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A Recent example of the boring *Gastrochaenolites lapidicus* Kelly and Bromley and its producing organism in north Norfolk, eastern England

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Abstract

Recent *Gastrochaenolites* borings on the Norfolk coast, eastern England, are commonly left in open nomenclature due to incomplete preservation. A second nominal ichnospecies of *Gastrochaenolites*, *G. lapidicus* Kelly and Bromley, is identified from this area, infesting erratics of Upper Cretaceous Chalk. The other nominal *Gastrochaenolites* known from north Norfolk, *G. ornatus* Kelly and Bromley, has a less globular main chamber with a circular or spiral bioglyph at the base; it is commonly larger than *G. lapidicus*. The smooth, unlined, clavate borings of *G. lapidicus* were produced by the boring pholadid bivalve *Barnea candida* (Linnaeus).

Key words: ichnology, systematics, erratics, Chalk, *Barnea candida*

Introduction

It is a mantra of the ichnologist that determining the specific identity of an organism that created a given modern trace or trace fossil is only possible if the producer is preserved in close association with its spoor. This is almost invariably true apart from rare, most distinct examples such as certain tetrapod tracks (see, for example, Lockley *et al*., 2008). Trace fossils produced by invertebrates are rarely so species specific. Even traces that are generally attributed to particular groups may be the spoor of other, unrelated taxa. For example, *Cruziana* d'Orbigny and *Rusophycus* Hall were, despite a broad misconception, not always generated by trilobites (Donovan, 2010), and, pertinent to the present communication, *Gastrochaenolites* Leymerie is not invariably the result of boring by bivalves (Bromley, 2004, p. 462).

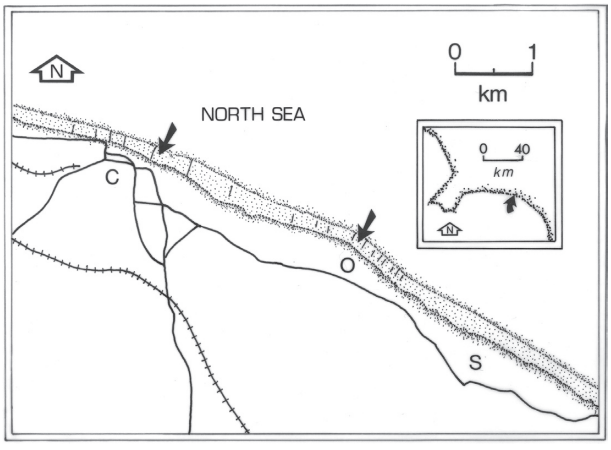

Fig. 1. Outline map of the north coast of Norfolk between Cromer (C), Overstrand (O) and Sidestrand (S) (after Donovan, 2012, fig. 1). The dark arrows indicate the approximate limits of the beach from which the specimens described herein were collected. The stippled area is between the low water mark and cliff top; it includes both the beach (groynes are indicated) and slope of the cliffs. Principal roads are shown as solid lines; railways are shown as trellised lines. The inset map of the Wash, and Lincolnshire and Norfolk coasts, shows the position of the main map (arrowed) in eastern England.

The north coast of Norfolk, eastern England (Fig. 1), is a productive site for the study of ichnology and neoichnology. Three aspects have been the focus of recent research: modern borers invading reworked bioclasts from the Upper Cretaceous Chalk (Donovan and Lewis, 2010, 2011); Palaeozoic erratics reworked from local Plio–Pleistocene fluvial sequences and preserving ancient trace fossils (Donovan, 2011b); and the diversity and generation of modern *Gastrochaenolites* ispp. in reworked Chalk substrates (Donovan, 2011a, b). The present paper is a contribution to the last-named field of study. *Gastrochaenolites* is a common ichnogenus in Chalk clasts, where it is presumably excavated by boring bivalves, but beach clasts only rarely retain the borer. The recognition of the producing bivalves may be further confused by nestling clams that invade the borehole at a later stage (Donovan, 2011a, p. 187).

The only nominal ichnospecies of *Gastrochaenolites* (and its producing bivalve) to be identified from the study area hitherto was *Gastrochaenolites ornatus* Kelly and Bromley, 1984 (Donovan, 2011a), which is produced by *Zirfaea crispata* (Linnaeus, 1758) (Donovan, 2011b). Herein, I identify a second boring-producer association from this productive site.

Material and methods

The Chalk clasts and shells described herein were collected by

myself on the beach between Overstrand and Cromer, north Norfolk, eastern England, approximately between NGR TH 225 422 and 249 410, during late July and early August 2011 (Fig. 1). The beach in the study area, although dominantly sandy, also has numerous lithoclasts, the majority of which are locally derived from the Upper Cretaceous (Campanian–Maastrichtian), including pebbles and cobbles of flint and, less commonly, Chalk. Fossils in these Cretaceous clasts include rare sponges, inoceramid bivalves, belemnites (Donovan and Lewis, 2010) and echinoderms (Donovan and Lewis, 2011; Donovan, 2012). Chalk clasts and bioclasts are commonly bored (Donovan, 2011a, b).

Large Chalk clasts bearing *Gastrochaenolites lapidicus* borings have been broken down mechanically to release the enclosed bivalve shells. Where this has necessitated the breakage of the actual boring, these have been repaired using white woodworking glue (Fig. 2B). The better preserved of the two borings has been cast using latex rubber (Fig. 2A). Specimens are deposited in the palaeontological collections of the Naturalis Bicodiversity Center, Leiden (RGM). Terminology of trace fossil morphology follows Häntzschel (1975) and, particularly, Kelly and Bromley (1984). My approach to ichnotaxonomy follows Pickerill (1994). Specimens were photographed using a Canon G11 digital camera.

Systematic ichnology

Ichnogenus *Gastrochaenolites* Leymerie, 1842

Type ichnospecies: *Gastrochaenolites lapidicus* Kelly and Bromley, 1984, p. 797, by subsequent designation.

Other species: See Donovan (2011a, p. 187).

Diagnosis: (After Kelly and Bromley, 1984, p. 797.) "Clavate borings in lithic substrates. The apertural region of the boring is narrower than the main chamber and may be circular, oval, or dumb-bell shaped. The aperture may be separated from the main chamber by a neck region which in some cases may be widely flared. The main chamber may vary from sub-spherical to elongate, having a parabolic to rounded truncated base and a circular to oval cross section, modified in some forms by a longitudinal ridge or grooves to produce an almond- or heart-shaped section."

Remarks: *Gastrochaenolites* borings are excavated principally by endolithic bivalves, but also by Recent coralliophilid gastropods and some sipunculan worms (Bromley, 2004, p. 462).

Gastrochaenolites lapidicus Kelly and Bromley, 1984

(Fig. 2)

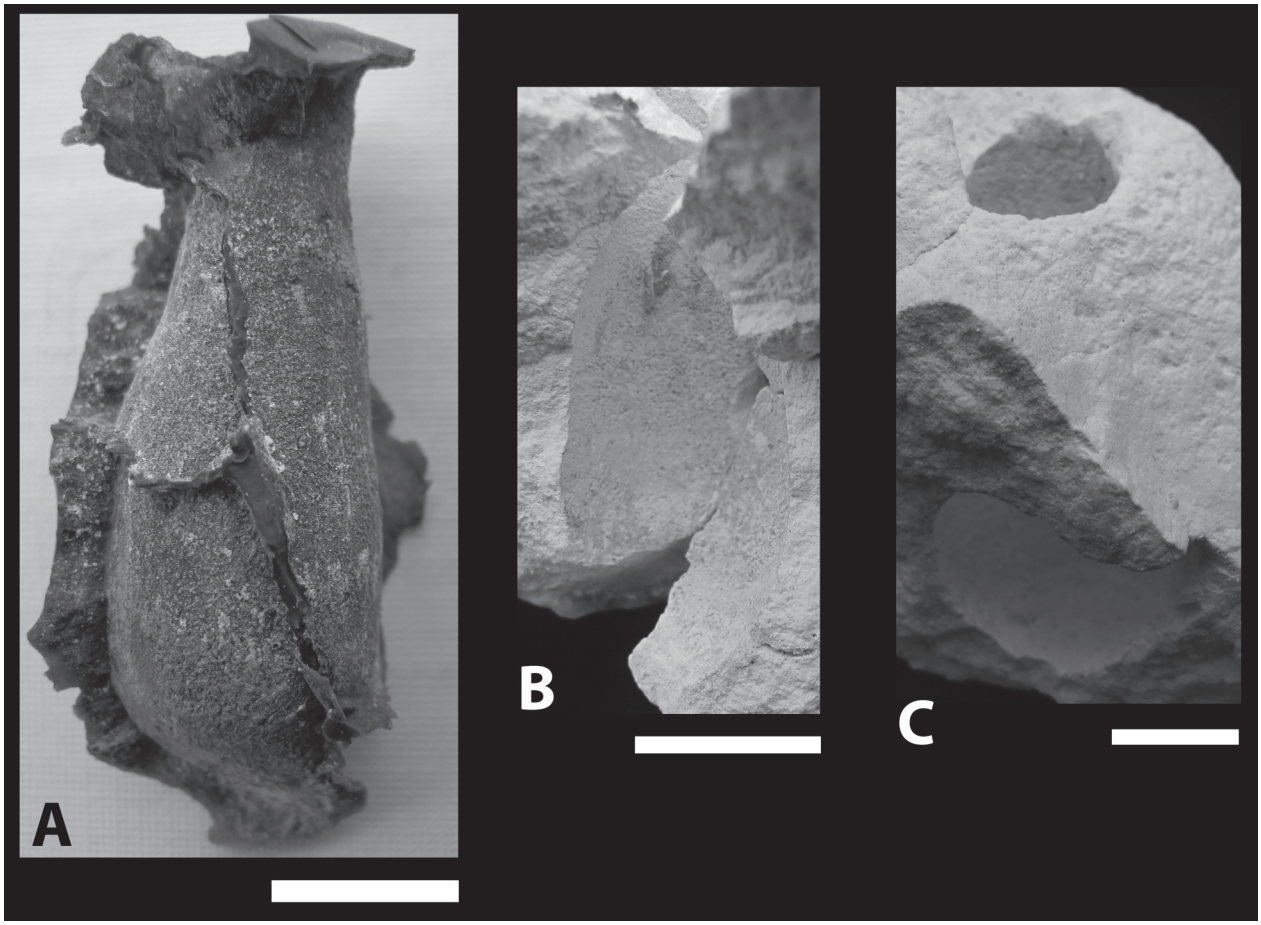

Fig. 2. *Gastrochaenolites lapidicus* Kelly and Bromley, 1984, from the Recent of north Norfolk, eastern England. (A, B) RGM 780 601. (A) Latex cast of boring (compare with Kelly and Bromley, 1984, text-fig. 3A). (B) Boring in Chalk; the specimen was broken to release the bivalve shell and has been repaired using white woodwork glue. (C) RGM 780 602, boring in Chalk. Specimens uncoated. Scale bars represent 10 mm.

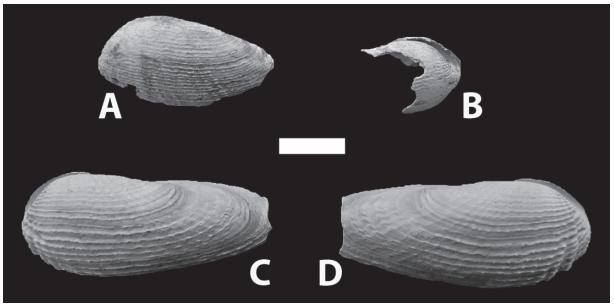

Fig. 3. Left and right valves of *Barnea candida* (Linnaeus, 1758) removed from the borings *Gastrochaenolites lapidicus* Kelly and Bromley, 1984, RGM 780 601 (A, B) and 780 602 (C, D). Specimens uncoated. Scale bars represent 10 mm.

Material: Recent borings in each of two Chalk clasts, RGM 780 601 and 780 602, both damaged during collection. The former is the more complete and has been cast in latex.

Locality and horizon: Beach erratics of reworked Upper Cretaceous Chalk between Overstrand and Cromer, north Norfolk, eastern England (see above).

Diagnosis: (After Kelly and Bromley, 1984, p. 798.) "Smooth, clavate boring; elongate ovate; circular cross-section throughout length including the neck region except for immediate area of the aperture where the section is usually oval, but may be circular; base bluntly paraboloid in longitudinal section; widest diameter located approximately central within the main chamber."

Description: Incomplete clavate (=club-shaped) borings in Chalk clasts that preserved shells of producing bivalves when collected (see below). Borings smooth-sided, unlined. Aperture not preserved, but neck may have been slightly elliptical in section. Boring slightly constricted at the base of the neck, about 10 mm below the aperture in the latex cast of RGM 780 601 (Fig. 2A). Main chamber incomplete, circular in section, but 40+ mm long in RGM 780 601 and expanding gradually to widest point about 30 mm below constriction. Base of chamber smoothly curved, unsculptured.

Remarks: The other nominal *Gastrochaenolites* known from the study area, *G. ornatus* Kelly and Bromley, 1984, is distinguished from *G. lapidicus* in having a less globular main chamber, with its base sculpted with a circular or spiral bioglyph (Kelly and Bromley, 1984, p. 801). Commonly, *G. ornatus* is also larger.

Discussion

These specimens are interesting for two principal reasons. Their preservation is unusually good for this site; this is only the second nominal *Gastrochaenolites* isp. to be recognised from Overstrand and Cromer from many hundreds of Chalk lithoclasts. Although neither specimen is complete, having been removed from larger clasts, they are both identifiable as *G. lapidicus*. Other, incomplete borings on the beach are commonly preserved as transverse sections (Donovan, 2011b, fig. 2C), and can only be referred to as *Gastrochaenolites* isp.

More significantly, the boring bivalves that produced these traces are preserved (Fig. 3). Kelly and Bromley (1984, p. 798) considered *G. lapidicus* to be "... produced by several species of *Lithophaga* and *Hiatella* today, the former commonly lined". The shells in both of these specimens are identified as the boring pholadid *Barnea candida* (Linnaeus, 1758), the white piddock (compare Fig. 3 with Barrett and Yonge, 1958, pl. 20; Tebble, 1976, text-fig. 96a). Tebble (1976, p. 181) considered *B. candida* "... a versatile borer, into peat, wood, mudstone, shale, slate, chalk, marl and sand ... and may be found from the middle of the intertidal zone to depths of a few fathoms." It is widely distributed around the coast of the British Isles and elsewhere.

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