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Site selectivity of pits in the Chalk (Upper Cretaceous) echinoid *Echinocorys* Leske from France

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Abstract

A test of the holasteroid echinoid *Echinocorys* from the Turonian-Coniacian (Upper Cretaceous) Chalk of northern France bears two circular, shallow, non-penetrative pits assignable to *Oichnus* cf. *excavatus* Donovan and Jagt. The pits are situated in adjacent columns in ambulacrum IV and at approximately the same height above the ambitus. One pit is directly in line with the column of ambulacral pores; it appears to be eccentrically situated over a pore pair. The pit-forming organisms are considered to have infested *Echinocorys* when the echinoid was alive. They were most probably filter-feeding organisms that used the echinoid for protection, elevation above the sediment surface and orientation in the preferred direction of movement.

Key words: Ichnology, *Oichnus*, *Echinocorys*, Upper Cretaceous, France, Chalk

Introduction

Fossil echinoids perforated by small round circular holes or bearing pits, or both, assignable to the ichnotaxon *Oichnus* Bromley, 1981, remain rare and enigmatic fossils. Circular drillholes that perforate the test are commonly considered to be the result of predatory or parasitic activity by certain groups of gastropods (Kowalewski and Nebelsick, 2003; Leighton and Aronowsky, 2003; Santos *et al*., 2003; Ceranka and Złotnik, 2003; Donovan and Pickerill, 2004). It is more difficult to determine the function of circular pits on the surface of the test, morphologically *Oichnus*, but obviously not predatory in function (Donovan and Jagt, 2002, 2004). The present contribution examines a specimen of the common Late Cretaceous echinoid *Echinocorys* Leske, which bears two *Oichnus* pits that invite palaeoecological consideration.

The specimens discussed herein are deposited in Oertijdmuseum de Groene Poort, Boxtel, The Netherlands (MAB). Our philosophy of open nomenclature follows Bengtson (1988).

Systematic Ichnology

Ichnogenus *Oichnus* Bromley, 1981

Type species: *Oichnus simplex* Bromley, 1981, p. 60, by original designation.

Other species: *Oichnus asperus* Nielsen and Nielsen, 2001; *Oichnus coronatus* Nielsen and Nielsen, 2001; *Oichnus excavatus* Donovan and Jagt, 2002; *Oichnus gradatus* Nielsen and Nielsen, 2001; *Oichnus ovalis* Bromley, 1993; *Oichnus paraboloides* Bromley, 1981.

Diagnosis: (After Donovan and Pickerill, 2002, p. 87; see also Nielsen *et al*., 2003, p. 7.) " Small, circular, subcircular, oval or rhomboidal holes or pits of biogenic origin in hard substrates, commonly perpendicular to subperpendicular to substrate surface. Excavation may pass directly through substrate as a penetration, most commonly where the substrate is a thin shell, or may end within the substrate as a shallow to moderately deep depression or short, subcylindrical pit, commonly with a depth:width ratio of ≤ 1, with or without a central boss. "

Discussion: Analogous circular pits in Palaeozoic echinoderm tests were formerly named *Tremichnus* Brett, 1985. This ichnogenus was synonymised with *Oichnus* by Pickerill and Donovan (1998; see also Nielsen and Nielsen, 2001).

Oichnus cf. *excavatus* Donovan and Jagt, 2002
(Fig. 1)

Material: MAB 003183. Two circular pits (Fig. 1b, c) on a test of the holasteroid echinoid *Echinocorys scutata*

Leske, 1778 (Fig. 1a) *sensu* Smith and Wright (2003, pp. 530-534; but see also Jagt, 2000, pp. 269-274). The echinoid test is preserved in intimate attachment with a flint nodule (Fig. 1a).

Locality and horizon: MAB 003183 (donated by Mr. J. Buurman) was collected from scree slopes along the cliff section between Ault and Onival (Somme, northern France), and thus lacks precise details of provenance. As noted by Fouray (1981) and Mortimore and Pomerol (1987), these cliffs expose rocks of Late Turonian / Coniacian age (levels C3 and C4 of Fouray, 1981) which yield an abundance of micrasterid echinoids. On the basis of these, an expanded *Micraster normanniae* Zone was demonstrated by Mortimore and Pomerol (1987, p. 117, fig. 13), who referred to Turonian *M. normanniae sensu stricto* and Coniacian *M. normanniae sensu lato.* Herein we recognise a Late Turonian / Coniacian age for MAB 003183.

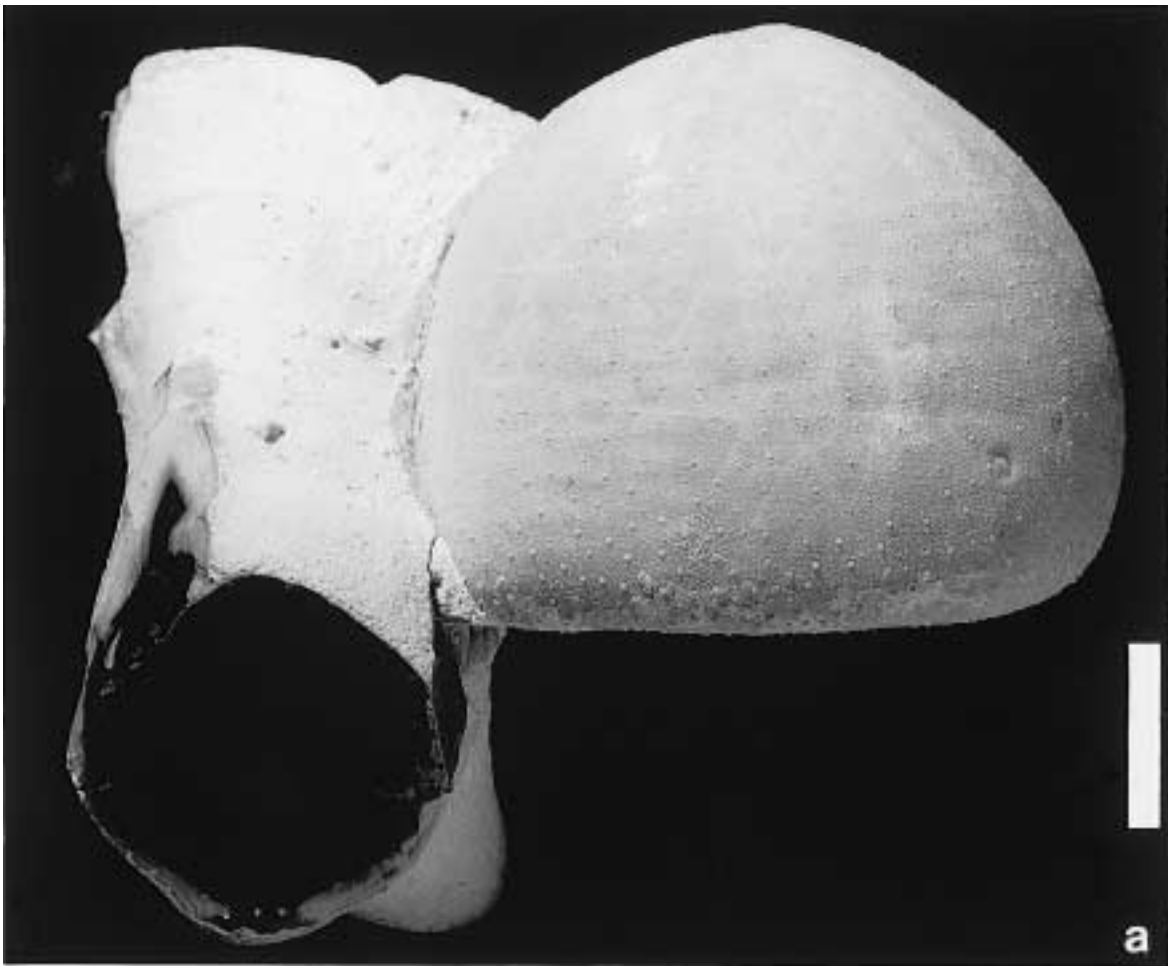
Description: Small, shallow, circular, non-penetrative pits in echinoid test, situated in adjacent columns in ambulacrum IV and at approximately same height above ambitus. The larger pit is in line with a column of ambulacral pores (note pore pairs just above and inside left pit in Fig. 1b, c), the other being slightly to one side of a pore column. Other specimen shallow(?) pit (right in Fig. 1b), incomplete, conical with abraded circumference. Base of pit convex, forming a broad, but low, boss, with a narrow, irregularly circular, more planar circumferential margin with a few very small pits, irregularly spaced (most prominent pair in close association, an ambulacral pore pair as already noted; Fig. 1c, 7 o'clock on pit).

Discussion: Drillhole / pit researchers are divided into two groups, those that name their small round holes / pits and those that do not, leaving them in open nomenclature (Donovan, in press; Donovan and Pickerill, 2004). We agree with the fundamental idea of systematic ichnology, so succinctly defined by Pickerill (1994, p. 15), that" ... the labelling of ichnotaxa provides a necessary vocabulary for writing and conversing about trace fossils." It is thus central to the present contribution to assign our round pits to the appropriate ichnotaxon.

The circular pits described above pose problems of classification mainly due to indifferent preservation. They undoubtedly belong in the ichnogenus *Oichnus* Bromley, but are included in *O. excavatus* only with some hesitation. As originally defined by Donovan and Jagt (2002), they would not be included within *O. excavatus*, which was diagnosed as" Circular to elliptical, non-penetrative *Oichnus*, almost invariably with a broad, high, raised central boss. Aperture of boring overhanging and walls concave." The one French specimen that shows sufficient detail to be described lacks a large central boss (although there must be some suspicion that it has been damaged), concave walls and an overhanging aperture. However, Blissett and Pickerill (2003, p.223) used cogent arguments to revise the ichnospecific diagnosis, in which the boss is" ... almost invariably ..." present and the walls" ... may be V-shaped." The French specimen is at least close to this diagnosis, more so than any other *Oichnus* ichnospecies, and is the first echinoid to be adequately documented with this morphology of *O. excavatus*.

However, the main interest in these pits rests in the palaeoecology of their producers. Small round holes in the tests of fossil echinoids present problems of interpretation, the most obvious questions being who did it and why? Both have been the cause of considerable conjecture by ichnologists and echinoderm palaeontologists. Most simple perforations, either cylindrical (*Oichnus simplex* Bromley) or parabolic in section (*Oichnus paraboloides* Bromley) in Upper Cretaceous and younger echinoids are probably the result of the attentions of certain gastropod groups. The reason why may be less certain, as morphologically similar borings may be the result of either predatory or parasitic behaviour (see references in introduction, above). The unusual non-penetrative *Oichnus excavatus* Donovan and Jagt, which are locally common in tests of *Hemipneustes striatoradiatus* (Leske) in the Meerssen Member, Maastricht Formation (Upper Cretaceous; Maastrichtian), have concave walls bearing echinoid tubercles and a large central boss. Blisters inside tests from the Meerssen Member show that this infestation occurred when the echinoid was alive; the tubercles may have supported spines that pierced the unmineralized tissues of the pit-forming organism, enhancing attachment (Donovan and Jagt, 2004).

The specimen of *Echinocorys scutata* provides another example of distinctive behaviour of such pit-forming organisms. The two shallow, non-penetrative pits are close together and each is precisely located within an ambulacral plate column, one is directly in line with a column of ambulacral pores and appears to be eccentrically situated over, but not enlarging, an ambulacral pore pair. Such precision of location is strongly suggestive that the echinoid was alive when infested by the pit-forming organisms, although there is no indication, such as obvious deformity of echinoid test growth, to support this. The pits may represent examples of disturbed predation or, more probably, could represent the traces of one or two organisms who hitched a ride on the test for protection or to gain a feeding / respiratory advantage (compare with discussion in Donovan and Jagt, 2002). In this connection their position in ambulacrum IV may indicate a preference by the pit-forming organism for the anterior part of the echinoid. This is comparable to the infested crinoid described by Donovan (1991), where an *O. simplex* pit is in an analogous position in a cup of the Lower Carboniferous crinoid *Synbathocrinus conicus* Phillips. The pit-forming



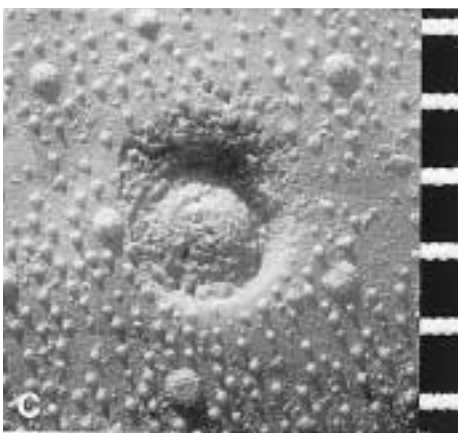


Fig. 1. *Echinocorys scutata* Leske, 1778, with two pits of *Oichnus* cf. *excavatus* Donovan and Jagt, 2002, in ambulacrum IV. a, Oblique left anterior view of test (MAB 003183), interambulacrum 3 central, ambulacrum III left of centre. Pits in ambulacrum IV to right; flint nodule left. Scale bar represents 10 mm. b, Enlargement of pits. Scale bar represents 5 mm. c, Detail of larger pit. Scale in mm.

organism was deduced to be" ... filter feeding, gaining elevation and automatic orientation [anteriorly], as well as protection "(Donovan, 1991, p.4). Although that example was infesting a member of the sessile, rather than vagile, benthos, such an interpretation may be equally applicable to the present example. The preference for an ambulacrum suggests a number of interpretations, but most probably the tube feet of the echinoid performed some function for the embedding organism.

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