

Unusually large Late Campanian – Early Maastrichtian foraminifera from the Southern North Sea Basin

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ABSTRACT—A low diversity fauna of unusually large (individuals of two to three times the normal size) agglutinated and calcareous benthic foraminifera is recorded from the Late Campanian – Early Maastrichtian Chalk sequences of two boreholes (Shell 49/19.1 and Shell 49/20.2) in the Southern North Sea Basin. Associated planktonic species are extremely rare. This distinctive assemblage provides a useful local stratigraphical marker.

INTRODUCTION

The foraminifera of Chalk sequences from three boreholes drilled by Shell (UK) Exploration and Production Limited in the Southern North Sea Basin during 1965–1971 have been investigated in order to establish a local biostratigraphical zonation for the Upper Cretaceous. The boreholes are Shell 44/2.1 (54°52'38"N., 02°23'35"E.) on the southern edge of the Mid North Sea High, and Shell 49/19.1 (50°23'48"N., 02°45'21"E.) and Shell 49/20.2 (53°27'26.056"N., 02°58'15.124"E.) in the Indefatigable Gas Field (Fig. 1). Geophysical logs are a major tool for correlation and analysis of such offshore sequences but where a full suite of these is not available, or where a monotonous response is produced such as that through the Chalk Group, detailed subdivision must rely heavily on micropalaeontological criteria.

Most borehole samples from offshore are generally available only as "ditch cuttings" which are tiny chips of rock cut by the drill bit. In the present study, these were sampled at 30 ft. intervals. The cuttings are brought to the surface by drilling mud that is circulated to lubricate the drill bit and to prevent the well caving in. One of the several problems encountered when ditch cutting are used in biostratigraphical studies is that of "cavings" which is material introduced into the mud system from stratigraphical levels higher up the well. To compensate for this, biostratigraphical and chronostratigraphical boundaries are drawn at extinctions (i.e. first down-hole appearances) of fossil taxa. The Upper Cretaceous stage boundaries in the three boreholes examined have been established on this basis using the known foraminiferal ranges from onshore Britain and elsewhere in Europe. These boundaries are shown, together with the geophysical log signatures (Gamma Ray and Formation Density) for Borehole 49/20.2 in Fig. 2.

SAMPLE PREPARATION AND EXAMINATION

Each sample was disaggregated in white spirit, washed through a 75 µm sieve, dried and then split into four size

fractions in a nest of sieves (500 µm, 250–500 µm, 180'–250 µm, 125–180 µm).

The 500 µm fraction of the samples from 1500 ft.–2000 ft. in Borehole 49/19.1 and 2870 ft.–3800 ft. in Borehole 49/20.2 yielded extraordinarily large specimens (see Pl. 1, figs. 5a, b) of a low diversity fauna of agglutinated and calcareous benthic foraminifera (see below). Only rare planktonic forms were recorded. This unusual assemblage was not recovered from Borehole 44/2.1.

SYSTEMATIC PALAEONTOLOGY

Arenobulimina courta (Marie)

(Pl. 1, fig. 1)

Remarks. This species was described originally from the Campanian (*mucronata* Zone) of the Paris Basin (Marie, 1941). The test is free and globular; the chambers are arranged trochospirally in three to four whorls and are inflated to very inflated in the last whorl which makes up over half of the test. The sutures are distinct and depressed, and the aperture is a single slit or semi-circular opening midway along the internal margin of the last chamber at the junction of the four sutures of the final whorl. The wall is thick and the surface rugose. The species has been compared with *Bulimina obesa* Reuss, first described from the Upper Cretaceous of Poland, but the relationship between the two species remains unclear.

Dimensions. Average

Height: 0.63 mm

Width: 0.49 mm

Bigger forms

Height: 1.3 mm

Width: 1.0 mm

Arenobulimina elevata (d'Orbigny)

(Pl. 1, fig. 2)

Remarks. This species was described originally from the Campanian of the Paris Basin (d'Orbigny, 1840) and is very similar to *A. courta* (see above). However, it may be distinguished by its bigger size (four to five whorls) and high trochospire.

Dimensions. Average

Height: 1.3 mm

Width: 1.1 mm

Bigger forms

Height: 2.0 mm

Width: 1.7 mm

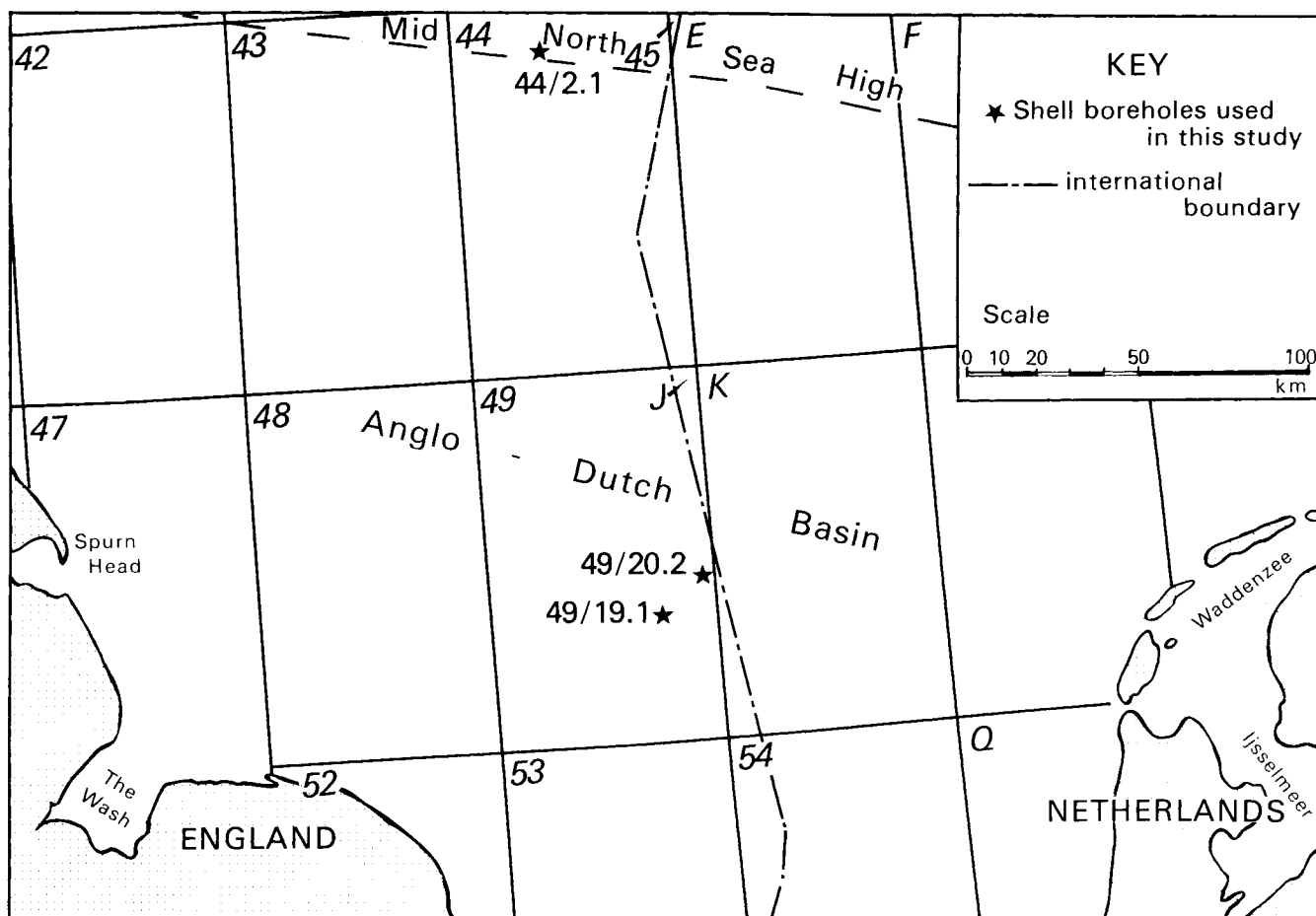


Fig. 1. Location of the three boreholes in the Southern North Sea Basin used in this study.

Eggerellina brevis (d'Orbigny)

Remarks. This species was described originally from the Campanian of the Paris Basin (d'Orbigny, 1840). It shows a wide range of morphological variation and well documented dimorphism (microspheric and megalospheric forms). However, its taxonomic history is rather confused. The type figures show clearly the characteristic dominance of the last overlapping whorl, the trilobed appearance and the 'key-hole' shaped aperture. Two and a half chambers are usually visible from the summit. The wall is agglutinated but composed of calcareous particles.

Dimensions. Average Bigger forms
 Height: 0.56 mm Height: 1.17 mm
 Width: 0.49 mm Width: 0.96 mm
Ataxophragmium rimosum (Marsson)
 (Pl. 1, fig. 4)

Remarks. This species was described originally from the Chalk of Rügen Island, East Germany (Marsson, 1878). The test is free and subspherical; the chambers are arranged in a tightly coiled helical spire of two to three

distinctly overlapping whorls and are obscured by the strong ornamentation of randomly arranged grooves which roughen the surface and distinguish the species from other members of the genus. The grooves may be the result of dissolution of the sponge spicules that were once cemented together to form the test. The sutures are flush, and the aperture varies from a simple semi-circular interiomarginal opening on the final chamber to a narrow slit extending up the apertural face.

Dimensions. Average Bigger forms
 Height: 0.53 mm Height: 0.83 mm
 Width: 0.49 mm Width: 0.77 mm

Ataxophragmium variabile (d'Orbigny)
 (Pl. 1, figs. 5a, b)

Remarks. This species was described originally from the Campanian of the Paris Basin (d'Orbigny, 1840) and is type of the genus *Ataxophragmium*. It is a highly variable form with a free test which is subglobular to elongate with a variable outline but always broader than high. The chambers are arranged in a helical spire of two to three loosely to tightly coiled overlapping whorls.

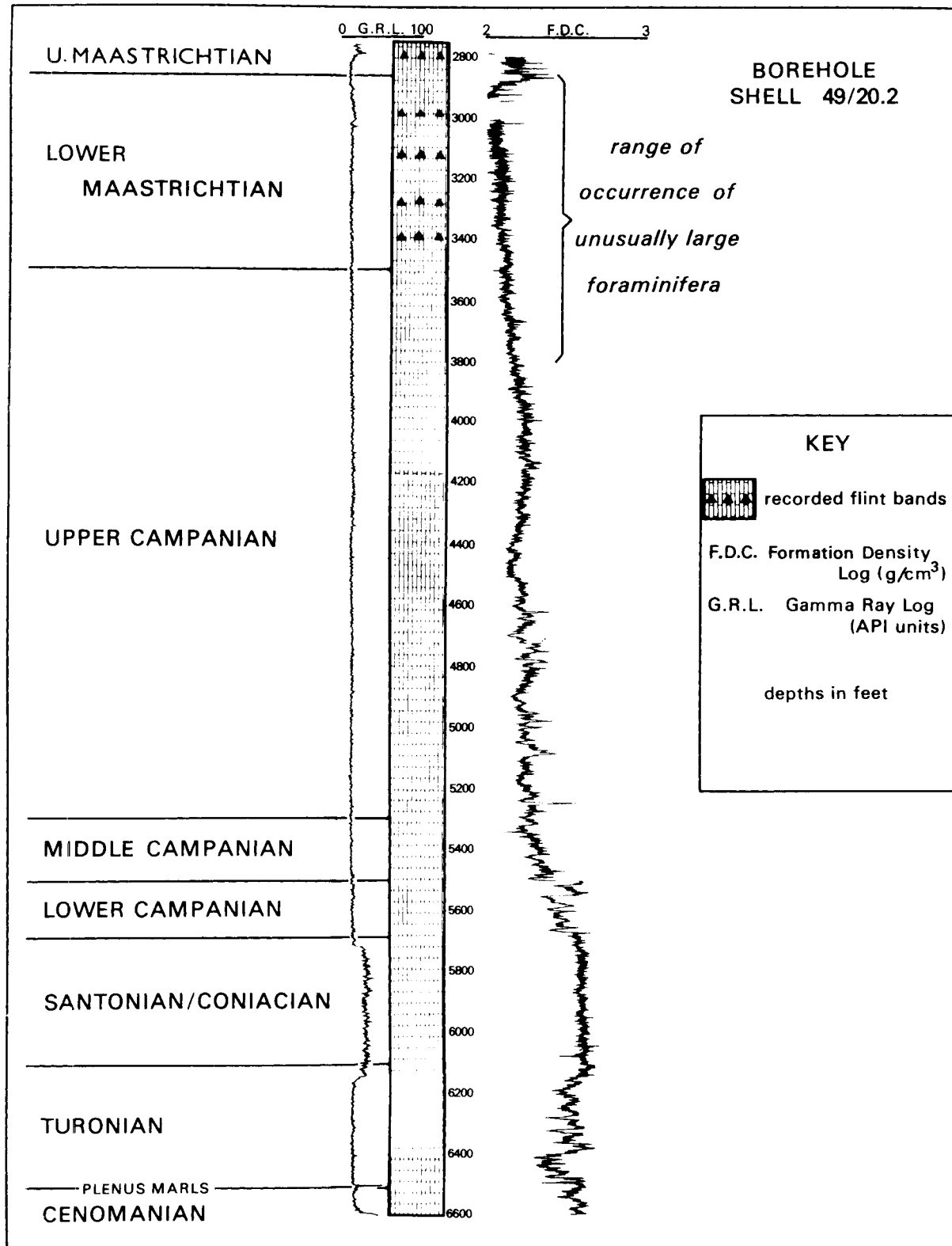


Fig. 2. Stratigraphical interpretation of the Chalk sequence in Shell 49/20.2.

The sutures are flush to slightly depressed. The aperture is usually a simple semi-circular opening at the inner margin of the last chamber, but it may vary in form and be a narrow, elongate slit that extends up the apertural face which is always flattened. The wall is thick and the surface smooth or slightly rugose. The considerable morphological variation shown by this species has resulted in much taxonomic confusion and in the past, certain variants have been accommodated in other, sometimes new, genera (e.g. *Orbignyna*, *Ataxogyroidina*) and species (e.g. *concava* Marie, *cylindrica* Marie, *gibbosa* Marie, *ovoidea* Marie).

Dimensions. Average Bigger forms
Height: 0.34 mm Height: 0.91 mm
Width : 0.31 mm Width : 0.86 mm

Ataxophragmium sp. nov. A

(Pl. 1, fig. 6)

Remarks. This species has a free, asymmetrical test which is sometimes subspherical tending to plano-convex. The chambers are indistinct, slightly inflated and higher than broad, and are arranged trochospirally usually in two (but sometimes in up to three) overlapping evolute whorls. There are six chambers per whorl and the last chamber of each tends to overlap the previous whorl. The sutures are distinct and flush. The aperture is a simple, sub-rectangular, deep slit extending along the interiomarginal suture of the last chamber; the apertural face is flattened. The wall is thick and finely agglutinated with much calcareous cement; the surface is smooth.

Marie (1941) referred an identical form from the Campanian (*mucronata* Zone) of the Paris Basin to *Nonionina globulosa* von Hagenow, 1842. However, several authors (e.g. Marsson, 1878; Cushman, 1931; Visser, 1951) have concluded that von Hagenow's unfigured species was based on a calcareous perforate form, not an agglutinated form. Therefore, Marie's

species and the present form cannot be accommodated with *globulosa* and a new specific name is required. Sweicicki (unpublished thesis, 1980) created the new species *mariae* for it, but until this taxon is published formally, the identification *Ataxophragmium* sp. nov. A. is favoured.

Dimensions. Average Bigger forms
Height: 0.72 mm Height: 1.2 mm
Width : 0.64 mm Width : 1.05 mm

Orbignyna ovata von Hagenow

(Pl. 1, fig. 7)

Remarks. This species was described originally from the Chalk of Rügen Island, East Germany (von Hagenow, 1842). The test is free, elongate and compressed. The chambers are indistinct and uninflated; the first five or six are arranged in a broadly rounded planispiral coil and are strongly overlapping on the inner coiled margin but later, they expand moderately and uniformly and the coil becomes evolute with the last chamber or two being partially uncoiled. The sutures are initially indistinct but later distinct, depressed and curved. The apertural face is weakly inflated with a distinct depression about the aperture which is a simple, terminal circular to elliptical pit. The wall is coarsely agglutinated and the surface is roughened by many longitudinal grooves as in *Ataxophragmium rimosum* (see above).

Dimensions. Average Bigger forms
Height: 0.88 mm Height: 1.4 mm
Width : 0.66 mm Width : 1.2 mm

Orbignyna sherlocki Barnard

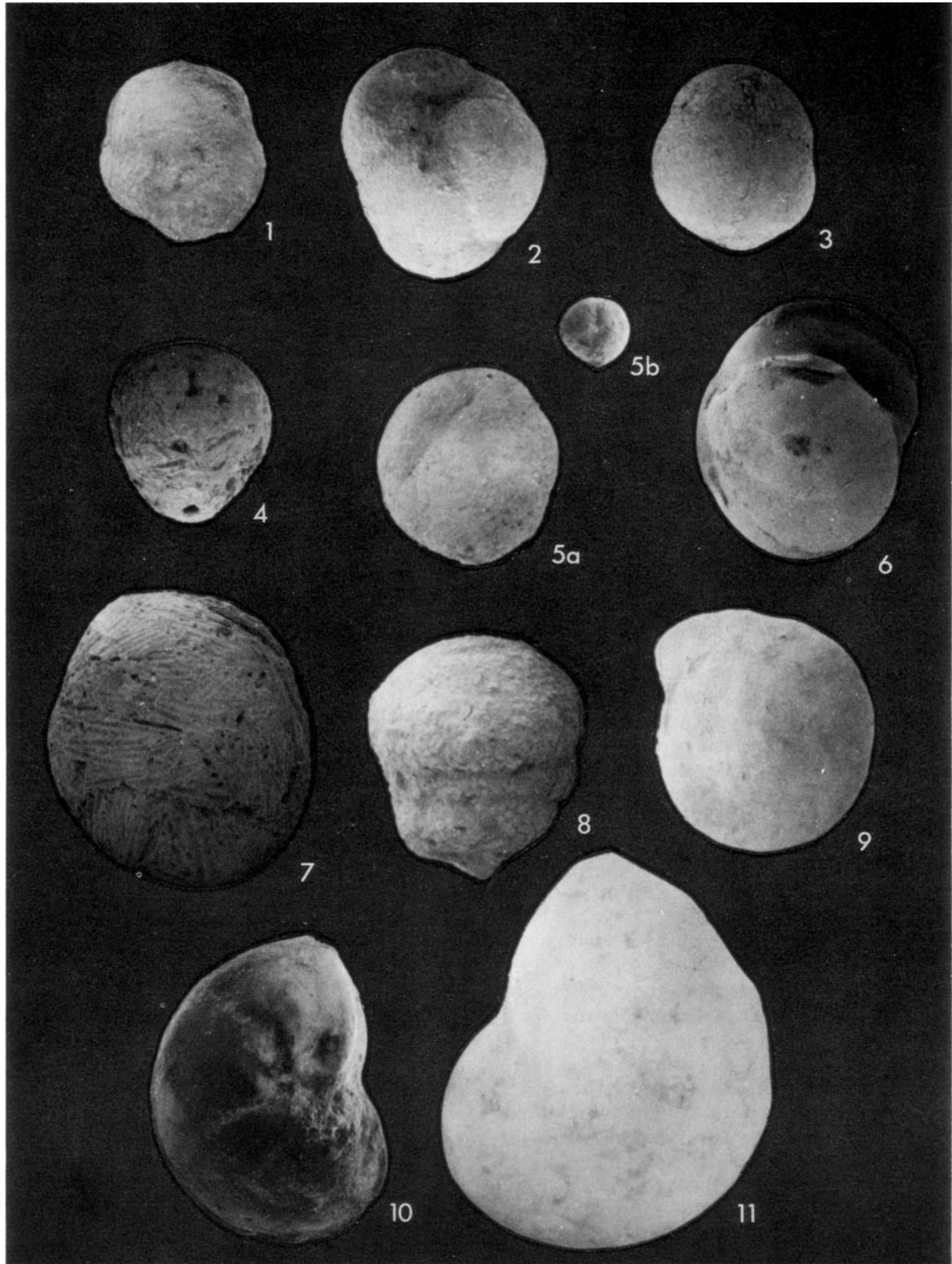
(Pl. 1, fig. 8)

Remarks. This species was described originally from the Campanian (*mucronata* Zone) of Council's Pit, Newmarket Road, Norwich, Norfolk (Barnard, 1953). It is distinguished from *O. ovata* (see above) by its conical form, circular and weakly inflated apertural face, and moderately rugose surface.

Explanation of Plate 1

All figures are $\times 35$. Specimen numbers refer to the collections of the British Geological Survey (Keyworth).

- Fig. 1. *Arenobulimina courta* (Marie), apertural view, MPK 4088; Shell 49/20.2, 3650 ft.
Fig. 2. *Arenobulimina elevata* (d'Orbigny), apertural view, MPK 4089; Shell 49/20.2, 3590 ft.
Fig. 3. *Eggerellina brevis* (d'Orbigny), apertural view, MPK 4090; Shell 49/20.2, 3020 ft.
Fig. 4. *Ataxophragmium rimosum* (Marsson), apertural view, MPK 4091; Shell 49/20.2, 3020 ft.
Fig. 5. *Ataxophragmium variabile* (d'Orbigny): (a) apertural view, MPK 4092; Shell 49/20.2, 3620 ft.; (b) apertural view, MPK 4093; Shell 44/2.1, 3360 ft., 'normal' size.
Fig. 6. *Ataxophragmium* sp. nov. A, apertural view, MPK 4094; Shell 49/20.2, 3230 ft.
Fig. 7. *Orbignyna ovata* von Hagenow, side view, MPK 4095; Shell 49/20.2, 3200 ft.
Fig. 8. *Orbignyna sherlocki* Barnard, side view, MPK 4096; Shell 49/20.2, 3620 ft.
Fig. 9. *Cibicidoides* (?) *voltziana* (d'Orbigny), spiral view, MPK 4097; Shell 49/20.2, 3200 ft.
Fig. 10. *Lenticulina* sp., side view, MPK 4098; Shell 49/20.2, 3620 ft.
Fig. 11. *Lenticulina* sp., side view, MPK 4099; Shell 49/20.2, 3590 ft.



Dimensions. Average	Bigger forms
Height: 0.62 mm	Height: 1.1 mm
Width : 0.44 mm	Width : 1.02 mm
<i>Cibicidoides</i> (?) <i>voltziana</i> (d'Orbigny) (Pl. 1, fig. 9)	

Remarks. This species was described originally from the Upper Campanian of the Paris Basin and England (d'Orbigny, 1840). The characteristic large plano-convex test with prominent calcite bosses make this species distinctive although its generic position is unclear. It has been referred to a number of genera including *Cibicides*, *Cibicidoides*, *Gavelinella* and *Gavelinopsis*, all of which display similarities in basic morphology but differ in their test wall structure. Most foraminiferal tests from the Upper Chalk have undergone fine-scale recrystallisation resulting in a secondary heterogeneous granular wall structure (Reiss, 1959; Schlanger & Douglas, 1974) and therefore the true generic position of this species cannot be established; study of unrecrystallised material may clarify the position.

Dimensions. Average	Bigger forms
Diameter: 0.51 mm	Diameter: 1.02 mm
Height : 0.22 mm	Height : 0.45 mm
<i>Lenticulina</i> spp. (Pl. 1, figs. 10, 11)	

The unornamented *Lenticulina* are in most cases nearly impossible to speciate. They have long stratigraphical ranges which reduces their potential as useful biostratigraphic indicators and in the present study, no effort was made to determine them beyond generic level.

Dimensions. Average	Bigger forms
Diameter 1: 0.59 mm	Diameter 1: 1.77 mm
Diameter 2: 0.51 mm	Diameter 2: 1.54 mm

CONCLUSIONS

The low diversity but dominant fauna of unusually large benthic foraminifera described above has been recorded from the same stratigraphical interval in the two boreholes studied from Block 49 – Shell 49/19.1 and Shell 49/20.2. It is suggested that the occurrence of this distinctive assemblage provides a useful local stratigraphical marker.

All chronostratigraphical and biostratigraphical interpretations were based on down-hole appearances which have been related to known foraminiferal ranges from onshore Britain and elsewhere in Europe (e.g. Koch, 1977; Sweicicki, 1980 (unpubl.); Hart *et al.*, 1981). The assemblage is dated as Early Maastrichtian – Late Campanian because of the down-hole appearances of the Maastrichtian forms *Osangularia navarroana* (Cushman), *Praebulimina laevis* (Beissel) and planktonic *Rugoglobigerina rugosa* (Plummer) together with *Arenobulimina elevata* (d'Orbigny), *Bolivina laevigatus* Marie, *B. miliaris* Hiltermann & Koch, *Cibicidoides* (?) *voltziana* (d'Orbigny), *Orbignyna ovata* von Hagenow,

O. sherlocki Barnard and *Praebulimina obtusa* (d'Orbigny), followed by the Late Campanian forms *Gavelinella monterelensis* (Marie), *Globorotalites hiltermanni* Kaever, *Globorotalites micheliniana* (d'Orbigny), *Osangularia cordieriana* (d'Orbigny) and rarely the planktonic *Archaeoglobigerina cretacea* (d'Orbigny).

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REFERENCES

- Barnard, T. & Banner, F. T. 1953. Arenaceous Foraminifera from the Upper Cretaceous of England. *Q. Jl Geol. Soc. Lond.*, **109**, 173–216, pls. 7–9.
- Cushman, J. A. 1931. A preliminary report on the foraminifera of Tennessee. *Bull. Tenn. Div. Geol.*, Nashville, **41**, 1–62, pls. 21–23.
- Hagenow, F. von. 1842. Monographie der Rugenschen Kreide. Versteinerungen pt. Mollusken E. Cephalopoda Foraminifera. *Neues Jb. Miner. Geog. Geol.*, **9**, 568–575.
- Hart, M. B., Bailey, H. W., Fletcher, B. N., Price, R. J. & Sweicicki, A. 1981. Cretaceous. In Jenkins, D. G. & Murray, J. W. (Eds.), *Stratigraphical Atlas of Fossil Foraminifera*, 149–227, pls. 7.1–7.25, text figs. 7.1–7.16. Ellis Horwood Ltd., Chichester for British Micropalaeontological Society.
- Koch, W. 1977. Biostratigraphie in der Oberkreide und Taxonomie von Foraminiferen. *Geol. Jb.*, Hannover, Reihe A **38**, 128 pp., 19 pls.
- Marie, P. 1941. Les Foraminifères de la Craie à Belemnitella mucronata du Bassin de Paris. *Mem. Mus. natn. Hist. nat.*, Paris, n.s. **12**, 1–296, pls. 1–37.
- Marsson, T. F. 1878. Die Foraminiferen der weissen Schreibkreide der Insel Rügen. *Mitt. naturw. Ver. Neu-Vorpomm.*, Berlin, **10**, 115–196, pls. 1–5.
- Orbigny, A. d' 1840. Memoire sur les Foraminifères de la craie blanche du Bassin de Paris. *Mem. Soc. Geol. Fr.*, Paris, **4** (1), 1–51, pls. 1–4.
- Reiss, Z. 1959. The wall structure of *Cibicides*, *Planulina*, *Gyrogonoides* and *Globorotalites*. *Micropaleontology*, New York, **5**, 355–357, pl. 1.
- Schlanger, S. O. & Douglas, R. G. 1974. Pelagic ooze-chalk-limestone transition and its implications for marine stratigraphy. In Hsu, K. J. & Jenkyns, H. C. (Eds.), *Pelagic Sediments: On Land and Under the Sea*. *Int. Ass. Sediment. Spec. Publ.*, **1**, 117–148.
- Sweicicki, A. 1980. *A foraminiferal biostratigraphy of the Campanian and Maastrichtian Chalks of the United Kingdom*. Unpub. Ph.D. Thesis (CNA A), Plymouth Polytechnic.
- Visser, A. M. 1951. Monograph of Foraminifera from the type locality of the Maastrichtian (S. Limburg, Netherlands). *Leidse Geol. Med.*, Leiden, **16**, 197–360, 16 pls.