A Derbyshire screwstone (Mississippian) from the beach at Overstrand, Norfolk, eastern England

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A distinctive chert erratic pebble found on the beach at Overstrand, north Norfolk, eastern England, is a Derbyshire screwstone. Such cherts are typical of the Mississippian (Lower Carboniferous) limestones of the southern Pennines (White Peak), over 200 km to the northwest. It was most probably transported by fluvial or glacial action during the Pleistocene and was recently disinterred by coastal erosion. The most diagnostic feature of screwstone cherts are the included mouldic crinoid ossicles, particularly columnals. Columnals of the monobathrid camerate crinoid *Megistocrinus*? *globosus*? (Phillips) are described from this screwstone; these have a circular outline, central pentagonal lumen and a raised perilumen. The uncertainty of the identification is due not only to the indifferent preservation of the columnals, but also to our poor knowledge of the morphology of the stems of all the nominal crinoids from the Mississippian of the White Peak.

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Introduction

> "... erratics are seldom seen in the cliff section, but may be observed on the beach ... the accumulation probably of centuries of coast erosion" (Harmer, 1910, p. 4).

Although it is a pastime practised by many people, beachcombing (McCann, 2004) has a particular importance for natural historians and may yield treasures up to the size of, quite literally, a whale (e.g., Kompanje & Reumer, 1995). For an invertebrate palaeontologist the beach may yield dead specimens of modern organisms that have direct relevance to studies of ancient life (Palmer, 1977; Donovan, 1989, 2007, in press) or unusual specimens of rocks or fossils that are worthy of comment in their own right (Donovan & Lewis, 2010). The present communication is concerned with one of the latter, a chert clast from eastern England of unexpected morphology that indicates a provenance rather different from that of the thousands of Upper Cretaceous flint pebbles and cobbles that crowd the same beach. In an area where the local geology is dominated by

Plio-Pleistocene deposits related to fluvial and glacial action, including ice-rafted masses of Maastrichtian chalk, the clast in question is a Derbyshire screwstone, an erratic derived from the Mississippian (Lower Carboniferous). However, the White Peak of the Derbyshire Peak District, from where this specimen was most probably derived, is more than 200 km to the north and west.

Terminology of the morphology of the crinoid endoskeleton follows Moore *et al*. (1968, 1978), Ubaghs (1978a) and Donovan (1986). My philosophy of open nomenclature follows Bengtson (1988); in particular, the use of a question mark indicates that the identification is uncertain.

Locality

The chert pebble described herein is deposited in the collections of the Nationaal Natuurhistorisch Museum - Naturalis, Leiden, NNM RGM 544 455. It was collected by the author on the beach at Overstrand, north Norfolk, eastern England, approximately NGR TH 249 410, during late July 2009 (Fig. 1). The beach at Overstrand, although dominantly sandy, also has numerous pebbles and cobbles, the majority of which are

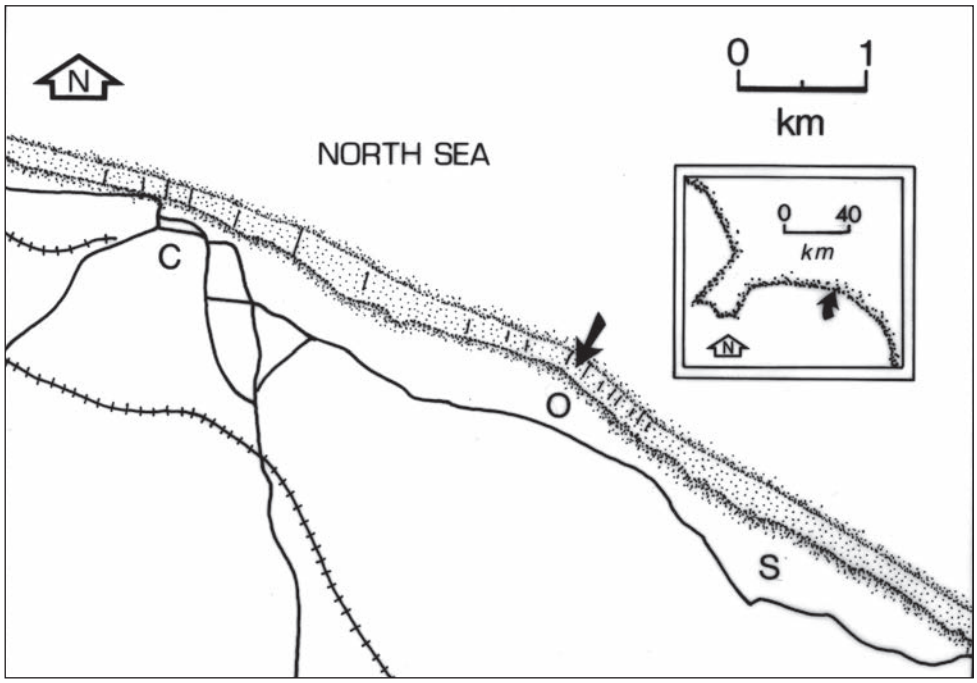

Fig. 1. Outline map of the north coast of Norfolk between Cromer (C), Overstrand (O) and Sidestrand (S). The dark arrow indicates the approximate position on the beach that yielded the Derbyshire screwstone erratic, NNM RGM 544 455. The stippled area is between the low water mark and cliff top; it includes 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, with a stippled coastline, shows part of the east coast of England, with Lincolnshire (left), the Wash (towards bottom left) and Norfolk (centre and right). The area of the main map is arrowed.

locally derived from the Upper Cretaceous, including cobbles of flint and, less commonly, chalk. Fossils in these Cretaceous clasts include rare sponges, inoceramids, belemnites (Donovan & Lewis, 2010) and *Echinocorys* (Donovan & Lewis, 2011), but no crinoids. Other rare erratics include some of igneous origin.

Description

The pebble of banded chert is 56.6 mm in maximum dimension; three measurements taken perpendicular to each other are 30.4 × 51.2 × 50.6 mm. The pebble is irregular in shape (Pls. 1-3), with low to moderate roundness and low sphericity, but some faces are moderately smooth. An incipient crack (Pl. 2) suggests that the shape of the pebble is modified by irregular breakages and subsequent abrasion. The pebble is pale grey in colour with internal laminations formed by four thin (2-3 mm thick), parallel, curved bands of darker, harder chert; two are prominent in Plate 2, a third forms the smooth and regular external surface in the upper left (suggesting that it is particularly hard), and the fourth is between this surface and the first prominent band. The porous surface is produced by very numerous moulds of (presumably) fossils, although only larger crinoid columnals and a shell fragment(?) are readily identifiable. Moulds are less prominent on darker grey chert; for example, contrast the upper surface and 'nose' to the right in Plate 3 (= darker grey chert) with the centre of Plate 1 (= paler grey chert).

Provenance

NNM RGM 544 455 is a chert pebble of unique morphology among those of the beach at Overstrand, the only one of its kind recognised in intermittent beachcombing during July 2008 and July to August 2009 (about three weeks in total). Although collected from a sandy coastline with many thousands of Upper Cretaceous flint cobbles and pebbles of myriad shapes and sizes, it is distinct from these on the basis of its lithology; most particularly, the mouldic preservation of the included crinoids.

Although crinoid columnals may be preserved in flints from the Chalk (Lewis, 2000, fig. 3I), common and distinctive Upper Cretaceous taxa such as those of isocrinids and bourgueticrinids are not seen in NNM RGM 544 455. Although the large columnals described below as *Megistocrinus*? *globosus*? (Phillips, 1836) might conceivably be derived from Cretaceous millericrinids, the suite of morphologies in this specimen are of typical Palaeozoic, not Mesozoic aspect.

The only British Palaeozoic cherts rich in mouldic crinoid debris are Derbyshire screwstones (Mississippian). There is no Carboniferous outcrop in the local area. With such a notable lithology, it is better to presume that NNM RGM 544 455 originated from the White Peak of Derbyshire where cherts, including screwstones, occur in the "upper parts of the Carboniferous Limestone" (Cope, 1998, p. 27).

Derbyshire screwstones are morphologically distinctive cherts in which the enclosed crinoid ossicles are preserved as moulds, the internal fills of the axial canals of pluricolumnals having a screw-like appearance and, hence, the common name for such rocks (Humble, 1860, p. 396; Woods, 1999). These silicified moulds of crinoid ossicles may reveal superior morphological detail to specimens in limestone when fresh and unabraded (Donovan, 2006). The chert may faithfully preserve fine morphological

detail and mouldic preservation may be either adequate for detailed examination or can be enhanced by taking rubber casts from the surface. NNM RGM 544 455 does not include any long pluricolumnals, so Derbyshire screws *per se* are not seen, but it is otherwise a typical example of this lithology.

Perhaps surprisingly, at least three Neogene formations in the Overstrand area are each known to contain a small proportion of clasts of Carboniferous cherts (Green & McGregor, 1990; Rose *et al*., 2001; Moorlock *et al*., 2002): the Wroxham Crag Formation; the Overstrand Formation; and the Holkham Till Member of the Holderness Formation. Presumably, the Carboniferous origin of clasts in these units was determined from their distinctive fossil content, although the present paper includes the first systematic examination of crinoids from a screwstone from north Norfolk (see below). The Wroxham Crag Formation includes Carboniferous cherts derived by pre-glacial fluvial action from Yorkshire and, notably, the south Pennines; the other two units are glacial in origin (Moorlock *et al*., 2002, pp. 8, 15 and 18, respectively).

Because of its geographic location, it might be suspected that NNM RGM 544 455 was most likely to be derived from the Overstrand Formation. Further, as this formation includes erratics from the Oslofjord region, it is also possible that NNM RGM 544 455 is of Scandinavian origin. However, both of these speculations are no better than that and a White Peak origin for this clast remains the most plausible explanation for its provenance.

Systematic palaeontology

Class Crinoidea J.S. Miller, 1821

Subclass Camerata Wachsmuth & Springer, 1885

Order Monobathrida Moore & Laudon, 1943

Family Periechocrinidae Bronn, 1849

Genus *Megistocrinus* Owen & Shumard, 1852

Type species – *Actinocrinus evansii* Owen & Shumard, 1850, p. 68, pl. 7, figs 3a, 3, by monotypy (Ubaghs, 1978b, p. T446; Webster, 2003).

Other species – Webster (2003) listed a further 36 nominal species of this genus, plus synonyms, subspecies and *Megistocrinus* spp. in open nomenclature.

Diagnosis – See Ubaghs (1978b, p. T446), which stated "Column stout; axial canal wide, quinquelobate." The familial diagnosis noted "Column cylindrical" (Ubaghs, 1978b, p. T443).

Range – Devonian (Emsian) - Mississippian (Osagean) of North America, Early Devonian of Germany and New Zealand, and Mississippian of northern England (Webster, 2003).

Megistocrinus? *globosus*? (Phillips, 1836)

Pl. 3.

Material – NNM RGM 544 455, a small chert clast including numerous crinoid columnals preserved as external moulds, at least two of which are moderately large

columnals assigned to *Megistocrinus*? *globosus*? (Phillips). The more complete specimen is lower and just right of centre in Plate 3.

Locality and horizon – Erratic from the beach at Overstrand, north Norfolk, eastern England, approximate NGR TH 249 410. Mississippian (Lower Carboniferous).

Description – Circular crinoid columnals with a central, pentagonal lumen surrounded by a narrow, ridge-like perilumen. Other features of articular facet poorly preserved, particularly remnants of a radial symplectial articulation. Latera planar and unsculptured, columnals moderately high.

Measurements from larger specimen – Columnal diameter about 8.3 mm; lumen diameter = 1.6 mm; columnal height = 3.6 mm.

Remarks – The Mississippian crinoids of the Derbyshire White Peak were recently considered by Donovan *et al*. (2003, 2005). Eight genera containing ten nominal species are known. Three species are platycrinitd monobathrids, whose unusual columnals of elliptical section with synarthiral articulation are well known, although such columnals are not particularly common in the Mississippian rocks of the White Peak. Of the others, the features of the proxistele are known, at best (Table 1). Thus, despite the Mississippian limestones of the White Peak being crammed with thousands of crinoid columnals and pluricolumnals at some horizons, the stems of the nominal crinoids from the area remain poorly known.

Table 1. Nominal fossil crinoids of the Lower Carboniferous (Mississippian) of the White Peak of the Peak District (southern Pennines) (modified after Donovan *et al*., 2003, table 1), with available information on morphology of columns.

Classification	Stratigraphy	Features of stem
Cladids		
Derbiocrinus diversus Wright	Asbian	pentagonal proxistele with small pentagonal lumen (Donovan *et al*., 2005)
Hydreionocrinus cf. *amplus* Wright	Asbian?	column of *H. amplus sensu stricto* "... round, nodular, alternating" (Wright, 1951b, p. 85)
Zeacrinites impressus (M'Coy)	Viséan	stem unknown
Monobathrids		
Megistocrinus globosus (Phillips)	Viséan?	see text
Ectocrinus olla (M'Coy)	Viséan	columnals "... round, very thin and alternating" (Wright, 1955a, p. 206)
Ectocrinus expansus Wright	Asbian?	stem unknown, presumed similar to *E. olla*
Platycrinites? *vesiculosus* (M'Coy)	Viséan	) column elliptical
Pleurocrinus ellipticus (Phillips)	?	) in section with
Pleurocrinus tuberculatus (J.S. Miller)	Asbian	) synarthrial articulation
Diplobathrids		
Gilbertsocrinus fionae Donovan	Brigantian	pentalobate lumen, prominent perilumen, marginal symplexy, columnal round, latus convex

Comparison of the columnals from Overstrand with the stems of other Mississippian crinoids from the Peak District suggests they are closest to *Megistocrinus globosus*. In particular, the specimen of *M. globosus* from Derbyshire that was figured by Wright (1955a, pl. 48, fig. 8) has a circular articular facet at the base of the cup with a pentagonal lumen. The similarity with columnals on NNM RGM 544 455 may only be superficial, but, at present, this is the closest comparison that is possible with any nominal crinoid from the White Peak of Derbyshire (Table 1). The features of the articular facets on NNM RGM 544 455 are poorly preserved, presumably in part due to their journey of over 200 km by fluvial or glacial transport. Superior specimens of both these columnals and *M. globosus* are necessary to determine if any similarities are more than trivial.

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Plate 1

NNM RGM 544 455, Derbyshire screwstone (Mississippian), erratic from the beach at Overstrand, north Norfolk, eastern England. General view of chert pebble to show numerous small crinoid columnals preserved as external moulds in pale grey chert (centre). The banding of the chert is weakly apparent towards the top. The side shown in Plate 2 is to the right, that in Plate 3 towards the top. Scale in mm. Coated with ammonium chloride for photography.

Plate 2

NNM RGM 544 455, Derbyshire screwstone (Mississippian), erratic from the beach at Overstrand, north Norfolk, eastern England. View to show banding of chert; the upper surface that curves down to the left is formed by a thin band of darker chert. Note numerous moulds of crinoid columnals and incipient crack (upper centre). Scale in mm. Uncoated.

Plate 3

NNM RGM 544 455, Derbyshire screwstone (Mississippian), erratic from the beach at Overstrand, north Norfolk, eastern England. Note external moulds of two large columnals, described herein and tentatively determined to be *Megistocrinus*? *globosus*? (Phillips, 1836) herein. Scale in mm. Coated with ammonium chloride for photography.