SHALLOW-WATER CRETACEOUS BRACHIOPODS FROM ROCKALL BANK, NORTH ATLANTIC

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ABSTRACT. A shallow-water fauna of terebratulide brachiopods, bryozoans, and bivalves is described from the western margin of Rockall Bank, occurring in phosphatized ferruginous sandstones of 'greensand' facies. '*Carneithyris*' *rockallensis* sp. nov. suggests a date of Upper Cretaceous age, possibly as young as Maastrichtian. A glacial origin is possible.

THREE rock dredge hauls from the western margin of Rockall Bank, text-fig. 1, have yielded the first recorded Mesozoic shelf fauna from the North Atlantic. They were taken during Cruise 4/78 of R.R.S. *Shackleton* whilst the vessel was engaged in an underwater television and dredging study of carbonate sedimentation on the northern part of the Bank. Fossiliferous material was obtained from the following stations:

Station	Lat.	Long.	Water depth	Material collected	Repository
69/2	57° 00·3′ N.	15° 10·8′ W.	474 m	Subrounded phosphatic cobbles; loose fossils	BM
71/2	57° 09·2′ N.	14° 57·6′ W.	387 m	Individual phosphatized terebratulides; broken ferruginous sandstone	HM × 1030 (TS 69/001–12)
72	57° 19·5′ N.	14° 51·6′ W.	360 m	Tabular slabs of terebratulides in sandstone	BM; HM × 10743, 10744, 10746

BM = British Museum (Natural History), Palaeontological Collections; HM = Hunterian Museum (University of Glasgow), Geological Collections

At station no. 69 the dredge brought up a spectacular variety of obviously glacial material (quartzite, arkose, phyllite, pumice, granite) in addition to the more frequent fossiliferous phosphate, which was subrounded. Further north-east, however, at stations nos. 71 and 72, nothing was recorded except blocks of phosphatic sandstone and large, extremely well-preserved, highly polished, individual fossil terebratulides (text-fig. 3). Smaller terebratulides may also have been present, but these would have been lost during hoisting because of the relatively large mesh of the dredge bag.

It is always difficult to be certain whether boulders dredged from high-latitude shelves and banks represent the solid geology or have been plucked from a surface strewn with ice-rafted drop-stones. This problem is acute on the margins of Rockall Bank, for Belderson *et al.* (1973, p. 217, fig. 4) and Roberts (1975, p. 456, fig. 5) show that iceberg plough marks are often encountered between 500 and 150 m. However, the following observations are not inconsistent with the interpretation of a solid substrate for stations nos. 71 and 72: all the material was of a single rock type; none shows evidence of striation or rounding and some blocks show fresh fractures; no 'tide-marks' free of epifauna were present around the base of blocks, such as would indicate partial burial in sediments.

On Rockall Bank, material associated with iceberg plough-marks is generally basaltic (Belderson *et al.*, 1973, p. 220); on the Scottish shelf, boulders are often striated and cobbles rounded or subrounded, including a wide range of types (just as at station no. 69). It cannot be ruled out, therefore, that solid Cretaceous phosphatic sandstones crop out on the western flank of Rockall Bank in the region of 59° 9–19′ N. and 14° 52–58′ W., and that grounding icebergs moving southwards have dispersed the material more widely.

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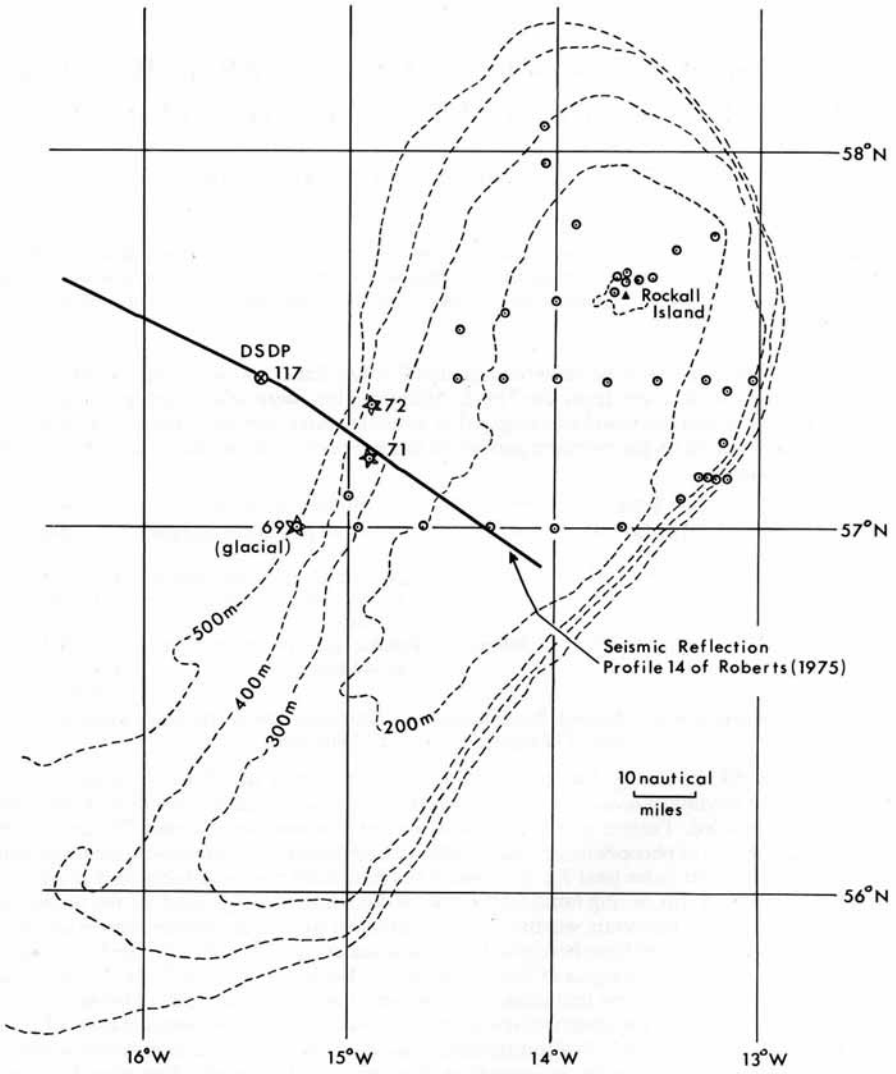


TEXT-FIG. 1. Map showing the location of the three dredge stations yielding fossiliferous Upper Cretaceous sedimentary rocks. [Bathymetry from I.O.S. chart of north-east Atlantic: line of seismic reflection profile from Roberts (1975, fig. 12, p. 472); other stations plotted during R.R.S. *Shackleton* cruise 4/78 did not yield any Cretaceous material.]

TEXT-FIG. 2. Mass of large bryozoan specimens in pseudoconglomeratic phosphate block, dredged from station no. 69/2, ×1·25.

Identification and age of the fauna

Brachiopods constitute the most spectacular element in the fauna, though they are equalled, if not outnumbered, by large quantities of a stout, ramose bryozoan (text-fig. 2) unlike anything with which we are familiar in the British Cretaceous. Two poorly preserved internal moulds were identified as follows:

1. Fragment of a bivalve internal mould reminiscent of the Crassatellacea but with a posterior adductor scar unusually close to the umbo.
2. Internal mould of an arcticacean bivalve with no hinge or muscle scars preserved, similar in shape to some Cretaceous species.

Phosphatic blocks are noticeably nodular, even conglomeratic, in appearance. This is, in part, caused by projecting fossil Bryozoa and, in part, the result of present-day biological erosion. They are strikingly similar to the Cenomanian glauconitic calcarenite illustrated by Laughton, Berggren *et al.* (1972, from DSDP 111, pl. 1B, p. 85 and pl. 9, p. 101) which is a phosphatized hardground.

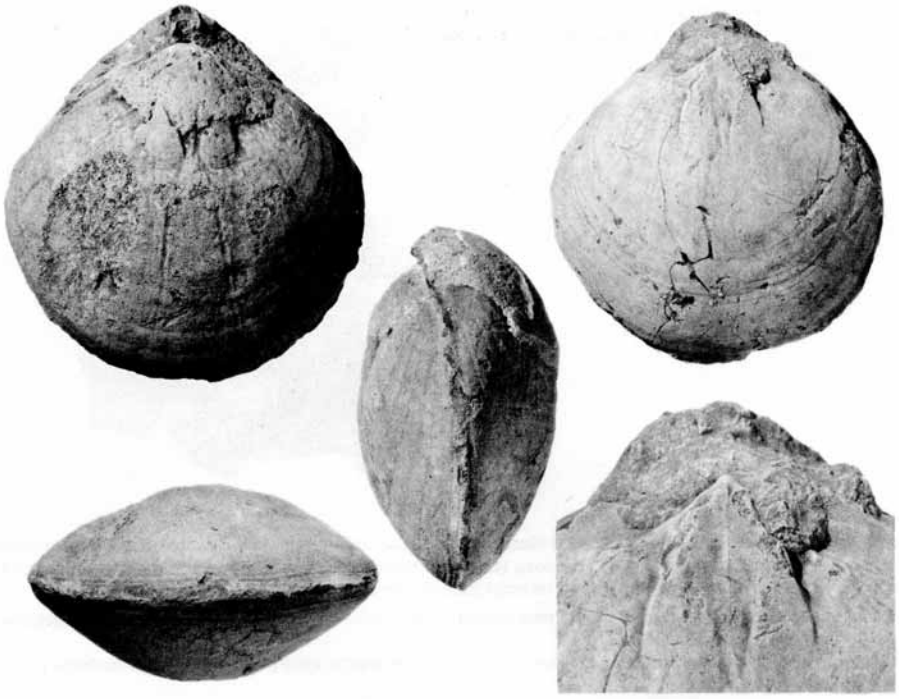
A block of highly glauconitic, phosphatic sandstone, 16 × 20 cm, contained a fauna of large, subcircular, acutely biconvex terebratulides which at first were thought to be assignable to the genus *Cyrtothyris*, originally described by Middlemiss (1959) from the Upper Aptian of Upware, Cambridge. A more critical examination involving transverse serial sections of one of the specimens suggested a close affinity to the genus *Carneithyris*, which Sahni (1925*a*) described from the Upper Chalk, *Belemnitella mucronata* Zone, Norwich, Norfolk. There are, however, minor features within the internal structure of the Rockall specimen which are regarded as atypical of Sahni's *Carneithyris*, and it is for this reason that a broader interpretation of the genus is used for the species described here as '*Carneithyris*' *rockallensis* sp. nov.

SYSTEMATIC DESCRIPTIONS

Superfamily TEREBRATULACEA Gray, 1840
Family TEREBRATULIDAE Gray, 1840
Subfamily CARNEITHYRIDINAE Muir-Wood, 1965
'*Carneithyris*' *rockallensis* sp. nov.

Text-figs. 3, 4

Description. Large pentangulate to subcircular carneithyride, 59·1 mm long, 56·4 mm wide, and 31·6 mm thick. Evenly biconvex, rectimarginate. Pedicle valve with short massive, slightly incurved umbo, truncated by a large subcircular foramen with fairly distinct permesothyridid beak-ridges. Deeply incised, elongate adductor muscle



TEXT-FIG. 3. '*Carneithyris*' *rockallensis* sp. nov. Lower Maastrichtian (dredged) at station no. 71/2, on north-western slope of Rockall Bank. Left and centre, holotype (B.M. specimen no. BB 76583) in dorsal, lateral, and anterior views, × 1. Right, B.M. specimen no. BB 76584: above, showing general pentangulate outline and position of subparallel muscle scars just anterior to dorsal umbo, × 1; below, umbonal region to show faint median ridge between the muscle scars, × 2.

scars lie centrally placed, one on either side of a low median depression on the floor of the brachial valve. The faint impressions of numerous branching pallial markings are visible on the surface of internal moulds.

A massive cardinal process, semicircular in transverse outline, extends well into the pedicle valve, becoming more elongate and peg-like.

Low, thickened, ventrally concave hinge-plates, with well-developed inner and outer socket-ridges, diminish rapidly and incline dorsally. Rounded hinge-teeth with poorly developed accessory denticulae become subquadrate to broadly triangular in transverse outline.

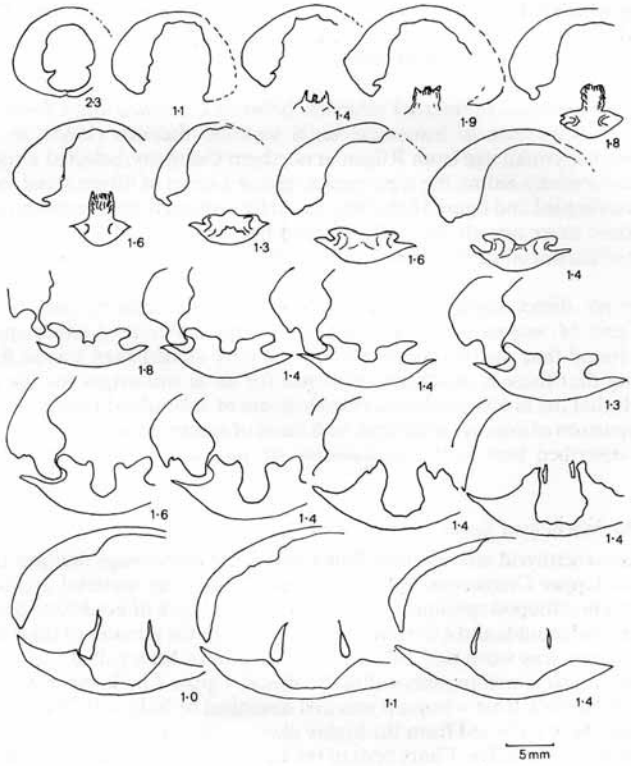
Thickened, but elongate, subparallel crural processes are given off from the distal ends of the hinge-plates.

Remarks. '*Carneithyris*' *rockallensis* sp. nov. differs from the type species, *Carneithyris carnea* (J. Sowerby) in having a more pentangulate general outline, larger pedicle foramen, more distinct beak-ridges, and slightly more produced and incurved umbo.

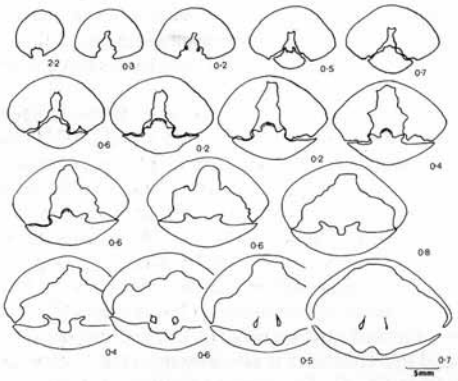
In transverse outline it is seen to have a similar degree of thickening of the shell to that of *C. carnea*, particularly in the umbonal region, and the same general transverse outline of teeth and sockets. It also has similarly developed hinge-plates with well-developed inner and outer socket-ridges, but in '*Carneithyris*' *rockallensis* these remain low and slightly concave on their ventral surface. They extend well into the body cavity where they begin to incline steeply towards the dorsal valve, a character also observed in transverse serial sections of *Oleonithyris harlani* (Morton) from the Paleocene of New

Jersey, U.S.A. (Feldman 1977, p. 93). This stage is reached earlier in the development of the shell in *C. carnea*. Nevertheless, the general pattern and development of the internal characters of the two species, as seen in serial sections (text-figs. 4, 5), shows very clearly that the two forms have a great deal in common.

The predominance of the massive cardinal process with its characteristic bulbous shape, distinguishes the Carneithyridinae from other Upper Chalk Terebratulidae and Sahni (1925*b*) used these and certain hinge characters to distinguish morphological variants which he split into genera and species. Recently, Asgaard (1975) in an exhaustive study of Upper Chalk Carneithyridinae, has shown that Sahni's interpretation of these characters was too narrow, suggesting that he had not understood the true range of variation within the Carneithyridinae as a whole. His results, though somewhat advanced for the time, cannot now be applied stratigraphically with any degree of confidence. It can be seen, however, that certain morphological differences do exist between forms which Sahni had described as *Magnithyris*, *Carneithyris*, and *Chatwinothyris*. One of these differences lies in the absence, in *Magnithyris magna* Sahni, of a marked median ridge or low septum separating the muscle scars on the floor of the brachial valve and this character is also absent in transverse serial sections of '*C.*' *rockallensis* sp. nov. shown here (text-fig. 4). The general outline of *Magnithyris*



TEXT-FIG. 4. Twenty transverse serial sections through the umbo of a specimen of '*Carneithyris*' *rockallensis* sp. nov. obtained from a block of sandstone dredged from the north-western slope of Rockall Bank.



TEXT-FIG. 5. A series of sixteen transverse serial sections through the umbo of a specimen of *Carneithyris carnea* (J. Sowerby) from the Upper Senonian, *Belemnitella mucronata* Zone, Portrush, Northern Ireland.

magna, the species which Sahni had selected as type species of the genus, and that of '*C.*' *rockallensis*, on the other hand, are very similar and the pedicle foramen in both forms is large, circular, and with fairly well-marked permesothyridid beak-ridges.

Similarly, minor differences of internal structure between *C. carnea* and *Chatwinothyris* are also discernible from a comparison of transverse serial sections. Steinich (1965), in a description of brachiopods of Maastrichtian age from Rügen in northern Germany, selected a specimen which he identified as *C. subcardinalis* Sahni, the type species, giving a series of fifteen serial sections (fig. 28, p. 42) which have been copied and figured here (text-fig. 6) for comparison. The mode of development of the cardinal process, more acutely ventrally inclined hinge-plates and less well-developed median ridge on the floor of the dorsal valve, suggest a closer affinity between this species and '*C.*' *rockallensis* sp. nov.

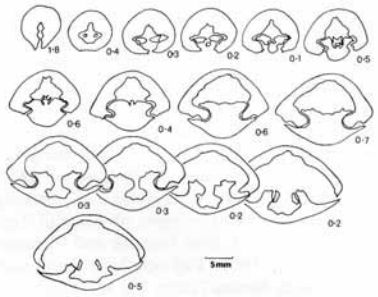
Unfortunately no direct comparison of transverse serial sections can be made between '*C.*' *rockallensis* and *M. magna* due to the lack of suitable material of either species and it may subsequently be found that the two forms are more closely affined than was at first envisaged.

While admitting that there is insufficient evidence for an *in situ* origin for the sandstone block examined, it is felt that the brachiopods described here are of undoubted Upper Cretaceous age and, as a result of comparison of internal structures with those of species considered to be of Maastrichtian age, the species described here as '*C.*' *rockallensis* sp. nov. is tentatively assigned to the Lower Maastrichtian.

Significance of the brachiopod fauna

The presence of a carneithyrid terebratulide fauna within the assemblage dredged from the Rockall Bank indicates an Upper Cretaceous age or younger. Clearly the material might well have been transported but the brachiopod specimens extracted from the block of sandstone described here were well-preserved internal moulds and a few single specimens with the remains of thick calcareous shells. None of the specimens was worn nor did they appear to have been rolled.

The genus *Carneithyris* is well represented in the British Upper Chalk, *mucronata* Zone, from the Norwich district of Norfolk from whence it was first described by Sahni (1925*a*). Species referable to this genus have also been collected from the highly glauconitic beds of equivalent age at Portmuck, Co. Antrim, and also from the Top Flinty beds of the Belfast area, Northern Ireland. Hancock (1961, p. 26) and Wood (1970, p. 78) consider the upper mass of White Limestone from the same district to be of Senonian age, but suggest that Maastrichtian beds were probably deposited within the Belfast area and have subsequently been eroded prior to the extrusion of the Tertiary Basalts.



TEXT-FIG. 6. A copy of fifteen serial sections through a specimen of *Chatwinothyris subcardinalis* Sahni from the Lower Maastrichtian of Rügen, North Germany (after Steinich, 1965, fig. 28, p. 42).

CONCLUSIONS

Shallow-water sediments with claimed ages from Upper Cretaceous to Eocene have been dredged from both sides of Rockall Bank and from the western slopes of Porcupine and Hatton Banks (Bailey and Haynes 1974; Watts *et al.* 1975; Dobson *et al.* 1976). Doubt may still exist over the *in situ* nature of particular individual occurrences, for a glacial origin is possible, but the regional totality of records is becoming impressive. The sediments include oolitic limestone from 59 N. (Watts *et al.* 1975, p. 642)—a surprisingly high latitude considering the probable Maastrichtian palaeolatitude of 40 N. (Smith *et al.* 1973, fig. 7), a fact that would be made more difficult to explain by invoking a glacial origin; arkose and lithic conglomerates (with a probable southerly derivation), and condensed phosphatic greensands of a high-energy environment containing a brachiopod fauna and also a hardground aspect (this paper).

Previous estimates of age have been based on either pelagic foraminifera from slope sediments (Dobson *et al.* 1976) or on dubious dinoflagellates (Watts *et al.* 1975). This record of '*C.*' *rockallensis* gives the first reliable age, Maastrichtian, for the shallow-water facies—an age slightly younger than that obtained for the Helen's Reef microgabbro intrusion, dated at 81 ± 3 m.y. (Harrison *et al.* 1975, p. 71). Shallowing of the Bank may have been associated with the intrusive event, or more plausibly could have resulted from general Maastrichtian eustatic regression (Hancock 1975, p. 104), the resulting facies representing the nearshore equivalents of the offshore chalks commonly recorded off the mainland massifs (e.g. Lapierre 1975; Hancock 1975, fig. 3).

Both the fauna and the lithology of the Rockall material show a close affinity with the Northern Ireland sequence, but are different from the East Greenland succession which is dominated by coarse clastics (Donovan 1957).

As a result of the rapid westward drift and the concomitant subsidence of Orphan Knoll (300 miles south of Rockall Bank) in the Senonian–Palaeocene interval, the Maastrichtian in that area is of pelagic facies (Laughton and Berggren 1972, p. 52), whereas the Rockall Plateau evidently remained as a stable block and may have had a very similar Cretaceous history to that of Northern Ireland.

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