisulcans* sp. nov. on kirjeldatud Gotlandi (Rootsi) Wenlockist. Laineline koja suue ja lainelised peristoomid on uuel liigil ainulaadsed perekonna *Conchicolites* liikide hulgas ning need võivad peegeldada seetade kunagist asukohta koja suudmel.