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Ichnology of Late Cretaceous echinoids from the Maastrichtian type area (The Netherlands, Belgium)—2. A pentagonal attachment scar on *Echinocorys* gr. *conoidea* (Goldfuss)

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Abstract

The tests of large holasteroid echinoids provided hard substrates that could become infested, both before and after death, by a range of invertebrates during the Late Cretaceous. A specimen of *Echinocorys* gr. *conoidea* (Goldfuss) from the (late Maastrichtian) upper Lixhe 1 Member, Gulpen Formation, of the Lixhe area, Belgium, preserves an elongate pentagonal scar. This trace fossil is non-penetrative and is probably the result of shallow embedment of an unmineralized, sessile invertebrate (a sea anemone?) on the test of the live echinoid. The elongation in an adapical-abapical direction may reflect the normal morphology of the producing species or was perhaps a plastic response to environment.

Key words: Ichnology, *Echinocorys*, attachment, Upper Cretaceous, Maastrichtian, Belgium

Introduction

Tests of large-sized Late Cretaceous holasteroid echinoid genera, such as *Echinocorys* Leske and *Hemipneustes* L. Agassiz, uncommonly preserve growth reactions to invasive interactions with settling, cementing and boring invertebrates, and lesions caused by vertebrates, that occurred during the life of the echinoid (for example, Donovan and Jagt, 2002; Donovan *et al*., 2008). There may be subtle evidence that infestations manifested themselves *in vivo*. The corollary of this is that infestations not associated with test modifications are interpreted as having occurred, most probably, post mortem, but prior to final burial of the echinoid test. The naked test of a dead echinoid on a soft chalk bottom may have provided a hard substrate and would thus have facilitated those benthic invertebrates that were obligate encrusters or borers, such as certain groups of bivalve and brachiopod, and most bryozoans, but would have been of limited or no interest to predatory vertebrates. There is ample evidence that species of these superficially burrowing holasteroid echinoids, both dead and alive, hosted a wide range of infesting organisms (for example, Joysey, 1959; Voigt and Soule, 1973; Donovan and Jagt, 2005; Jagt *et al*., 2007; Neumann and Wisshak, 2006; Wisshak and Neumann, 2006).

Herein, we describe an unusual attachment trace on a test of *Echinocorys*, one of the commonest and most widely distributed echinoid genera in the Upper Cretaceous of Europe. The specimen is deposited in the collections of the Natuurhistorisch Museum Maastricht, The Netherlands (NHMM).

Material and methods

Representatives of several species groups (Jagt, 2000) of *Echinocorys*

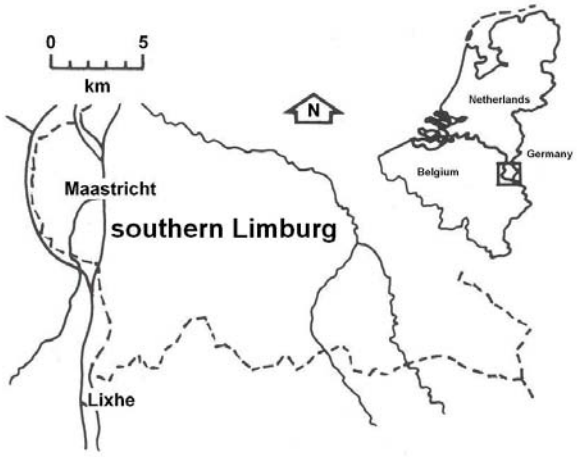

Fig. 1. Outline map of the study area (redrawn and simplified after Jagt, 1999, fig. 1; Donovan and Jagt, 2004, fig. 1), showing political boundaries (dashed lines), rivers and canals (solid lines), the city of Maastricht and the Lixhe area. The inset map of The Netherlands, Belgium and Germany shows the approximate position of the main map (box).

are locally common components of echinoid faunas in the Upper Cretaceous (Campanian and Maastrichtian) of southern Limburg (The Netherlands), and contiguous areas in the Belgian provinces of Limburg and Liège. The specimen discussed here is assigned to the group of *conoidea* (Goldfuss, 1829), which is abundant in the upper third of the Lixhe 1 Member (Gulpen Formation) (see Felder and Bosch, 2000, fig. 3.33). In the Haccourt-Lixhe area (Fig. 1), many hundreds of such flint-filled tests have been collected during recent years, in particular at the CPL SA-Haccourt and CBR-Lixhe quarries. NHMM 2009 005 comes from the upper Lixhe 1 Member at the former CPL SA quarry (now Kreko) (Fig. 1) and is of early late Maastrichtian age (*Belemnitella junior* Zone).

Description

The trace fossil is situated close to the centre of the right posterior interambulacrum, just overlapping with the interradial suture, and with most of it being on the more anterior column of plates. The elongate pentagonal symmetry is in part controlled by the plate sutures of the echinoid, and the bottom of the trace is about 18 mm above the ambitus.

In general, this test shows multiple small, round holes less than 1.0 mm in diameter of a type that has been described previously by Müller (1969) and Bromley (1981), mainly close to, but not in, the apical system, in the interambulacra and between columns of pore pairs in the ambulacra. One of these pits is situated between the pentagonal scar (see below) and the ambitus. Shallow parabolic pits occur in the same general areas. Such pits have not yet been formally named and their origin is still being debated, but may be putative *Oichnus* (*O. simplex* Bromley, 1981; *O. paraboloides* Bromley; 1981; see also Bromley and Heinberg, 2006). The fact that they occur in superficially burrowing echinoids as well as in deep-burrowing taxa such as *Micraster* (see Zamora *et al*., 2008) would suggest that they were produced post mortem. Highly typical is that they appear to be concentrated adapically and that, in general, they do not penetrate the test, which makes it likely that the producer preferred to feed on (the remains of) tube feet; holes found in interambulacral areas may represent failed attempts.

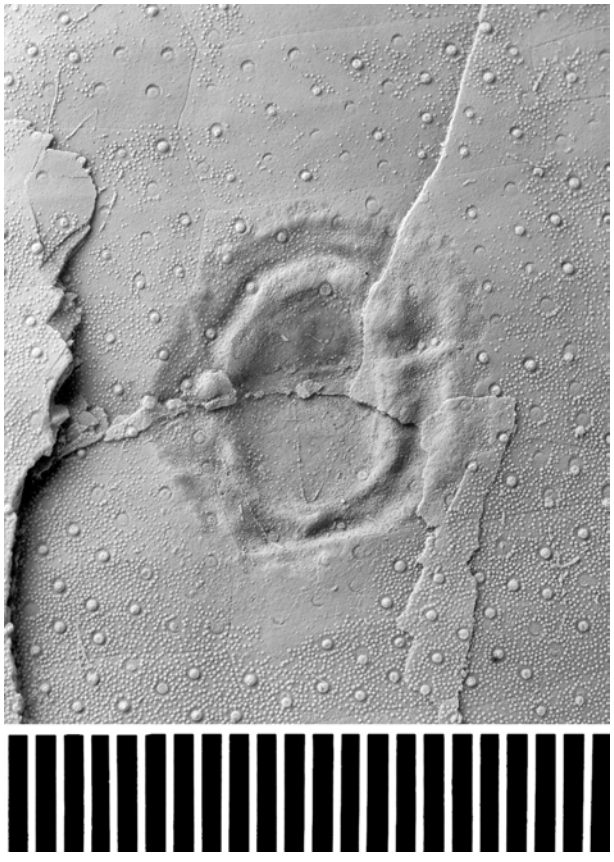

Fig. 2. Elongate pentagonal trace fossil (basal attachment scar) on the test of *Echinocorys* gr. *conoidea* (NHMM 2009 005, leg. P. P. M. A. Dols), from the upper Lixhe 1 Member (Gulpen Formation; lower upper Maastrichtian), former CPL SA quarry, Haccourt-Lixhe area, province of Liège, northeast Belgium. Scale in mm.

Although the test is slightly fractured and possibly lightly crushed, this has not altered the morphology of the large trace fossil (Fig. 2), which is non-penetrative and approximately rounded-pentagonal in outline with the long axis orientated adapically-abapically. The straight lower margin is controlled by a suture between interambulacral plates, whereas the morphology of the lower left margin is less strongly so. The margin of the trace is gently rounded to only slightly angular, dish-like and sloping gently towards the centre. Close to the circumference is a low raised ridge in the test, remaining approximately equidistant to form the circumference. This surrounds a central depression. Some primary tubercles are apparent within the trace, particularly close to the circumference, but others may have been lost; the test is bald around much of the trace. There is no evidence of the echinoid reacting to this infestation with any aberrant growth form.

Discussion

This trace fossil is unlikely to be a healed puncture, on account of the complex morphology of the margins, with the folded areas inside the circumference. We prefer to interpret it as the result of shallow embedment by some unmineralized, sessile invertebrate that attached to the test when the echinoid was still alive. The latter supposition is supported by the presence of some primary and numerous miliary tubercles within the area of the trace, suggesting that spines may have been present even after infestation (compare with Donovan and Jagt, 2002, 2004) or, perhaps more probably, regenerated after the death of the trace maker (compare with Wisshak and Neumann, 2006, fig. 5). The position of the trace close to the centre of the widest part of adjoining ambulacrum would have placed the maker near the maximum distance possible from any tube feet, but above the sediment surface. Bald areas of test around the trace may be the result of cleaning by the trace maker.

We favour interpretation of this trace as a basal attachment scar produced by a sessile, unmineralized invertebrate such as a sea anemone. Elongation in the adapical-abapical direction might have been normal for the producing species, but it may also be due to a plastic response to environment. For example, the producing organism may be elongated under the influence of gravity, having attached to an overly steep surface. Alternatively, if the organism was harvesting plankton from currents flowing past the test, then a more elongated form may

have facilitated a successful feeding strategy, the animal having a greater width than if it were radially symmetrical. Such an interpretation would suffice whether the echinoid was dead or alive. Further, the trace may be situated low down on the test to reap maximum benefit by feeding on resuspended sediment rich in organic detritus.

Cracks in the test are considered to be inorganic in origin (sediment compaction and flint fill) and not the result of failed predation. Cracks mainly cut across sutures and must be post-mortem and post-burial. A large flint nodule on the aboral test surface may be following a burrow system (*Thalassinoides*? isp.).

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