

Curiouser and curiouser: more on reworked *Echinocorys* (Echinoidea; Late Cretaceous) on the beaches of north Norfolk, eastern England

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Abstract A new collection of tests of the Chalk (Late Cretaceous) holasteroid echinoid *Echinocorys* ex gr. *scutata* Leske, occurring as clasts on the beach between Overstrand and Cromer, north Norfolk, England, show a range of features that have not been discussed hitherto. Unlike the previous report of similar reworked tests from the same locality, specimens are commonly not bored; where bored, *Entobia* and *Caulostrepsis* are commonest, and a sinuous boring (?) or burrow (?) immediately beneath the test surface is left in open nomenclature. Encrusting episkeletozoans, both Recent (bryozoans, serpulids, spirorbidae) and Late Cretaceous (bivalve? or brachiopod?, crinoid) are present on some better preserved tests.

Keywords Biostratigraphy · Reworked fossils · Holasteroids · Borings · Episkeletozoans

Introduction

The study of beach clasts is a slightly unusual one for any palaeontologist, but can yield interesting data, for example, in palaeoecology, neoichnology, and the identification of ancient transport routes by fluvial and glacial action (see, for example, Donovan 2010, 2011a; Donovan and Lewis 2010). Areas such as the beach between Overstrand and Cromer on the north coast of Norfolk, eastern England (Donovan and Lewis 2011, fig. 1), continue to contribute to all these areas of study. The underlying Upper Cretaceous

Chalk of this area, dipping east, and glaciotectionic Chalk rafts span the Upper Campanian/Lower Maastrichtian boundary (Moorlock et al. 2002; Burke et al. 2010). Long shore drift is towards the east, so beach clasts of flint and, less commonly, Chalk are most probably locally derived.

Echinoderms are a rare component of this reworked flint and Chalk fauna. Until summer 2011, the only Chalk echinoderms that I had collected consisted solely of the large and conspicuous holasteroid *Echinocorys* ex gr. *scutata* Leske, 1778 (Donovan and Lewis 2011), but recent collection has added the remains of three other species of echinoid and a crinoid (Donovan 2012). Donovan and Lewis (2011) discussed the neoichnology of *Echinocorys* from Overstrand and noted, for a collection of tests preserved in Chalk, an ichnofauna of *Caulostrepsis* isp. cf. *taeniola* Clarke, 1908, *Gastrochaenolites* isp. and, particularly, *Entobia* isp. This analysis was based on all specimens collected over three summer field seasons (2008–2010) and showed what was interpreted as a progressive infestation of tests that varied from near-pristine through more or less bored specimens with abundant *Entobia* isp. to remnants retaining just the oral surface adhering to a bored part of the Chalk infill.

It is therefore unexpected to report that collection in summer 2011 was particularly productive, yielding more than twice as many *Echinocorys* as were available to Donovan and Lewis (2011). It is also unanticipated to report that the pattern of borings is very different, with only three tests infested by *Entobia* isp. In late July 2011, strong onshore winds blew the sea on this part of the coast high onshore. Whether the cause or merely coincidental, Chalk clasts were commoner than they had been for the previous two summers, including sponges, belemnites and echinoderms, particularly, *E. ex gr. scutata* Leske. It is therefore considered of interest to describe this new collection of

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Echinocorys, and attempt to interpret the new taphonomic and neoichnologic signals they provide.

Complete details of the locality and horizon may be found in Donovan and Lewis (2011, pp. 44–45, fig. 1). All specimens are deposited in Naturalis Biodiversity Center, Leiden, The Netherlands (RGM).

Description

There are 28 specimens of *Echinocorys* ex gr. *scutata* (RGM 780 634–780 661) in the new (2011) collection. The best preserved specimen is tolerably complete, retaining some details of tuberculation on the oral surface only, cracking, breakage anterior of the peristome (Fig. 1d) and encrustation by a serpulid worm tube. Other tests are more or less broken or have parts of the test spalled off (Fig. 1b) or bored (Fig. 1b, c, e, f), or both, some specimens being no more than a small remnant of test on a Chalk clast. Features such as tuberculation are commonly corraded away (sensu Brett and Baird 1986, p. 214). Only the flint steinkern is incomplete (Fig. 1a), preserving the posterior part of the apical surface of the test.

Only three specimens show sponge borings (*Entobia* isp.), two supra-ambitally (mainly apically) and the third apically (Fig. 1e), orally (Fig. 1f), posteriorly and right laterally (Fig. 1c). The latter (RGM 780 636) is also the largest specimen: height 85.0 mm, length 93.2 mm and width 80.7 mm (all measurements are incomplete due to bioerosion and breakage of the test). At least four specimens are bored by *Caulostrepsis* isp. cf. *C. taeniola*, each in the Chalk infill rather than the test. None of the specimens are bored by *Gastrochaenolites* isp. RGM 780 635 has a complex of sinuous borings (?) in the Chalk of the surface of the internal mould, exposed immediately below where the test has spalled away (Fig. 1b). Entry was apparently through aboral pores of the ambulacra. Unlike the collections of Donovan and Lewis (2011), some specimens preserve episkeletozoans (sensu Taylor and Wilson, 2002).

Discussion

“Curiouser and curiouser!” cried Alice” (Lewis Carroll, 2008, p. 11).

The most prominent feature of the smaller collection of tests of *E. scutata* described by Donovan and Lewis (2011) was the near pervasive occurrence of recent borings in specimens preserved in Chalk, most commonly *Entobia* isp., but also *Caulostrepsis* cf. *taeniola* and *Gastrochaenolites* isp. This suite of borings is typical of other modern

Fig. 1 *Echinocorys* ex gr. *scutata* Leske, 1778. **a** RGM 780 634, apical view, fragment of flint steinkern. **b** RGM 780 635, oblique anterolateral view, thick test cracked open to show sinuous borings (?) or burrows (?) in Chalk immediately below test surface. Anterior left of vertical crack to left. **c, e, f** RGM 780 636, test strongly bored by *Entobia* isp. in lateral (**c**, anterior to right), apical (**e**) and oral views (**f**). *Entobia* perforates a spirorbid worm tube towards the posterior, left of (*asterisk*) in (**f**). **d** RGM 780 637, oral view, most complete specimen showing good tuberculation, but broken anteriorly. Specimens uncoated. Anterior to top of page unless stated otherwise. All scale bars represent 10 mm

lithoclasts on the beach (Donovan and Lewis 2010; Donovan 2011b, 2013). In contrast, in the new collection of 27 *Echinocorys* tests preserved in Chalk (the only flint steinkern is unlikely to contain Recent borings, Fig. 1a), only three are noticeably bored by *Entobia* (e.g. Fig. 1c, e, f), four by *Caulostrepsis* and none by *Gastrochaenolites*. The collection described by Donovan and Lewis (2011) was noteworthy for its ichnological content; the new, larger collection is notable for the relative dearth of borings. While the pattern is different, it does not necessarily call into question the model for pattern of borings suggested by Donovan and Lewis, with the progressive degradation of tests. Many of the specimens in the present collections were probably bored at some time by clionoid sponges (*Entobia*) and annelids (*Caulostrepsis*), that, however, only penetrated rather superficially into the test calcite and Chalk, which was then weakened. Energetic corrasion may subsequently have removed the fragile, bored cortex, leaving the solid core; perhaps, these specimens are merely evidence for recent storms on the coast, causing abrasion and corrosion.

One boring (?) or burrow (?) in this new collection has not been reported hitherto in reworked *Echinocorys*. Structures in RGM 780 635 (Fig. 1b) are presumed to be Recent borings, but they could equally be ancient burrows. These slender and highly sinuous structures penetrate the surface of the internal mould and were obviously limited by the internal surface of the test. They may be single burrows/borings, but appear to be irregularly U-shaped, finding entry through ambulacral pores on the apical surface, although they could disappear under the in situ test surface. Until their precise morphology can be determined they are left in open nomenclature. The behaviour, although not the morphology, of these structures is reminiscent of *Arachnostega gastrochaenae* Bertling (1992).

There is also an evidence of post-mortem/post-exhumation encrustation of these specimens (=episkeletozoans, Taylor and Wilson 2002, Table 1); none were reported by Donovan and Lewis (2011). The colour of encrusters is either white (fossils) or cream (Recent). RGM 780 636 preserves, towards the anterior, remnants of Recent bryozoan colonies perforated by *Entobia* and a serpulid worm that appears to lie between borings (neither apparent in

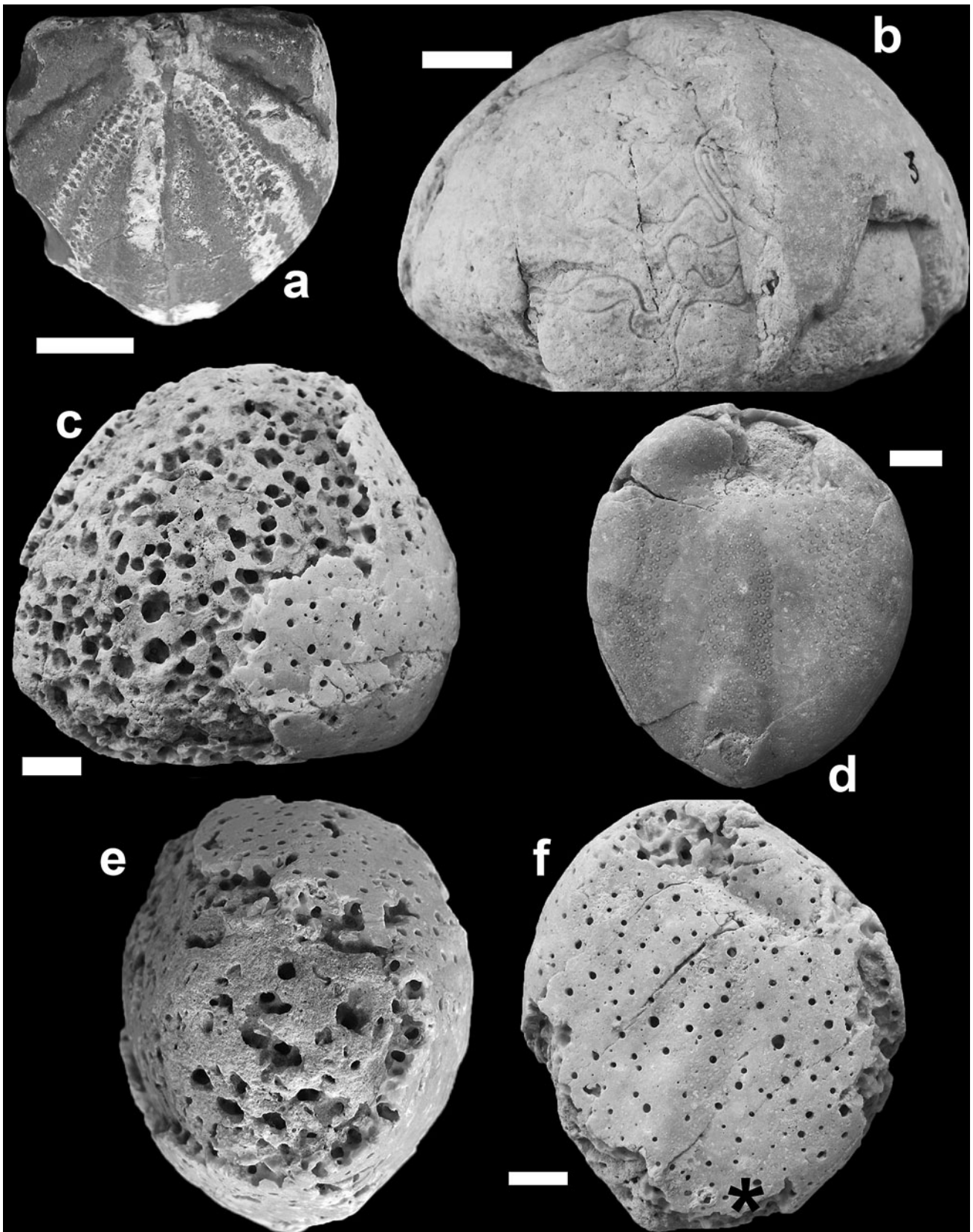


Fig. 1c). This indicates the relative ages of these structures; that is, *Entobia* postdates the bryozoans and predates the serpulid. Spirorbid worm tubes occur on the oral surface of this specimen, just posterior of the peristome and at the posterior of the oral surface, the latter perforated by *Entobia* (Fig. 1f, bottom). RGM 780 637 has a moderately broad serpulid tube anteriorly and supra-ambitally. RGM 780 635 has a poorly preserved, Late Cretaceous valve (bivalve? or brachiopod?) cemented posteriorly and supra-ambitally. Most unexpectedly, RGM 780 638 preserves a small, irregularly wart-like structure that appears to be a cemented crinoid attachment. This is similar in morphology to some of the bourgueticrinid attachments illustrated by Jagt et al. (in press, figs. 1E, 2A, B, F, G).

In conclusion, two collections of reworked *Echinocorys* ex gr. *scutata* from the same part of the coast of Norfolk, but collected in different years, show different neo-ichnofaunas, either commonly bored or not, mainly by clionoid sponges (*Entobia*) and annelids (*Caulostrepsis*). The paucity of borings in the new collection described herein may be a taphonomic artefact. Encrusting episkeltozoans, both Recent and Late Cretaceous, are present both on some of the bored and also better preserved tests in the new collection.

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