

**Bangor University**

## **DOCTOR OF PHILOSOPHY**

### **Late Quaternary benthonic Foraminiferal stratigraphy the western U.K. Continental Shelf.**

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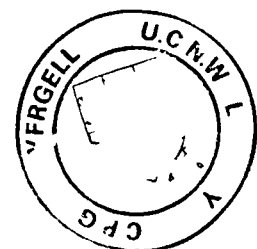
APPENDIX 1

INTRODUCTION

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Introduction

The present classification is based upon the scheme outlined by Loeblich and Tappan (1988). Systematic descriptions are brief and important name changes only are included in synonymy. Subjective descriptions of the material present are given; where 'limited numbers' refer to less than 10 specimens, 'moderate numbers' to between 10 and 50 specimens, and 'numerous' to more than 50 specimens. Dimensions of all the figured specimens are given, additional measured specimens are referred to by film/frame numbers.



Family           HORMOSINIDAE           Haeckel, 1894  
 Genus            REOPHAX                Montfort, 1808

*Reophax fusiformis* (Williamson)

Plate 1, figs.1,2,3.

*Proteonina fusiformis* Williamson, 1858, p.1, pl.1, fig.1.

*Reophax fusiformis* (Williamson) Siddall, 1879, p.4; Brady, 1884, p.290, pl.30, figs.7-10 (not 11?).

? *Reophax scorpiurus* Montfort, Murray, 1971, p.19, pl.2, figs.5-8.

#### Description

Test uniserial, elongate, composed of 3 irregular chambers which increase rapidly in size as added and taper towards the apex. Final chamber accounts for over 1/2 test length, greatest width at just over 1/2 length. Test wall coarsely agglutinated with sub-angular to sub-rounded fine to medium sand grains with a sparse fine silt matrix and cement. Aperture an irregular, rounded, terminal opening at the end of a short cylindrical neck.

#### Dimensions

	4/14	W.I.S.a	W.I.S.b	W.I.S.c
length	500 $\mu$ m	900 $\mu$ m.	975 $\mu$ m.	1.0 mm.
width	300 $\mu$ m.	450 $\mu$ m.	450 $\mu$ m.	475 $\mu$ m.

#### Material

Two broken specimens.

#### Provenance

VE 57/-09/89 0.00-0.01 m. and 2.40-2.45 m.

#### Remarks

There appears to be some confusion in the literature regarding this species. I have assigned my broken specimens to *R.fusiformis* on the basis of comparison with well preserved specimens from the Western Irish Sea which agree well with the descriptions and illustrations given by Haynes (1973), Harris (1958) and Murray (1965 & 1971 = *R.scorpiurus* Montfort). I find that the well preserved Irish Sea specimens differ from Höglund's *P.fusiformis* and are in many ways closer to the "central variant" of his *R.subfusiformis* Earland; a point noted by Harris (1958) who considered these two forms synonymous. Equally, there are similarities with material illustrated by Feyling-Hanssen (1964) as *R.subfusiformis*, synonymous with Höglund's material, and the specimens in side-view (pl.1, fig.16) from zone F of the Årum clay pit are very close to Irish Sea forms. It is interesting to note that *R.subfusiformis* has been considered synonymous with *R.fusiformis* by numerous authors, although Feyling-Hanssen (1964) has questioned this view.

#### Occurrence

There is some confusion, arising from the use of several specific names, as to the actual distribution pattern of this species. It appears to be particularly abundant in the Gullmarfjord, Kattegat and Skagerak, where it was recorded down to 700 m. water depth (Höglund, 1947).

Family	DISCAMMINIDAE	Mikhalevich, 1980
Genus	AMMOSCALARIA	Höglund, 1947

*Ammoscalaria runiana* (Heron-Allen & Earland)

Plate 1, figs.4,5.

*Haplophragmium runianum* Heron-Allen & Earland, 1916b, p.224, pl.40, figs.15-18.

*Haplophragmoides runianum* (Heron-Allen & Earland) Cushman, 1920, p.48, pl.10, figs.1-2.

*Ammoscalaria runiana* (Heron-Allen & Earland) Höglund, 1947, p.162, pl.9, figs.23-24, text-fig.137.

*Ammoscalaria runiana* (Heron-Allen & Earland) Murray, 1971, p.29, pl.7, figs.6-8.

#### Description

Test planispiral, flattened, showing no obvious external expression of the chambers which are reported to be separated by chitinous septal walls. Marginal edge very irregular, thick and rounded. Test wall coarsely agglutinated with angular sand grains up to 150  $\mu\text{m}$ . in diameter, little fine matrix, moderately cemented. Aperture not observed but reported to be a protruding oval opening in the apertural face with a lip.

#### Dimensions

Test diameter 700  $\mu\text{m}$ . & 1 mm.

#### Material

Two specimens only.

#### Provenance

VE 57/-09/89 0.10-0.20 cm.

#### Remarks

Both my specimens agree well with those illustrated by Feyling-Hanssen (1964) and Murray (1971) in the coarseness of the test wall. Murray (1971) notes that unlike *A.pseudospiralis* this species does not uncoil, although Höglund reports that the later portion is sometimes uncoiled. My specimens show no evidence of uncoiling and neither do numerous specimens collected in grab samples from the Western Irish Sea Mudbelt at a depth of 70 m.

#### Occurrence

Murray (1971) records it as an inner shelf species and Höglund (1947) equally notes "the species is clearly a pronounced shallow water form". However, Murray (1965b) did record it off Plymouth at depths of up to 60 m. and Christiansen (1958) reports dead tests at 170 m. in the Drøbaksund of the Oslofjord. It's occurrence at 10-20 cm. within VE 57/09/89, recovered from 156 m. water depth, suggests that these tests may be derived?

Family	LITUOLIDAE	de Blainville, 1825
Genus	AMMOBACULITES	Cushman, 1910

*Ammobaculites* aff. *balkwilli* Haynes

Plate 1, fig.8

*Haplophragmium agglutinans* Balkwill & Wright, 1885, p.330, pl.13, fig.18-20 (not *Spirolina agglutinans* d'Orbigny).

*Ammobaculites balkwilli* Haynes, 1973, p.25, pl.2, figs.2-3, pl.29, figs.5-6, text-fig.4, nos.1-5.

#### Description

Test medium, elongate; initial part a compressed planispire, followed by three uniserially arranged chambers. Initial coil of an indeterminate number of chambers giving way to 3 greatly increased, nearly spherical chambers with distinctive horizontal sutures; uniserial part sub-parallel sided. Aperture terminal, large, bordered by a slightly raised lip. Test wall very coarsely agglutinated, mainly fine sand, with echinoid fragments up to 100  $\mu$ m. in diameter present.

#### Dimensions

length = 760  $\mu$ m.; width = 435  $\mu$ m.; maximum diameter (uniserial part) = 310  $\mu$ m.

#### Material

Single specimen only.

#### Provenance

VE 57/-09/89 0.9-1.0 m.

#### Remarks

I have tentatively assigned this form to Hayne's species *A.balkwilli*, described and illustrated from the Dovey marshes of West Wales. However, it differs from that species in several important respects, particularly its large initial coil and generally coarser test wall. Haynes (1973, p.26) remarks that there is considerable variation in chamber shape and growth rate, but that this is typically in the uniserial part. Equally, specimens illustrated as *Haplophragmium agglutinans* by Balkwill

and Wright (1885) from off the Dublin coast, and synonymous with *A.balkwilli*, are typically more elongate, lacking the large initial coil of this form. It may possibly belong with specimens illustrated by Alve and Nagy (1986) from Sandebukta as *A.agglutinans* (d'Orbigny).

#### Occurrence

Reported from the east and west coasts of the Irish Sea, *A.balkwilli* appears to be a predominantly marsh species.

Family SPIROPLECTAMMINIDAE Cushman, 1927

Genus SPIROPLECTAMMINA Cushman, 1927

*Spiroplectammina earlandi* (Parker)

Plate 1, figs.6,7

*Textularia elegans* Lacroix, 1931, p.14, fig.11; 1932, p.8, figs. 4 & 6, not 5. (not *Plecanium elegans* Hantken, 1868),

*Textularia tenuissima* Earland, 1933, p.95, pl.3, figs.21-30.

*Textularia tenuissima* Earland, Höglund, 1947, p.176, pl.13, fig.1a & b; text-figs.154 a & b, 155 & 161 (not Häusler, 1881).

*Textularia earlandi* Parker, Thalmann in Phleger, 1952b, p.86, pl.13, figs.22-23.

*Textularia earlandi* Parker, 1952b, p.458, pl.2, figs.4-5 (*T.cf. tenuissima* in text, new name in footnote).

*Textularia earlandi* Phleger, Feyling-Hanssen, 1964, p.238, pl.3, figs.9-10.

*Textularia aff. earlandi* Phleger, Feyling-Hanssen, 1964, p.235, pl.3, fig.8.

*Spiroplectammina elegans* (Lacroix) Nørvang, 1966, p.14, pl.1, fig.24; pl.2, fig.11.

*Textularia earlandi* Parker, Murray, 1971, p.33, pl.9, figs.1-5.

*Spiroplectammina earlandi* (Parker) Haynes, 1973, p.31, pl.3, fig.5; pl.8, fig.11.

#### Description

An elongate and slender species of *Spiroplectammina*, about 2.5 times as long as broad. Chambers increase slowly in size and become increasingly inflated producing an initially straight

periphery which becomes increasingly lobate with overhanging chambers. Sutures distinct, impressed. Bluntly rounded apex reported to consist of 3 or 4 closely coiled chambers, followed by up to 15 biserially arranged pairs. Test wall coarse, sparsely cemented and largely composed of angular silt grains; colour ferruginous.

#### Dimensions

Length 358  $\mu\text{m}$ ., maximum width 150  $\mu\text{m}$ ., thickness about  $\frac{2}{3}$  width. Angle of taper about 18°.

#### Material

One specimen only.

#### Provenance

VE 57/09/89 sample no.31.

#### Remarks

The tortuous synonymy referred to by Haynes (1973) and discussed in some detail by Höglund (1947) illustrates the problems encountered in naming the form. Feyling-Hanssen (1964), following doubts raised by Höglund and later by Parker (1952), suggests that two distinct forms exist; one a cold water species (= *T. earlandi* Phleger) and the other inhabiting warm and temperate waters (= *T. aff. earlandi* Phleger).

However, after examining Earland's South Georgia specimens, Haynes did not consider there to be sufficient grounds, on the basis of wall structure and colour, to separate them from his boreal specimens which he noted exhibit both grey and ferruginous forms. This is in agreement with the conclusions reached by Earland who, after exchanging specimens with Lacroix, himself working on Mediterranean material, decided that they were one species.

#### Occurrence

Höglund (1947) notes this species as "one of the most abundant" in the Gullmarfjord, Skagerak and Kattegat, occurring within a depth range from 17 to 700 m.. Murray (1971) records it as an inner shelf species with living records from the Bristol Channel, 66-91 m. and from 14-42 m. off the south coast of Cornwall (Murray, 1970 as *S. biformis*). Christiansen (1958) records it living in Dröbak Sound, Oslofjord at depths from 30-160 m.. This species appears to be widespread with numerous North Atlantic records as well as the South Atlantic, including 25 stations around South Georgia (Earland, 1933) and it is reported as "widely distributed" from the Antarctic (Parr, 1950). Numerous Pacific records include Japan (Matoba, 1970) and the Californian coast (Bandy, 1963).

*Spiroplectammina wrightii* (Silvestri)

Plate 1, figs.9,10,11,12

*Spiroplecta sagittula* Wright, 1891, p.471; 1902a, p.211, pl.3, figs.5-8 (not *Textularia sagittula* Defrance).

*Spiroplecta wrightii* Silvestri, 1903, p.59, text-figs.1-6.

*Spiroplectammina wrightii* (Silvestri) Cushman, 1949, p.6, pl.1, figs.2-4; Haynes, 1973, p.32, pl.3, figs.1-2.

*Textularia sagittula* Brady, 1884, p.361, pl.42, figs.17-18 (not Defrance).

*Textularia cuneiformis* Williamson, 1858, p.75, pl.6, figs.158-159 (not d'Orbigny).

*Textularia sagittula* Defrance var. *cuneiformis* Göes, 1894, p.36, pl.7, figs.288-290 (not d'Orbigny).

*Textularia williamsoni* Göes, 1894, p.36, pl.7, figs.285-287 (*nomen oblitum*).

#### Description

A large, compressed species of *Spiroplectammina* with distinctive microspheric and megalospheric forms. The microspheric generation is acutely pointed and has a sharp, sagittate keel with an initial angle of taper of 40°- 50° following the often damaged planispire, but tending to decrease to about 10° later. The megalospheric generation is characterised by 4 inflated chambers arranged in a planispire following a large proloculus, is less strongly keeled and tends to become sub-parallel sided. Biserial chambers number up to 14 pairs in the microspheric generations and generally number fewer than 10 pairs in the megalospheric forms. Chambers are sub-rectangular, twice as wide as high and separated by distinctive although only slightly impressed, sub-horizontal, gently curving sutures. The final chambers tend to become slightly more inflated. Test wall of angular/sub-angular silt grains and heavily cemented, producing a 'smoothed' surface. Colour variable, but most commonly orange/ yellow. Aperture a narrow crescentic opening at the inner margin of the final chamber.

#### Dimensions

microspheric length 1.0 mm., width 450 µm., thickness 200 µm.  
megalospheric length 650 µm., width 340 µm., thickness 190 µm

#### Material

Very common taxon (>40% in some samples).

#### Provenance

VE 57/09/89 <sup>c</sup>/6 10-15 cm. (microspheric)  
VE 57/09/60 <sup>a</sup>/4 16-18 cm. 'outer' (megalospheric)



#### Remarks

This species has been persistently confused with *T.sagittula* Defrance, although that species is much larger and more inflated than *S.wrightii* and lacks the initial planispiral part. Following Feyling-Hanssen (1964) and Murray (1971) I had myself tended to lump all biserial forms into *T.cf.sagittula*; these are now largely placed within *S.wrightii*. However, a very few specimens do not belong here and are better described by *T.bocki* Höglund. The two forms differ in that *T.bocki* is less compressed, has higher, more inflated chambers and lacks the sharp, carinate keel of *S.wrightii*; the initial chamber arrangement also differs.

For a comprehensive discussion on the systematic treatment of *S.wrightii* see Haynes (1981, p.67-70).

#### Occurrence

This taxon appears to show a marked Lusitanian-Mediterranean distribution pattern and occurs largely at shelf depths. Living records include Dröbak Sound, Oslofjord, 30-70 m. (Christiansen, 1958) and numerous records by Murray (1971) from south west Britain. The high frequencies (>40%) of this taxon in zone 2 of vibrocore 57/09/46 are considered largely a response to the fine sand/mud of the enclosing sediments; a relationship noted by Christiansen (1958) from the Oslofjord, Höglund (1947) from the Gullmarfjord and Edwards (1982) from the North Minch Channel.

Family	TROCHAMMINIDAE	Schwager, 1877
Genus	TROCHAMMINA	Parker & Jones, 1859

#### *Trochammina inflata* (Montagu)

Plate 1, figs.13,14,15

*Nautilus inflatus* Montagu, 1808, p.81, pl.18, fig.3.

*Rotalina inflata* (Montagu) Williamson, 1858, p.50, pl.4, figs.93 & 94.

*Trochammina inflata* (Montagu) Carpenter, 1862, p.141, pl.11, fig.5; Murray, 1971, p.35, pl.10, figs. 3-6; Haynes, 1973, p.37, pl.4, figs. 15-17, pl.6, fig.3.

#### Description

(based on specimens illustrated from Laugharne: figs.14 & 15)  
Test globose, with 14 inflated chambers following the proloculus in a dextral, low trochospire. Periphery rounded and lobate, chambers longer than high, rhomboidal. Sutures deeply impressed, slightly curved and radial; spiral suture sub-angular, less markedly impressed. Aperture a narrow, arched opening beneath a distinctive lip which extends from the periphery into the deeply excavated umbilicus along the basal margin of the final chamber. Test wall of very fine, neatly arranged, silt grains; orange/brown

colour. Proloculus and first 3 or 4 chambers on the convex dorsal side commonly damaged.

Dimensions

maximum diameter 600  $\mu\text{m}$ . (Laugharne), 360  $\mu\text{m}$ . (this study).

Material

single specimen only from study area.

Provenance

VE 57/-09/89 0.75-0.80 m.

Described specimens from the marsh surface, Laugharne, Taf Estuary, South Wales.

Remarks and Occurrence

This is a common species on hyposaline marsh surfaces with a worldwide distribution; see Haynes (1973) for a comprehensive list. Many authors, including the earliest, have noted the rarity of marine occurrences, with the possible exception of deep/cold water records eg. Earland (1934) on the Weddell Sea and Falklands area; such marine occurrences are generally accepted as the product of allochthonous transportation. In this respect, the cold/deep water records of Earland are of particular interest and deserve further investigation, since he was clearly familiar with the British near-shore distribution of this species (Heron-Allen & Earland 1909, 1911, 1913b, 1916a&b) and, as Haynes (1973) points out, Heron-Allen & Earland working on specimens from Selsey suggested that they may have been derived from nearby Chichester Harbour and/or Bosham mud flats.

*Trochammina ochracea* (Williamson)

Plate 1, figs.16,17

*Rotalina ochracea* Williamson, 1858, p.55, pl.4, fig.112, pl.5, fig.113.

*Trochammina ochracea* (Williamson) Balkwill & Millett, 1884, p.25, pl.1, fig.7; Höglund, 1947, p. 211, pl.16, fig.2, text-fig.190; Murray, 1971, p.37, pl.11, figs.1-5; Haynes, 1973, p.40, pl.5, figs.15-18.

*Trochammina ochracea ochracea* (Williamson) Rhumbler, 1938, p.190.

Description

Test small, highly compressed, concavo-convex with an acute, lobate periphery. Three whorls visible on the convex, evolute, dorsal side, 9 chambers in the final whorl. Chambers long and tapered towards the periphery, with an elongate, shallow central depression. Sutures distinct, slightly impressed and very strongly curved; spiral suture more clearly defined. Ventral side concave, involute (?) - no detail visible. Test wall finely agglutinated, of well sorted fine silt and mostly smooth.

Dimensions

maximum diameter 4/17=300  $\mu\text{m.}$ , 11/20=200  $\mu\text{m.}$ , 11/21=120  $\mu\text{m.}$

Material

Limited to 3 damaged specimens

Provenance

VE 57/-09/89 2.25-2.35 m. and 2.40-2.45 m.

Remarks

Whether the three rather poorly preserved specimens recovered here belong to *T.ochracea* or whether or not they are all one species is, in my mind, doubtful. However, they agree in general terms with the descriptions and illustrations available for this species, particularly the two smaller specimens. The larger specimen does exhibit rather exaggeratedly arched and tapering chambers on the dorsal side, but in view of the fact that the ventral face of this and the other two specimens are damaged they are here placed in affinity with *T.ochracea* as the nearest form.

Occurrence

Murray (1971) notes that live specimens are found clinging to seaweeds and pebbles and that its distribution is that of an inner shelf species, with live records from Plymouth, 10-60 m., south coast of Cornwall, 14-42 m., and the English Channel south of the Lizard, 84-95 m. (where it accounts for up to 16% of the foraminiferal fauna). A number of records exist from the British Isles, including the original description from the Isle of Skye; Cardigan Bay (Haynes, 1973 - very rare); Jersey (Halkyard, 1889) and from Clare Island, west of Ireland (Heron-Allen & Earland, 1913). There are numerous records from the NW Atlantic coastline (Cushman, 1944) as well as Scandinavian records by Höglund (1947) and as rare from the Late Glacial and Holocene of the Oslofjord (Feyling-Hanssen, 1964).

Family	VERNEUILINIDAE	Cushman, 1911
Genus	GAUDRYINA	d'Orbigny, 1839

*Gaudryina rudis* Wright

Plate 2, figs.1,2

*Gaudryina rudis* Wright, 1900, p.53, pl.2, fig.1a,b.

*Gaudryina rudis* Wright, Murray, 1971, p.43, pl.14, figs.1-6

Description

A large, conical species of *Gaudryina*. Final, biserial stage well rounded in section producing an apertural face with a diameter of about  $\frac{2}{3}$  overall length. Aperture a large, irregular, overhung arch at the inner margin of the final chamber. Test wall coarsely agglutinated and rough, except on the smoother apertural

face.

Dimensions

maximum length 1.4 mm.; maximum diameter 1.0 mm.  
angle of taper about 50°.

Material

Limited numbers

Provenance

VE 57/-09/89<sup>e</sup>/6, 60-70 cm.  
VE 57/-09/60<sup>a</sup>/4, 16-18 cm. 'outer'.

Remarks

These specimens are characterized by very robust tests, although early chambers are commonly broken, as illustrated by Murray (1971).

Occurrence

Murray (1971) records the live distribution of this species as 'inner shelf' with rare live specimens from the Bristol Channel, 66-91 m., the English Channel south of the Lizard, 84-95 m., and from Connemara, Ireland. The distribution of dead tests is similar to the living, but more abundant.

Family           EGGERELLIDAE           Schwager, 1877

Genus            EGGERELLOIDES        Haynes, 1973

*Eggerelloides scabrum* (Williamson)

Plate 2, figs.3,4,5,6

*Bulimina scabra* Williamson, 1858, p.65, pl.5, figs.136,137  
(*B.arenacea* on plate explanation).

*Textularia scabra* (Williamson) Fischer, 1870, p.393.

*Verneuilina scabra* (Williamson) Cushman, 1922, p.55, pl.10, figs.  
5,6.

*Eggerella scabra* (Williamson) Cushman, 1937a, p.50, pl.5, figs.  
10,11; Höglund, 1947, p.191, pl.13,  
figs.12-14, text-figs. 162-165;  
Feyling-Hanssen, 1964, p.243, pl.4,  
figs.4-6; Murray, 1971, p.45, pl.15,  
figs.1-6.

*Verneuilina polystropha* Brady, 1884, p.386, pl.47, figs.15-17 (not  
Reuss).

*Eggerelloides scabrum* (Williamson) Haynes, 1973, p.44, pl.2, figs.  
7-8, pl.19, figs.10-11, text-fig.8,  
nos.1-4.

#### Description

Test small, elongate, triserial. Initial end damaged, distal end inflated. About 10 irregularly arranged chambers visible; broader than high initially but tending to increase in height and become more inflated later. Final whorl accounts for over  $\frac{1}{2}$  test length. Wall coarsely agglutinated and rough, comprised of angular silt grains and little cement. Aperture interiomarginal, partially obscured, consisting of a low arch at the inner margin of the final chamber, apertural face slightly concave.

#### Dimensions

length c.300  $\mu\text{m}$ ., maximum width 200  $\mu\text{m}$ .  
angle of taper about  $40^\circ$

#### Material

A single specimen only.

#### Provenance

VE 56/-09/142 <sup>a</sup>/6, 67-69 cm.

#### Remarks

I am placing this single specimen in *E.scabrum* with some hesitation and believe that it may possibly belong in *Verneuilina media* Höglund. For comparative purposes and to illustrate the difficulty in placing this form I have figured additional specimens from a number of localities. The specimen from Vigo Bay, N.W. Spain (fig.4) closely resembles the material illustrated by Haynes (1973) and many other authors as *E.scabra*. A specimen from vibrocore 51/-07/17 of the Celtic Sea closely resembles the material illustrated by Murray (1971). I also have also illustrated specimens from the Western Irish Sea for comparative purposes (see figs.5,6).

It appears that gradational forms may exist between these species. Höglund (1947,p.193), as noted by Feyling-Hanssen (1964), has remarked that these two forms are easily confused.

#### Occurrence

An abundant and widespread species which appears to be largely confined to N.W. Europe and the Lusitanian bioprovince. It often occurs on the inner shelf but rarely at water depths greater than 60 m. On the other hand, *V.media* is known from deeper waters; Höglund found it to be an abundant species at depths >22 m., particularly within the Gullmarfjord and Skagerak.

Family           TEXTULARIIDAE           Ehrenberg, 1838  
 Genus           BIGENERINA           d'Orbigny, 1826

*Bigenerina nodosaria* d'Orbigny

Plate 2, figs.7,8,9

*Bigenerina nodosaria* d'Orbigny, 1826, p.261, pl.11, figs.9-12.

*Bigenerina nodosaria* d'Orbigny, Harris, 1958, p.149, pl.6, fig.8,  
 pl.11, fig.7.

#### Description

Test large, elongate and coarsely agglutinated. Biserial at first, flattened and wide, giving way at a sharp step to uniserial chamber arrangement over the latter  $\frac{1}{2}$  -  $\frac{2}{3}$  of the test. Biserial portion roughly wedge shaped, about twice as long as broad, sharply rounded periphery; sutures distinct. Uniserial portion circular in cross-section, parallel-sided, lobate with distinct, impressed sutures. Chambers inflated, tending to become increasingly spherical, numbering 5 or 6 in uniserial part. Test wall coarse with angular sand grains up to 200  $\mu$ m. in diameter, little cement. Terminal aperture slightly produced and sub-rounded.

#### Dimensions

	4/3	4/4	11/18
length	1.75 mm.	1.12 mm.	1.12 mm.
maximum width	450 $\mu$ m.	----	----
diameter (uniserial part)	400 $\mu$ m.	300 $\mu$ m.	400 $\mu$ m.

#### Material

Limited numbers only.

#### Provenance

VE 57/-09/89 <sup>a</sup>/6 10-20 cm.

#### Remarks

I have not had the opportunity to view d'Orbigny's original illustrations of this species. However, my specimens do agree closely with the description and illustrations given by Harris (1958) on material from the North Sea; except that he reports several small openings in the terminal aperture, while the present material exhibits a single opening only.

#### Occurrence

Harris reports this species from 3 samples at depths between 115 m. and 130 m. from the North Sea. I can find no further recent references to this species from western Britain.

*Textularia bocki* Höglund

Plate 2, figs.10,11

*Textularia agglutinans* Goës, 1894 p.35, pl.7, figs.281-284, 294-296.(not *T.agglutinans* d'Orbigny, 1839).

*Textularia bocki* Höglund, 1947, p.171, pl.12, figs.5-7, text-figs. 152-153; Feyling-Hanssen, 1964, p. 234, pl.3, figs.6-7.

*Textilina bocki* (Höglund) Haynes, 1973, p.47, pl.3, figs.6-7, pl.8 fig.8.

#### Description

An inflated, tapering species of *Textularia*, very broad and rounded at the oral end. Megalospheric forms obtusely rounded at apical end, microspheric forms larger and more acutely pointed; both biserial with a maximum of 7 pairs of chambers visible. Periphery sub-angular, very slightly carinate. Sutures fairly distinct, impressed and slightly curved; more pronounced as final chambers tend to be increasingly inflated. Aperture a narrow, sub-rectangular opening at the inner-margin of the final chamber. Test wall arenaceous, fairly smooth and generally an off-white colour.

#### Dimensions

	4/9 (megalospheric)	11/15 (microspheric)
length	800 $\mu\text{m}$ .	950 $\mu\text{m}$ .
width	475 $\mu\text{m}$ .	700 $\mu\text{m}$ .
thickness	290 $\mu\text{m}$ .	350 $\mu\text{m}$ .
angle of taper	c.40°	c.50°

#### Material

Moderate numbers.

#### Provenance

VE 57/-09/89 <sup>a</sup>/6 80-90 cm.  
VE 57/-09/46 <sup>a</sup>/6 0-5 cm.

#### Remarks

This species was not identified during the initial sample counting programme and has been 'lumped' with *Spiroplectamina wrightii*. I am grateful to Dr. Karen Luise Knudsen, Århus (pers. comm., 1991) who suggested that I might have misidentified *T.bocki* in vibrocore VE 57/-09/46; this comment was based upon inspection of a detailed faunal diagram only. Re-examining the picked residues of this core revealed that up to about 5% of the specimens assigned to *S.wrightii* from zone 2 do in fact belong here. This species differs from *S.wrightii* in its more inflated and higher chambers and lacks the sharp, carinate keel of the latter; the initial chamber arrangement is biserial and remains so throughout.

I am in agreement with Höglund's description of the

megalospheric generation as biserial throughout, following the proloculus. Unfortunately, all my microspheric specimens were damaged at the delicate initial part, a feature which Höglund also notes, and the possibility of an initial single triserial coil as discussed by Höglund was not established.

#### Occurrence

The distribution of this species appears to be much as described by Höglund (1947), who found it to be a locally abundant species in the Gullmarfjord, Skagerak and Kattegat, being confined mainly to water depths of less than 305 m.. Harris (1958) reports it as "a most abundant species" with a lower limit of 250 m.

An examination of Holocene core material from the Celtic Sea (B.G.S. vibrocore VE 51/-09/199) reveals that *T.bocki* has much higher sample percentage frequencies than *S.wrightii*. Both Le Calvez (1958) and Atkinson (1970) have recorded this species from the area.

Genus                    SIPHOTEXTULARIA    Finlay, 1939

*Siphotextularia flintii* (Cushman)

Plate 2, figs.12,13

*Textularia flintii* Cushman, 1911, p.21, text-figs.36a,b.

*Siphotextularia flintii* (Cushman) Murray, 1971, p.33, pl.9, figs.6-8.

#### Description

Test free, quadrangular in section with broadly rounded, lobate periphery. Biserial throughout with up to 10 pairs of inflated chambers in the larger microspheric form. Sutures distinct, downward sloping, slightly depressed. Angle of taper approximately constant in the megalospheric form, changing after the 4<sup>th</sup> or 5<sup>th</sup> pair of chambers in the microspheric form. Test wall finely to moderately agglutinated with a large proportion of matrix and cement. Aperture a distinctive, sub-ovate opening with a flared lip, raised above the inner margin on the final chamber.

#### Dimensions

	4/13	2/12	4/11
length	700 $\mu$ m.	425 $\mu$ m.	600 $\mu$ m.
width	400 $\mu$ m.	260 $\mu$ m.	300 $\mu$ m.
thickness	150 $\mu$ m.	150 $\mu$ m.	150 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

VE 57/-09/89 0.0-0.1 m.

#### Remarks.

My specimens agree well with those illustrated by Murray



(1971). It would appear that *T. heron-alleni* Harris belongs here, his descriptions and illustrations correspond to the present material, except that he reports an initial coil of 3 chambers following the proloculus. I have therefore not included Harris' species here, although they may prove to be synonymous after further investigation. In this respect it should be noted that Harris (1958) considered his species to be synonymous with *T. concava* (Karrer) illustrated by Heron-Allen and Earland.

Occurrence.

Murray (1971) notes that there are no living British records of *S. flintii* and that he has only recovered dead tests from the Western Approaches to the English Channel at depths of between 420 m. to 1,002 m.. Harris (1958) records *T. heron-alleni* from waters of moderate depth (130-500 m.) from the Faeroe Shelf/Channel and from north west of the Shetland Isles. Heron-Allen and Earland described *T. concava* (Karrer) var. *heterostoma* Fornasini as being "new to Britain" from the material collected during the cruise of the S.Y. "Runa" along the west of Scotland; a species which is considered to be conspecific with *T. heron-alleni* by Harris and may well belong here.

Family            CORNUSPIRIDAE        Schultze, 1854  
Genus            CORNUSPIRA            Schultze, 1854

N.B. From reading Loeblich & Tappan (1988) my understanding of the present situation is that *Cyclogyra multiplex* Wood, 1842 which was the type species for *Cyclogyra* is suppressed (genus & species) for purposes of the Law of Priority, ICZN and is now included under the genus *Cornuspira* Schultze, 1854. The type species of the latter is *Orbis foliaceus* Philippi, 1844.

*Cornuspira foliacea* (Philippi)

Plate 2, fig.14; Plate 3, fig.1.

*Orbis foliaceus* Philippi, 1844, p.147, pl.24, fig.26

*Cornuspira foliacea* (Philippi) Carpenter, Parker & Jones, 1862, p.68, pl.5, fig.16; Cushman, 1948, p.40, pl.4, figs.9-10.

*Cyclogyra foliacea* (Philippi) Feyling-Hanssen, 1964, p.245, pl.4, fig.8.

#### Description

Large planispiral test, highly compressed with sub-rectangular periphery. Numerous whorls, increasing in diameter slowly at first, then more rapidly later so that the final height of the chamber is nearly  $\frac{1}{3}$  of the test diameter. Test wall porcelaneous, milky white in colour and smooth except for the distinctive backward curving growth lines. Aperture a long and narrow terminal slit.

#### Dimensions

	fig.14	9/20
maximum diameter	720 $\mu$ m.	1.90 mm.

#### Material

Three specimens only.

#### Provenance

fig.14	VE 56/-09/142	1.22-1.25 m.
9/20	VE 57/-09/32	0.0-0.1 m. (not illustrated)
fig.1	VE 57/-09/89	0.2-0.3 m.

#### Remarks

This is a very distinctive and readily recognized form of *Cornuspira* and agrees well with the specimens described and illustrated by Cushman (1948) from the Arctic.

T.Cedhagen (seminar Aarhus, 1989) discussed aspects of the growth of this species, mentioning that when the surface area:volume ratio reaches a critical point growth changes from isometric to allometric and that in warmer water allometric growth is earlier. Unfortunately, due to the limited number of specimens available, I have been unable to test this hypothesis within the

climatostratigraphic context of the present material.

#### Occurrence

The distribution of this species appears to be essentially within arctic waters, with rare records from Quaternary sediments eg. the Late Quaternary of the Oslofjord area, Feyling-Hanssen (1964).

*Cornuspira involvens* (Reuss)

Plate 2, figs.15,16,17.

*Operculina involvens* Reuss, 1850, p.370, pl.46, fig.30.

*Cornuspira involvens* (Reuss) Reuss, date??, p.39, pl.1, fig.2;  
Loeblich & Tappan, 1953, p.49, pl.7,  
figs.4-5.

*Cyclogyra involvens* (Reuss) Feyling-Hanssen, 1964, p.246, pl.4,  
fig.9; Murray, 1971, p.53, pl.18,  
figs.1-3; Knudsen, 1971, p.192,  
pl.1, fig.14.

#### Description

Test free, planispiral, moderately evolute, with well rounded periphery. Possible megalospheric specimens with a globular proloculus, followed by a long, undivided, tubular second chamber which increases gradually with up to 3<sup>1</sup>/<sub>2</sub> whorls present. A larger, possibly microspheric, form with between 7-8 whorls is also present and tends to become increasingly compressed and slightly more evolute. Spiral suture well defined, impressed. Aperture a simple, terminal opening. Test wall calcareous, imperforate (porcelaneous) and generally very smooth.

#### Dimensions

	fig.15	fig.16	fig.17
maximum diameter	730 $\mu$ m.	170 $\mu$ m.	320 $\mu$ m.
proloculus diameter	<40 $\mu$ m.	80 $\mu$ m.	50 $\mu$ m.

#### Material

limited numbers only.

#### Provenance

fig.15 VE 57/-10/21 1.30-1.33 m.  
fig.16 VE 56/-09/142 0.67-0.69 m.  
fig.17 VE 57/-09/46 1.00-1.05 m.

#### Remarks

The megalospheric generation (?) is typical of the material illustrated by Murray (1971), particularly fig.16, and by Feyling-Hanssen (1964) and Knudsen (1971), particularly fig.17. The possible microspheric generation (fig.15) is very similar, although somewhat smaller than the specimens illustrated by Loeblich and Tappan (1953) from N. Alaska and N.W. Greenland; having an approximately equal number of whorls. Haynes (1973,

p.49) comments on two large specimens of *C.involvens* illustrated by Loeblich and Tappan (1953) while discussing *C.selseyensis* and considers them to be "well developed examples of the megalospheric generation". Loeblich and Tappan, however, state that both specimens exhibit a minute proloculus?

There is therefore some confusion regarding the generations of this and related species. Heron-Allen and Earland (1909), for example, considered that specimens of *Cornuspira selseyensis* might represent megalospheric generations of *C.involvens*. Haynes discusses this possibility in his treatment of *C.selseyensis* and considers the two forms distinct.

The present forms are distinguished from *C.selseyensis* by their generally smooth test wall. Some of the possible megalospheric specimens resemble Loeblich and Tappan's hypotypes of *Gordiospira arctica* but are again smoother than the specimens illustrated by them.

#### Occurrence

Since there appear to be problems associated with the correct identification of this species, any reference to its distribution should be treated cautiously. According to Murray (1971) it is an inner shelf species with a number of live records from around the British Isles, ranging from the intertidal zone to depths of 91 m.

Arctic records are mostly from depths of less than 100 m., but are known from 223 m., and include Loeblich and Tappan (1953) and Nørvang (1945). Harris (1958) records this species at depths between 16-120 m. from the North Sea and off northern Scotland, but only sparingly.

Feyling-Hanssen (1964) notes this species as very rare in Late Quaternary deposits of the Oslofjord area, while Knudsen (1971) records two specimens from zone 3 of the Sandnes Clay, Norway; it is also recorded by Knudsen (1982).

Genus                    CORNUSPIRELLA            Cushman, 1928

*Cornuspirella diffusa* (Heron-Allen & Earland)

Plate 3, fig.2

*Cornuspira diffusa* Heron-Allen & Earland, 1913, p.272, pl.12,  
p.276, text-fig.37.

*Conrnuspirella diffusa* (Heron-Allen & Earland) Murray, 1971.

#### Description

Flattened, thin-walled and fragile test. Part of a larger, initially planispiral, later many-branched, test. The irregular, transverse lines visible on this fragment are growth increments and are slightly convex towards the terminal, elongate apertural opening. Test wall calcareous, imperforate, smooth.

#### Dimensions

length 1.20 mm., width 850  $\mu$ m.

Material

Two fragments only.

Provenance

VE 57/-09/46 0.05-0.10 m. & 0.38-0.43 m.

Remarks and Occurrence

The limited number of broken 'branch' fragments agree well with those illustrated by Murray (1971) who records live specimens from off Plymouth at depths between 50-60 m. and from along the south coast of Cornwall at depths between 14-42 m.. Dead specimens are known from elsewhere, including the North Sea. I can find no record of this species occurring in Quaternary deposits.

Family            NUBECULARIIDAE    Jones, 1875

Genus            SPIROPTHALMIDIUM<sup>1</sup> Cushman, 1927

<sup>1</sup> *nom. corr.* Paalzow, 1932.

*Spirophthalmidium acutimargo* var. *emaciatum* Haynes

Plate 3, fig.3

*Spiroloculina acutimargo* Brady, 1884, p.154, pl.10, fig.14  
(not fig.13); Heron-Allen & Earland,  
1913, p.24, pl.1, fig.8.

*Spirophthalmidium acutimargo* Cushman, 1949, p.16, pl.2, figs.14-15

? *Spiroloculina* sp. *abnorm.* Barker, 1960, p.20, pl.10, fig.14

*Spirophthalmidium acutimargo* var. *emaciatum* Haynes, 1973, p.50,  
pl.5, fig.11, pl.9, fig.16, text-  
fig.10, nos.1-4.

Description

Test elongate, highly compressed with very sharp, wide keel. Proloculus globular, followed by tubular second chamber, then by 2 chambers per whorl as a spiroloculine spiral. Later chambers become strongly overlapping with raised flaps; test about 4 times as long as wide. Sutures obscured, especially at the base by overlapping flaps. Aperture terminal at the end of a tubular neck, with a pronounced circular lip; no tooth structure visible. Test wall thin, calcareous, imperforate porcelaneous.

Dimensions

length 225  $\mu$ m.; maximum width 95  $\mu$ m.

Material

A single specimen only.

Provenance

VE 56/-09/142 0.67-0.69 m.

Remarks

The specimen described and illustrated here is very close to Haynes' variety from Cardigan Bay. It is readily distinguished from *Spirophthalmidium* sp. of the present study by its long, slender test and produced aperture. However, the present form is very close to toptype material illustrated by Loeblich and Tappan (1988) from the Holocene, South Atlantic.

I have adopted Paalzow's (1932) corrected spelling of this genus over Cushman's (1927) spelling *Spirophthalmidium* on the basis that it is a valid genus (Loeblich & Tappan, 1988) and distinct from *Ophthalmidium* Kübler & Zwingli (1870) as discussed by Haynes.

Occurrence.

This species is noted as occurring widely in the seas off N.W.Europe with records from Clare Island, W.Ireland (Heron-Allen & Earland, 1313); the Dublin coast (Balkwill & Wright, 1885); Cardigan Bay (Haynes, 1973); the Belgian coast (Cushman, 1949); the Netherlands (Voorthuysen, 1960) as well as the South Pacific as a variant in populations of *S.acutimargo* (Brady, 1884)

*Spirophthalmidium* sp.A

Plate 3, figs.4,5,6.

Description

Test sub-ovate, highly compressed. Periphery sharp and distinctly keeled. Chambers arranged in a spiroloculine spiral, following a moderately large (c.20 µm.) proloculus and undivided second chamber. Chambers increasing rapidly in size and becoming increasingly enveloping with very slight flaps developed which obscure the sutures. Aperture terminal, bordered by a well developed rounded lip. Test wall smooth, imperforate, porcelaneous.

Dimensions

	7/16	7/17	7/18
maximum length	195 µm.	210 µm.	222 µm.
maximum width	158 µm.	158 µm.	167 µm.

Material

Moderate numbers.

Provenance

VE 56/-09/142 0.67-0.69 m.

Remarks

I have been unable to place this form during my limited researches, but I am convinced that such a readily identifiable form, while never abundant in the present study, has been described before. Balkwill and Wright (1885), for example, illustrate similar forms as new from Lambay, western Irish Sea at depths between 45-50 fathoms as *Ophthalmidium carinatum*; the present form may well belong here.

Family           SPIROLOCULINIDAE   Wiesner, 1920  
Genus            SPIROLOCULINA       d'Orbigny, 1826

*Spiroloculina canaliculata* d'Orbigny

Plate 3, fig.7

*spiroloculina canaliculata* d'Orbigny, 1846, p.269, pl.16, figs.  
10-12; Cushman, 1944, p.22, pl.4,  
figs.1-11; Harris, 1958, p.189,  
pl.13, fig.5.

? *Spiroloculina depressa* d'Orbigny, Williamson, 1858, p.82, pl.7,  
fig.177.

*Spiroloculina limbata* d'Orbigny, Parker & Jones, 1865, pl.17,  
fig.83.

#### Description

Test medium, compressed and flattened, oval in outline, with a distinctive neck anteriorly. Biconcave, chambers increasing gradually as added with 5 pairs visible following a globular proloculus. Chambers elongate, compressed, about twice as wide as high, widest at base and produced anteriorly. Aperture terminal, simple and sub-rectangular at the end of a long, flattened neck; no tooth structure visible.

#### Dimensions

length 900  $\mu\text{m}$ .; height 550  $\mu\text{m}$ .; width 250  $\mu\text{m}$ .

#### Material

Single specimen only.

#### Provenance

VE 57/-09/89 0.8-0.9 m.

#### Remarks and Occurrence

There appears to be some confusion and difficulty surrounding the identity of British specimens. The present form agrees well with the description and illustration given by Harris (1958), who in turn follows Cushman's (1944) interpretation of the species after the latter had examined topotype material.

Harris notes the occurrence of this species in small numbers only from the Scottish Shelf at depths ranging between 103 and 440 m..

*Spiroloculina depressa* d'Orbigny

Plate 3, fig.8.

*Frumentaria Sigma et Rhombos* Soldani, 1795, p.229, pl.155, fig.kk.

*Spiroloculina depressa* d'Orbigny, 1826, p.298, modèle 92; Parker, Jones & Brady, 1871, p.248, pl.8, fig.23 (figure after Soldani); Cushman, 1929, p.44, pl.9, figs.8,9 (8 after Brady); Loeblich & Tappan, 1964, c453, fig.343 - Ia,b; Loeblich & Tappan, 1988, pl.340, figs.2-5; Haynes, 1973, p.78, pl.9, figs.6,7.

*Spiroloulina limbata* d'Orbigny, Brady (part), 1884, p.150, pl.9, fig.17 only (not *S. excavata* d'Orbigny).

Description

Test spiroloculine, compressed ovate in side view. Periphery distinctly truncate and square, sides flattened. Chambers increasing steadily in size, two per whorl, rectangular tubes. Sutures distinct but only slightly impressed. Aperture terminal, at the end of a short neck, sub-circular, with a short and simple tooth. Test wall smooth, imperforate, porcelaneous.

Dimensions

maximum length = 421  $\mu$ m. height = 295  $\mu$ m.

Material

Limited numbers only, rare.

Provenance

Taf estuary, S. Wales.

Remarks

This is a distinctive form, easily recognized by its square periphery, compressed test and only very slightly concave sides. As Haynes (1973, p.78) has discussed, there is confusion regarding the identity of this form, particularly with *S. limbata*. Murray's (1971, pl.19, figs.1-3) illustrations of this form as *S. excavata* are not considered valid in view of the fact that the latter is reported as "briefly characterized as having thick edges and deeply sunk centre" (Brady, 1884, p.151).

Occurrence

Numerous Mediterranean records exist for this species eg. Colom (1942), Hofker (1932), but confusion with other species makes it difficult to establish a reliable distribution. Records from south and west of the British Isles include: off Skye, Scotland (Brady, 1884); Cardigan Bay (Haynes, 1973); Western Approaches (Murray, 1970); and the coast of Calicia (Colom, 1952).



*Spiroloculina rotunda* d'Orbigny

Plate 3, figs. 9, 10.

*Spiroloculina rotunda* d'Orbigny, 1826, p.299; Parker, Jones & Brady, 1871, pl.8, fig.25.

*Spiroloculina* cf. *rotunda* d'Orbigny, Murray, 1971, p.55, pl.19, figs. 4-6.

Description

Robust, spiroloculine test, sub-ovate in side view, compressed. Periphery truncated and gently convex; sides distinctly concave. About as long as high. Large, spherical proloculus, followed by two chambers per whorl, increasing gradually in size. Aperture terminal, sub-ovate, wider than high, with a simple, slightly divergent, short tooth. Test wall smooth, imperforate, porcelaneous, often with a milky-yellow colour.

Dimensions

	length	height	width
fig.9	690 $\mu$ m	564 $\mu$ m	--
fig. 10	800 $\mu$ m	--	360 $\mu$ m.

Material

Limited numbers only.

Provenance

fig.9 VE 57/-09/32 0.0 - 0.1 m.

Remarks and Occurrence

I have assigned this form to *S. rotunda* on the basis of its similarity to Murray's (1971, pl.19, figs. 4-6) illustrations and description. He describes it as an inner shelf species with no living records from around the British Isles.

Family           HAUERINIDAE           Schwager, 1876

Genus            MASSILINA            Schlumberger, 1893

*Massilina secans* (d'Orbigny)

Pl.3, figs. 11,12,13.

*Quinqueloculina secans* d'Orbigny, 1826, p.303, no.43, modèle no.96

*Miliolina secans* Brady, 1884, p.167, pl.6, figs.1,2 (not d'Orbigny).

*Miliolina secans* (d'Orbigny) Goës, 1894, p.112, pl.20, figs.856-856g; Mills, 1900, p.143, pl.10, fig.18.

*Sigmoilina secans* (d'Orbigny) Schlumberger, 1887, p.118.

*Massilina secans* (d'Orbigny) Schlumberger, 1893, p.218, pl.4, figs.82,83, text-figs.31-33; Feyling-Hanssen, 1964, p.254, pl.6, figs.2, 3; Murray, 1971, p.67, pl.-, figs.1-6; Haynes, 1973, p.58, pl.5, figs.3, 4, pl.8, fig.6, pl.32, fig.4.

#### Description

Test oval, tending to sub-circular in side view, compressed, sub-triangular in section; periphery sub-angular. Chamber arrangement a flattened quinqueloculine, with 4 visible externally, lacking the later spiroloculine spiral reported in many adult specimens. Sutures distinct, impressed, later chambers tending to become increasingly overlapping with a slight 'flange'. Aperture a terminal opening of the final chamber, sub-rectangular, distinctively arched backwards, slightly flared lip and extremely elongate, blade-like bifid tooth plate, free edge expanded.

#### Dimensions

	7/5	7/6	7/7
length	880 $\mu$ m.	1.15 mm.	818 $\mu$ m.
width	480 $\mu$ m.	888 $\mu$ m.	640 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

7/5 57/-09/89 <sup>c</sup>/6 35-45 cm.  
7/6 57/-09/89 <sup>d</sup>/6 0-5 cm.  
figs.11,12,13 = 57/-09/32 <sup>a</sup>/6 0-10 cm.

#### Remarks

These specimens compare well with the material described, and to a lesser extent illustrated, by many authors; particularly in the apertural details. They are however more inflated and have less typically well developed spiroloculine chamber arrangement in adult specimens.

Haynes (1973), while discussing *Quinqueloculina seminulum*, mentions Williamson's (1858) reference to *Miliolina seminulum* (Linnaeus), a specimen which he considers nearer to *M.secans*. The angularity of the chambers seems to be important in separating the two forms, particularly juveniles, and it may be that my less angular forms belong in *Q.seminulum* rather than *M.secans*.

#### Occurrence

The typical form of this species, originally described from the Mediterranean, is common around the British Isles with numerous records (see Haynes, 1973, p.53 for an extensive list). It is reported by Murray (1971) to be a stenohaline marine, inner-shelf species, commonly occurring in association with seaweeds and purported to reach its northern limit of distribution around the British Isles. Feyling-Hanssen (1964) notes that it is probably restricted to Boreal and Lusitanian waters and that it is rare in the Late Quaternary of the Oslofjord area.

Genus                   QUINQUELOCULINA     d'Orbigny, 1826

*Quinqueloculina agglutinata* Cushman

Pl.3, figs. 14,15

*Quinqueloculina agglutinata* Cushman, 1917, p.43, pl.9, fig.2;  
Cushman, 1948, p.33, pl.3, fig.13;  
Loeblich & Tappan, 1953, p.39, pl.5,  
figs.1-4; Feyling-Hanssen, 1964, p.  
247, pl.4, fig.11; Knudsen, 1982,  
fig.14:10.1.

#### Description

Large, rotund species of *Quinqueloculina* with 5 chambers visible externally. Adult specimens about  $\frac{2}{3}$  as wide as long, juveniles less elongate. Periphery sub-angular but tending to become sub-rounded at the apex and base, Chambers broadest at the base and most strongly curved at about  $\frac{1}{3}$  of chamber length from base. Aperture sub-rounded, like a horse-shoe, very slightly produced with a simple, squat tooth (not bifid) at its base. Test agglutinated, composed of coarse silt / fine sand, robust.

#### Dimensions

	3/30	3/31	3/36
length	1.25 mm.	980 $\mu$ m.	475 $\mu$ m.
width	800 $\mu$ m.	650 $\mu$ m.	340 $\mu$ m.

#### Material

Numerous specimens.

#### Provenance

fig.15 VE 57/-10/17 <sup>d</sup>/<sub>4</sub> 55-65 cm.  
3/36 VE 57/-09/89 1.90-1.94 m. (not illustrated).  
fig.14 VE 56/-09/142 <sup>b</sup>/<sub>6</sub> 22-25 cm.

#### Remarks

Cushman (1948) describes specimens from the Arctic as having a "wall on the exterior made up of agglutinated sand grains, with a smoothly finished exterior". The test walls of my specimens and those illustrated by subsequent workers are somewhat rougher; apart from this minor point, they agree in all other details with Cushman's original description.

#### Occurrence

This is a common taxon in Recent arctic waters and if Cushman's proposal that Brady's specimens of *Miliolina agglutinans* d'Orbigny belong here then it makes it one of the most common arenaceous miliolid species in the Arctic. Its depth distribution is uncertain, although Loeblich and Tappan (1953) report it at depths of <150 m. from northern Alaska, Greenland and the Canadian Arctic. Feyling-Hanssen (1964) reports its occurrence at 8 m. in the Wijdefjord, Spitsbergen.

It is known from Pleistocene and Holocene sediments from the Oslofjord area; from zone C of the Brastad borehole, S.W. Sweden in normal marine arctic faunal assemblages; Eemian deposits of the

Netherlands (Voorthuysen, 1957); and from the Older *Yoldia* Clay of Vendsyssel, north Jutland (Feyling-Hanssen *et al.*, 1971).

*Quinqueloculina bicornis* (Walker & Jacob)

Plate 3, figs.16,17

*Serpula bicornis ventricosa* Walker & Boys, 1784, p.1, pl.1, fig.2.

*Serpula bicornis* Walker & Jacob, 1798, p.633, pl.14, fig.2.

*Miliolina bicornis* (Walker & Jacob) Brady, 1884, p.171, pl.6, fig.9.

*Quinqueloculina bicornis* (Walker & Jacob) Terquem, 1875, p.443, pl.6, fig.6; Cushman, 1929, p.32, pl.5, figs.1-2; Feyling-Hanssen, 1964, p.249, pl.5, figs.1-2; Murray, 1971, p.57, pl.20, figs.1-5; Haynes, 1973, p.67, pl.7, fig.18, text-fig. 16, nos.1-3.

#### Description

Test ovate to sub-rectangular in outline, slightly longer than high. Broadly rounded periphery, sub-trigonal in section view. Chambers moderately inflated, arranged in a quinqueloculine spiral, 5 visible externally. Sutures distinct, slightly depressed and accentuated by the overlapping of surface ornamentation in earlier chambers. Test wall thick, calcareous imperforate porcelaneous, with distinctive longitudinal grooves which separate bifurcating, thickened costae. Aperture terminal, sub-rectangular and backwards curving with a thin, smoothed lip surrounding it and a long blade-like tooth internally.

#### Dimensions

	7/18	7/17
length	660 $\mu$ m.	1.05 mm.
height	400 $\mu$ m.	830 $\mu$ m.

#### Material

Limited to a few additional specimens.

#### Provenance

VE 57/-10/17 <sup>a</sup>/4 50-55 cm.

#### Remarks

These specimens agree well with the Cardigan Bay neotype illustrated and described by Haynes (1973) as based upon the Le Calvez and Le Calvez (1958) concept of this species following Brady (1884). This is a distinctive species in the study area and I do not have specimens intermediate with *Q.angulata* (Williamson) and hence the problem of distinguishing them as discussed by Haynes (*op. cit.*, p.68) and illustrated by Murray (1971). The latter author recognizes both this species and *Q.bicornis* (Walker & Jacob) var. *angulata* (Williamson). I have followed Haynes,

rather than Feyling-Hanssen (1964), in excluding *Miliolina bicornis* (Walker & Jacob) Williamson, 1858 from the synonymy on the basis that these specimens appear to be of an intermediate type as discussed.

#### Occurrence.

This species appears to be Boreal to Lusitanian in its distribution and is apparently limited to the inner shelf. Quaternary records are few, with occurrences limited to the Holocene.

*Quinqueloculina cliarensis* Heron-Allen & Earland

Plate 4, figs.1,2,3,4

*Miliolina cliarensis* Heron-Allen & Earland, 1930, p.58, pl.3, figs.26-31.

*Quinqueloculina cliarensis* (Heron-Allen & Earland) Cushman, 1949, p.9, pl.1, figs.10a-c; Murray, 1971, p.61, pl.22, figs.1-4.

*Quinqueloculina* cf. *cliarensis* var.A Haynes, 1973, p.70, pl.9, fig.5.

#### Description

Test elongate, sub-ovate, nearly twice as long as high. Chambers in an alternating quinqueloculine series, with a sub-angular to rounded periphery, strongly curved and having maximum chamber height and width at the base. Chambers slightly overlapping with a slim flange. Aperture terminal, rounded and at the end of a tubular, elongate neck with a short, simple tooth. Test wall smooth, calcareous, imperforate porcelaneous.

#### Dimensions

length 520  $\mu$ m. height 300  $\mu$ m.

#### Material

Single specimen only.

#### Provenance

VE 56/-09/142 <sup>a</sup>/6 67-69 cm.

#### Remarks

The specimen illustrated differs from the typical *Q.cliarensis* in having more inflated chambers and lacking the acute periphery. I have figured additional specimens from Holocene sediments of the central Celtic Sea which do illustrate the typical features of this species as originally defined by Heron-Allen and Earland (1930). The latter are included to illustrate the fact that the present form is not simply a 'poorly' developed juvenile, which its size precludes, but rather is a distinct form.

Heron-Allen and Earland illustrate two forms which might now be placed in synonymy with this species and, as noted by Harris

(1958), the first form (pl.1, figs.14,15) originally referred to *Miliolina stelligera* (Schlumberger) was later (1930) considered to be the distinct form *M.cliarensis*. However, the second form, assigned to *M.laevigata* d'Orbigny by Heron-Allen and Earland (pl.1, figs.12,13), is somewhat closer to Haynes' var.A and the present form and they may eventually prove to be conspecific.

#### Occurrence

Assuming a similar distribution pattern to *Q.cliarensis*, this would appear to be a Boreal to Lusitanian, inner shelf species.

#### *Quinqueloculina pygmaea* Reuss

Pl.4, fig.12, 13.

*Quinqueloculina pygmaea* Reuss, 1849, p.384, pl.1, fig. 3a,b;  
Harris, 1958, p.182, pl.12, fig.6.

*Miliolina pygmaea* (Reuss) Brady, 1884, p.163, pl.113, fig. 16a,b;  
Heron-Allen & Earland, 1916, p.211,  
pl.39, figs.10-18.

#### Description

Test small, long and very slender; sub-fusiform in side view, compressed. Initial chamber arrangement quinqueloculine, but tending to become spiroloculine in larger specimens. Chambers long and slender, circular in section, almost cylindrical, increasing gradually in size as added and generally six or more visible externally. Sutures distinct, impressed. Aperture terminal, at the end of a short neck, with a short and simple tooth-plate. Test wall uneven, calcareous, imperforate, porcelaneous.

#### Dimensions

	maximum length	maximum width
fig.12	382 $\mu$ m.	173 $\mu$ m.
fig.13	365 $\mu$ m	157 $\mu$ m.

#### Material

Moderates numbers.

#### Provenance

fig.12 VE 56/-09/142 1.89 - 1.91 m.  
fig.13 VE 56/-09/142 0.67 - 0.69 m.

#### Remarks and Occurrence

This distinctive slender species of *Quinqueloculina* is sometimes difficult to distinguish from *Q.stalkeri*, except that the latter is generally more inflated, has fewer chambers visible externally, and has a fine agglutinated exterior.

Harris (1958) notes its occurrence from northern Scotland as rare between 61-130 m. water depth and Brady (1884, p.163) notes "Though occasionally found in shallow water, it affects somewhat greater depths than most of the *Miliolinae*, and one-half of the localities are set down at more than 170 fathoms (>270 m.), the

deepest being 580 fathoms (c. 919 m.)". However, Brady's records of this species were from the southern Pacific Ocean. I can find no other N. W. European Quaternary record of this species.

*Quinqueloculina seminulum* (Linné)

Plate 4, figs.7,8

*Serpula seminulum* Linné, 1758, p.786.

*Quinqueloculina seminulum* (Linné) d'Orbigny, 1826, p.303; Feyling-Hanssen, 1964, p.251, pl.6, fig.1; Haynes, 1973, p.74, pl.7, figs.14,19 pl.8, fig.3, pl.32, figs.1-3, text-fig.18, nos.1-4.

*Miliolina seminulum* (Linné) Williamson, 1858, p.85, pl.7, figs.183-185.

#### Description

Test ovate, regular, about  $1\frac{1}{2}$  times as long as high. Periphery rounded, sub-trigonal in section; inflated chambers arranged in a quinqueloculine spiral, slightly overlapping but with 5 chambers visible externally. Sutures distinct, only slightly depressed. Aperture terminal, sub-ovate, with a flattened marginal area, but no lip. Apertural tooth short slightly protruding and bifid.

#### Dimensions

	9/2	9/3	9/4
length	950 $\mu$ m.	1.2 mm.	1.0 mm.
height	700 $\mu$ m.	850 $\mu$ m.	600 $\mu$ m.

#### Material

A very common taxon

#### Provenance

VE 57/-09/89 <sup>c</sup>/6 10-20 cm.

#### Remarks

Many authors have repeatedly confused this species with other, closely related forms. As Haynes (1973) states "there is apparently continuous variation from this species through to *Q.lata* which is oblong in outline and oval in section and in the other direction to *Q.dunkerquiana* which is short with angled chambers". While every effort has been made to separate these forms, the tendency during counting has been to "lump" closely related forms into a complex group of variable forms centred around the present form and designated *Quinqueloculina* gr. *seminulum*.

## Occurrence

This species has an apparently cosmopolitan distribution, almost certainly partly the result of poor taxonomic practice, with records reported from the Lias upwards. Murray (1971) considers its distribution to be that of a southern species which is close to its northern limit of distribution around the British Isles. However, although somewhat poorly illustrated, Cushman's (1948) record of this species from the Arctic appears to be valid and Nørvang (1945) also records it from Iceland. Equally, Heron-Allen and Earland (1932) record this species from around the Falkland Islands.

A common taxon in Quaternary marine deposits, this species occurs in most of the samples investigated in the present study, apparently confirming its cosmopolitan affinities. The test appears to be particularly robust and may well withstand considerable sediment reworking; indications of reworking are reflected in the varying degrees of test preservation/abrasion commonly observed. In the present study it appears to be best developed and least abraded in the shallow, interstadial sediments of vibrocore VE 57/-09/89.

*Quinqueloculina stalkerii* Loeblich and Tappan

Plate 4, figs.9,10,11

*Quinqueloculina fusca* Brady, Cushman, 1948, p.33, pl.3, figs.16-17 (not Brady, 1870).

*Quinqueloculina stalkerii* Loeblich & Tappan, 1953, p.40, pl.5, figs.5-9; Feyling-Hanssen, 1964, p.252, pl.4, figs.13-18; Knudsen, 1971, p.194, pl.2, figs.1-3; Knudsen 1978, figs.14:10.2,3 & 14:13.1.

## Description

Small elongate/ovate test with a highly arched posterior margin. Periphery well rounded, 5 inflated chambers visible externally. Sutures distinct, moderately depressed. Aperture sub-rounded, slightly projecting on a short neck, bordered by a distinctive lip and possessing a short bifid tooth. Test wall calcareous, imperforate with a finely agglutinated appearance and unevenly distributed 'coating' of very fine silt grains; white to off-white in colour.

## Dimensions

	3/32	3/33
length	300 $\mu\text{m}$ .	300 $\mu\text{m}$ .
width	150 $\mu\text{m}$ .	175 $\mu\text{m}$ .

## Provenance

VE 57/-10/21 <sup>d</sup>/5 52-55 cm.



#### Remarks

This form, although variable to the extent that agglutinated silt particles may be unevenly distributed over the test and in the form of the neck, is readily identified. It resembles *Q.fusca* Brady as described by Cushman (1948) who illustrates it from marine stations in N.E. Greenland. However, Feyling-Hanssen (1964) does not regard these species to be synonymous since Brady's form is reported to be siliceous. Loeblich and Tappan (1953, p.40) note this in their synonymy for this species and make the point that *Q.fusca* Brady s.s. was described as a characteristic brackish water form and that it is doubtful whether it would occur in normal marine Arctic waters. They further note that *Q.stalkeri* bears a resemblance to Nørvang's species *Q.nitida* but differs in the possession of a pronounced lip and small bifid tooth which the latter lacks; this difference is clearly illustrated in Cushman's (1948) figures of *Q.fusca* (= *Q.stalkeri*) and *Q.nitida* (= *Q.norvangi* Boltovskoy, 1954).

#### Occurrence

Cushman's material, discussed above, came from shallow (< 35 fathoms) often ice-proximal settings in N.E. Greenland. Loeblich and Tappan (1953) recorded it at depths of c.45 m. and less from N. Alaska and N.W. Greenland. Nagy (1965) found it in shallower waters (< 40 m.) from Vestspitsbergen.

This species is a well known form in Quaternary sediments, occurring in the Lateglacial of the Oslofjord area, particularly zone B from the south (Feyling-Hanssen, 1964). It has been recorded as common in Hoxnian deposits off the east coast of England (Fisher, Funnell & West, 1969) and from the Holsteinian deposits of Esbjerg, S.W. Jutland.

#### *Quinqueloculina* sp.A

Pl.4, fig.14

#### Description

Test large and rotund, almost sub-rhomboidal; about as long as high. Chambers moderately inflated, slightly overlapping with poorly developed flange; 7 chambers visible externally. Sutures distinct, impressed. Quinqueloculine coiling appears to give way to spiroloculine chamber arrangement with the addition of later chambers. Aperture a high arch with a short internal tooth. Test wall smooth, calcareous, imperforate, porcelaneous.

#### Dimensions

maximum length = 1.37 mm.      maximum height = 1.04 mm.

#### Material

Single specimen only?

#### Provenance

VE 57/-09/89 3.0 - 3.05 m.

Remarks

This is an unusual form of *Quinqueloculina* and exhibits many of the growth characteristics associated with *Miliolinella subrotunda* and *M.subrotunda* forma *hauerinoides* of the present study. However, it is distinguished from the latter by its distinctive apertural tooth-plate.

Genus                    MILIOLINELLA                    Wiesner, 1931

*Miliolinella subrotunda* (Montagu)

Plate 4, figs.15,16

*Serpula subrotunda dorso elevato* Walker & Boys, 1784, p.2, pl.1, fig.4.

*Vermiculum subrotundum* Montagu, 1803, p.521.

*Quinqueloculina subrotunda* (Montagu) d'Orbigny, 1826, p.302; Brady, 1867, p.94, pl.12, fig.2.

*Miliolina subrotunda* (Montagu) Fischer, 1870, p.386.

*Miliolinella subrotunda* (Montagu) Wiesner, 1931, p.63; Knudsen, 1971, p.197, pl.2, figs.10-12; Murray, 1971, p.73, pl.28, figs.5,6; Haynes, 1973, p.56, pl.5, figs.5,6 (not 12,13), pl.31, figs.8,9, text-fig.11, nos.1-3 (not 4), text-fig. 12, nos.1-5,9-11 (not 6-8).

Description (based upon inflated quinq. specimens)

Test inflated, quinqueloculine, almost circular in outline, sub-ovate in section; slightly longer than high. Chambers inflated, increasing steadily as added, overlapping with narrow flanges. Five chambers visible, 3 on one side, 4 on the other. Wall moderately robust, semi-translucent and smooth, calcareous imperforate. Aperture a low terminal arch with a poorly developed lip and pronounced semi-circular flap on the internal border which is continuous with the lip.

Dimensions (specimens illustrated)

length	1.1 mm.	1.3 mm.
height	1.0 mm.	1.2 mm.

Material

Numerous specimens.

Provenance

VE 57/-10/17 <sup>d</sup>/4 55-65 cm.

Remarks

My diagnosis of this species is restricted to include specimens which exhibit an apertural flap, but also includes both triloculine and quinqueloculine forms. Thus, while the hauerinid variety *Pateoris hauerinoides* (Rhumbler) may no longer have a

valid generic or specific status (see discussion on genus *Miliolinella* by Loeblich & Tappan, 1988), I still find it useful to distinguish the two forms. In this respect, it is an interesting exercise to break off the final, planispirally arranged chambers in the hauerinid variety to reveal well developed apertural flaps on earlier chambers; this was first demonstrated to me by Rolf Feyling-Hanssen).

Loeblich and Tappan (1988) illustrate specimens of *M.subrotunda* from 3.5 miles off Point Barrow, northern Alaska at a water depth of 42 m. which were originally described (Loeblich & Tappan, 1953) as *Pateoris hauerinoides* (Rhumbler) and are considered as distinct from the present form.

The specimens I have illustrated are particularly large, both are longer than 1.0 mm. and are considerably larger than the specimens described by Murray (1971), who quotes an average length of 0.2 mm., and Haynes (1973), who quotes the maximum length as 0.39 mm. The form described by Loeblich and Tappan (1953) as *Miliolinella chukchiensis* bears some resemblance to the larger specimens.

#### Occurrence

An understanding of the distribution of this species is somewhat confused by the taxonomic problems surrounding it and unfortunately, I have not had the opportunity to review the extensive list of occurrences reported by Haynes in the context of the present taxonomic subdivision. Murray (1971) notes this form as an inner-shelf species from around the British Isles and reports that it is a "southern species which reaches its northern limit of distribution around the British Isles".

*Miliolinella subrotunda* (Montagu) forma *hauerinoides* Rhumbler

Plate 4, figs.17,18

*Miliolina seminulum* (Linné) var. *disciformis* (Macgillivray)  
Williamson, 1858, p.86, pl.7, figs.  
188,189 (not *Vermiculum disciforme*  
Macgillivray, 1843).

*Miliola (Quinqueloculina) subrotunda* (Montagu) Parker & Jones,  
1865, p.411, pl.15, figs.38a,b (not  
*V.subrotundum* Montagu, 1803).

*Miliolinella subrotunda* (Montagu) ? Wiesner, 1931, p.63; Haynes,  
1973, p.56, pl.5, figs.12,13 (not 5-  
6), text-fig.11, no.4 (not 1-3),  
text-fig.12, nos.6-8 (not 1-5,9-11),  
(not *V.subrotundum* Montagu, 1803).

*Quinqueloculina subrotunda* (Montagu) forma *hauerinoides* Rhumbler,  
1936, p.206,217,226, text-figs. 167,  
208-212.

*Quinqueloculina subrotunda*(Montagu) ? Cushman, 1948, p.35, pl.3,  
figs. 20-21, pl.4, fig.1.

*Pateoris hauerinoides* (Rhumbler) Loeblich & Tappan, 1953, p.42, pl.6, figs.8-12, text-figs.1a,b; Feyling-Hanssen, 1964, p.256, pl.6, fig.5; Murray, 1971, p.69, pl.26, figs.1-4; Knudsen, 1971, p.198, pl.2, figs.13-16.

#### Description

Test ovate to sub-circular in outline, compressed, with a well rounded periphery. Early chambers quinqueloculine, later chambers added in a single plane and decreasing in length so that there are >2 chambers per coil. Test tending to become higher than long. Chambers inflated and overlapping with narrow flanges. Wall calcareous, imperforate, porcelaneous and smooth except for irregular markings on later chambers. Aperture terminal, a simple, open, low arch with a moderate lip; no apertural flap.

#### Dimensions

	10/21	10/22	9/26
length	530 $\mu\text{m}$ .	400 $\mu\text{m}$ .	375 $\mu\text{m}$ .
height	600 $\mu\text{m}$ .	380 $\mu\text{m}$ .	400 $\mu\text{m}$ .

#### Material

Numerous specimens.

#### Provenance

9/26 VE 56/-09/142<sup>e</sup>/6 23-25 cm. (not illustrated)  
 figs.17,18 VE 57/-10/17<sup>d</sup>/4 55-65 cm.

#### Remarks

This form is diagnosed here as having quinqueloculine chamber arrangement giving way to coiling almost in a single plane and with a simple aperture. I have adopted Rhumbler's original varietal name *hauerinoides* since it appears that Loeblich and Tappan's (1953) *Pateoris hauerinoides* (Rhumbler) is no longer valid. The form is therefore placed within the genus *Miliolinella* and the relationship with the closely related species *subrotunda* demonstrated, while retaining the immediately recognizable varietal name from which *P.hauerinoides* derives.

As mentioned above, fractured specimens assigned to this form do reveal internal chambers with apertural flaps, possibly suggesting that the hauerinid growth is a later ontogenetic stage. However, it is equally common to find small specimens of this form totally lacking an apertural flap. I have been eager to separate the two forms as described here since they appear to differ markedly in their modern distribution patterns and may prove useful in palaeoecological reconstructions.

#### Occurrence

There are apparently no live British records of this species, although dead specimens are found from the inner shelf around the British Isles. It is known (as *P.hauerinoides*) from the Arctic (Cushman, 1948; Loeblich & Tappan, 1953) and from Spitsbergen at depths of <10 m. (Feyling-Hanssen, 1964).

Records from Quaternary sediments are infrequent and include rare specimens from the Late Quaternary of the Oslofjord area (Feyling-Hanssen, 1964) and very rare specimens in zone 1 of the Sandnes Clay, the Older *Yoldia* Clay and the Postglacial of

Vendsyssel (Knudsen, 1971).

Genus            PYRGO                            DeFrance, 1824

*Pyrgo depressa* (d'Orbigny)

Plate 5, figs.1,2,3

*Biloculina depressa* d'Orbigny, 1826, p.298; Parker, Jones & Brady, 1871, pl.8, fig.5; Heron-Allen & Earland, 1913, p.22, pl.1, fig.5? (not 6).

*Pyrgo depressa* (d'Orbigny) Murray, 1971, p.71, pl.27, figs.1-4.

#### Description

Test nearly circular, compressed, about twice as wide as high; acute periphery forms distinctive keel. Chamber arrangement biloculine, strongly overlapping; suture a single continuous indistinct impression. Aperture terminal on the periphery, accounting for  $\frac{1}{6}$ <sup>th</sup> circumference, consisting of an elongate slit with flattened lips and no visible tooth structure. Wall calcareous, imperforate, porcelaneous, and smooth.

#### Dimensions

	7/30	7/31	7/32
maximum diameter	975 $\mu$ m.	875 $\mu$ m.	716 $\mu$ m.

#### Material

Moderately abundant.

#### Provenance

VE 57/-09/89 <sup>a</sup>/<sub>6</sub> 10-20 cm.

#### Remarks

Haynes (1973) notes the confusion regarding the two close forms *P.carinata* and *P.depressa*, as did Heron-Allen and Earland (1913) while remarking upon material assigned to *B.depressa* d'Orbigny from Clare Island. The latter comment that "two distinct forms are noticeable, one circular, the other oval in outline". The present forms are circular and in this respect agree with d'Orbigny's definition of *B.depressa* and with material illustrated by Murray (1971, pl.27, figs.1-4).

The "presence of a produced flap or tongue at the aboral extremity", which Heron-Allen and Earland (1913) note as a characteristic feature of the "oval type" of their *B.depressa* concept has not been observed in this study, except in specimens where the last chamber has broken away to reveal what is evidently part of that last chamber's apertural structure. Various authors, while discussing species of this genus, have noted such "processes" and these are reported to occur even when there is no evidence for the test having fractured eg. *B.depressa* from Clare Island (Heron-Allen & Earland, 1913).

### Occurrence

The distribution of this species is problematic owing to the confusion between d'Orbigny's closely related forms; assuming similar distribution patterns, it appears to be a North Atlantic species and widespread.

*Pyrgo williamsoni* (Silvestri)

Plate 5, figs.4,5,6,7

*Biloculina ringens, typica* Williamson, 1858, p.79, pl.6, figs. 169,170, pl.7, fig.171 (not *Miliolites ringens* Lamark).

*Biloculina williamsoni* Silvestri, 1923, p.73.

*Pyrgo williamsoni* (Silvestri) Loeblich & Tappan, 1953, p.48, pl.6, figs.1-4; Feyling-Hanssen, 1964, p.264, pl.7, figs.5-6, pl.8, figs.3-5; Murray, 1971, p.71, pl.27, figs.5-7; Haynes, 1973, p.61, text-fig.14, nos.1-3.

### Description

Test globose, ovate in side view with evenly rounded periphery. Higher than wide, longer than high. Chamber arrangement spiroloculine, with final chamber extending over the previous one on all margins so that only one distinctive, depressed and continuous suture is visible. Aperture terminal, raised above the suture line, sub-ovate with test wall overhanging above. A large bifid tooth nearly fills the aperture, protrudes slightly in side view and has an outwardly facing central depression beneath the divergent tines. Test wall silky and smooth, calcareous, imperforate, porcelaneous.

### Dimensions

	7/24	7/25	7/27	9/31
length	720 $\mu$ m.	----	1.0 mm.	----
height	----	800 $\mu$ m.	750 $\mu$ m.	----
width	590 $\mu$ m.	750 $\mu$ m.	----	c.180 $\mu$ m.

### Material.

A common taxon

### Provenance

VE 57/-09/89<sup>a</sup>/6 10-20 cm.

### Remarks

The specimens illustrated are large adult forms, highly rounded with well developed bifid teeth, much as illustrated by Murray (1971). However, smaller, more elongate specimens are also included here. Thus, the present species concept would include the small, somewhat elongate specimens illustrated by Loeblich and Tappan (1953;pl.6,fig.2), although Haynes precludes this particular specimen from his synonymy of *P.williamsoni*. I am in

agreement with the suggestion by many authors that further work is required to establish the validity and relationships of closely related species belonging to this genus; unfortunately, such an investigation was beyond the scope of this study and I am undoubtedly guilty of taxonomic "lumping" as far as this species is concerned!

#### Occurrence

Murray (1965) has found this species living off Plymouth at between 10-60 m. water depth. Numerous records, following Loeblich and Tappan's (1953) description, exist from the Arctic, to the extent that Haynes suggests that it is indicative of cold water. However, I find this form to be relatively frequent throughout the Lateglacial and Holocene of the Celtic Sea and Hebridean Shelf areas, suggesting either that its range may be broader than proposed by Haynes or that I am dealing with two or more closely related forms.

This species is recorded in Late Quaternary marine sediments, particularly Lateglacial strata, from the Oslofjord area (Feyling-Hanssen, 1964) and as rare in middle and late Weichselian deposits from north Jutland, Denmark (Knudsen, 1978).

Genus                    PYRGOELLA                    Cushman & White, 1936

*Pyrgoella sphaera* (d'Orbigny)

Plate 5, figs.8,9,10

*Biloculina sphaera* d'Orbigny, 1839, p.66.

*Pyrgoella sphaera* (d'Orbigny) Cushman & White, 1936, p.90.

#### Description

Test sub-spherical, chambers arranged in an apparent biloculine manner, very strongly enveloping; final chamber accounting for approximately 85% to 90% of the test surface. Suture indistinct, sub-circular and continuous, only very slightly depressed. Aperture terminal (?) extending from just above the sutural line as a series of digitate slits with fine, raised lips and a certain degree of symmetry about the long axis. Test calcareous, imperforate, porcelaneous and very smooth.

#### Dimensions

	7/28	7/21
maximum diameter	750 $\mu$ m.	750 $\mu$ m.
apertural length	285 $\mu$ m.	275 $\mu$ m.

#### Material

Two specimens only

#### Provenance

fig.8    VE 57/-09/32 <sup>a</sup>/6 0-10 cm.  
fig.9,10    VE 57/-09/89 <sup>a</sup>/6 10-20 cm.

#### Remarks and Occurrence

This very distinctive, albeit rare, species is readily identified and appears to be close to d'Orbigny's species as illustrated by Loeblich and Tappan (1988, pl.351, figs.1-2) from the Holocene of the Gulf of Mexico at a water depth of 420 m.. The present specimens do differ in the form of the aperture illustrated (pl.351, figs.3-4) in hypotype material from the U.S.N.M. Cushman Collection from the Pleistocene of Timms Point, California; the digitate slits of the Hebridean specimens are continuous with each other. I can find no British record of this species.

Genus            TRILOCULINA            d'Orbigny, 1826

*Triloculina trigonula* (Lamarck)

Plate 5, fig.11

*Miliolites (trigonula)* Lamarck, 1804, p.351, pl.17, fig.4

*Miliolina trigonula* (Lamarck) Williamson, 1858, p.83, pl.7, figs. 180-182.

*Triloculina trigonula* (Lamarck) Cushman, 1917, p.65, pl.25, fig.3; Feyling-Hanssen, 1964, p.258, pl.6, figs.11-13; Knudsen, 1971, p.196, pl.2, figs.4-6.

#### Description

Test moderately globose, sub-ovate in side view, sub-trigonal in sectional view. Periphery broadly sub-rounded, sides markedly convex. Inflated chambers arranged in a triloculine plan, sutures distinct, impressed. Aperture terminal with short bifid tooth. Test wall calcareous, imperforate, porcelaneous and smooth.

#### Dimensions

length 720  $\mu\text{m}$ .; width 580  $\mu\text{m}$ .

#### Material

moderate numbers.

#### Provenance

VE 57/-09/89 <sup>a</sup>/6 10-20 cm.

#### Remarks and Occurrence

At first glance this form appears to closely resemble the inflated specimens of *Pyrgo williamsoni* encountered in this study, particularly the design of the aperture and tooth-plate. However, it is clearly triloculine and agrees well with the specimens illustrated by Feyling-Hanssen (1964; pl.6, figs.11-13) from the Postglacial deposits of the Oslofjord region. The specimens illustrated by Knudsen (1971; pl.2, figs.4-6) from the Postglacial of Løkken are somewhat irregular in outline and show a less well



developed bifid tooth, but otherwise clearly belong here.

This species is known living from a number of sites along the Norwegian coast (Kiær, 1900). Harris (1958) records a few specimens from off northern Scotland and the Faeroe Shelf. However, Feyling-Hanssen (*op.cit.*, p.259) notes that it has never been recorded from the Arctic or the Antarctic (Nørvang, 1945). It is interesting to note that Lamarck's original description of this species is based upon material from the Eocene of France.

*Triloculina trihedra* Loeblich & Tappan

Plate 5, figs.12,13,14,15

*Triloculina trihedra* Loeblich & Tappan, 1953, p.45, pl.4, fig.10;  
Feyling-Hanssen, 1964, p.259, pl.6,  
fig.6; Knudsen, 1971, p.196, pl.2,  
fig.7, pl.15, fig.8.

Description

Test small to medium, triangular in sectional view, sub-rhomboidal in side view. Slightly inflated chambers arranged in a triloculine series; final chamber strongly overlapping so that whenever all 3 chambers are visible it clearly dominates. Periphery sub-angular. Sides straight to gently convex. Sutures distinct, moderately impressed. Aperture terminal, overhung by the periphery, ovate with a short, slightly projecting, angular bifid tooth which is Y-shaped. Test calcareous, imperforate, porcelaneous, smooth.

Dimensions

	9/15	9/16	9/34
length	470 $\mu$ m.	330 $\mu$ m.	820 $\mu$ m.
width	350 $\mu$ m.	230 $\mu$ m.	640 $\mu$ m.

Material

Moderate numbers.

Provenance

fig.13	VE 57/-10/17 <sup>b</sup> /4	70-75 cm.
fig.14	VE 57/-09/60 <sup>a</sup> /4	24-26 cm. 'inner'
figs.12,15	VE 57/-09/89 <sup>c</sup> /6	10-20 cm.

Remarks

My specimens agree well with the original illustrations and description by Loeblich and Tappan (1953), except that they are possibly slightly more inflated than the Arctic specimens of the latter. This species is readily distinguished from *T.trigonula* of this study by its more angular periphery, less inflated chambers, higher degree of overlap and distinctive Y-shaped tooth structure. Similarly, *T.tricarinata* d'Orbigny, described from the Red Sea, has an acuter periphery, more markedly concave sides and is less enveloping than the present form.

This appears to be a cold water taxon, an observation that is largely born-out by its distribution and faunal associations in the present study. Quaternary records include the Lateglacial and

early Postglacial of Jutland (Knudsen, 1971).

Genus                    TRILOCULINELLA                    Riccio, 1950

*Triloculinella* sp.A

Plate 6, figs.1,2,3

? *Miliolinella circularis* (Bornemann) var. *elongata* Kruit, 1955,  
p.110, pl.1, figs.15a,b; Murray,  
1971, p.73, pl.28, figs.1-4.

*Scutuloris* sp.A Haynes, 1973, p.76, pl.9, fig.14.

#### Description

Test sub-globose, elongate-ovate, sub-circular to ovate in section. Chamber arrangement cryptoquineloculine with 4 chambers visible externally; chambers strongly overlapping, particularly at the base. Chamber thickness and height greatest near the base, tapering towards the aperture and markedly curved; hence chambers appear to be added slightly obliquely to the long axis. Aperture terminal, a large, high arch with a slightly flared lip bordering it. A large,  $\frac{4}{5}$ <sup>th</sup> aperture height, lunate flap rises from the inner margin and protrudes in side view. Test wall calcareous, imperforate, porcelaneous, smooth and pearly but may exhibit transverse markings as chamber height/width ratio varies slightly during growth.

#### Dimensions

	9/27	7/19
length	520 $\mu$ m.	660 $\mu$ m.
height	280 $\mu$ m.	320 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

fig.3 VE 57/-09/46 0.75-0.82 m.  
fig.1,2 VE 57/-10/17<sup>a</sup>/4 75-80 cm.

#### Remarks

These forms correspond to Haynes' (1973) *Scutuloris* sp.A and are probably conspecific with the specimens illustrated by Murray (1971) and assigned to *Miliolinella circularis* (Borneman) var. *elongata* Kruit. I can find none of the similarity between this form and *Miliolinella chuckchiensis* Loeblich & Tappan (1953) as discussed by Haynes (1973).

The genus *Scutuloris* is placed in synonymy with *Triloculinella* according to Loeblich and Tappan (1988); although they disagree with the inclusion of *Miliolinella* which shows a tendency to become massiline and hauerinoid in chamber arrangement as based upon the neotype of *M.subrotunda*. The question of generic affinity is partly addressed by Haynes who places his specimens in the genus *Scutuloris* Loeblich & Tappan.

The present form differs from *S.tegminis* as described and illustrated by Loeblich and Tappan (1953), in that it is more elongate-ovate, less compressed and not obviously quinqueloculine. The specimens illustrated as *Scutuloris* cf. *tegminis* by Feyling-Hanssen (1964) are somewhat closer to the present form.

#### Occurrence

Assuming that they are conspecific with Murray's form then it would appear that this is an inner-shelf species which reaches the northern limit of its distribution around the British Isles.

#### *Triloculinella* sp.B

Pl.6, figs. 4,5

#### Description

Test small, sub-spherical, slightly longer than high. Chambers long and wide and overlapping, arranged in an almost biloculine manner; 3 chambers visible externally. Sutures indistinct, slightly impressed. Aperture terminal, crescentric and bordered by a very thin lip with a 'scoop-shaped' apertural flap. Test wall generally smooth, calcareous, imperforate, porcelaneous.

#### Dimensions

	length	height	width
fig.5	229 $\mu$ m.	200 $\mu$ m.	--
fig.4	--	240 $\mu$ m.	226 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

VE 57/-09/46 0.30-0.33 m.

#### Remarks

Balkwill and Wright (1885, pl.XII, figs. 6,7) illustrated a new variety of *Biloculina ringens* Lamarck from Lamby at a water depth of 45 fathoms, to which this form bears an affinity; except that the former is clearly biloculine and has a very distinctly impressed suture reminiscent of *Pyrgo williamsoni*. In respect to the latter species, it is interesting to note that Williamson's (1858) *B.ringens*, typica is placed in synonymy with it; while Brady (1884, p.142) says of *B.ringens* (Lamarck):

"The extreme variability of *Biloculina ringens* in respect of the size and form of the aperture, and the shape of the valvular tooth, as well as in the degree of angularity of the outer margin of the shell, has been dwelt upon by many writers; and the case has been so fully stated by Williamson (Rec. For. Gt. Br., p.80) that there is little left to be said on the subject. It is sufficient to report that in the genus *Biloculina* neither the shape of the aperture nor the roundness or irregularity of the margin furnishes any character sufficiently distinctive to be of more than comparative value to the systematist".

And later in the same paragraph: "but the fact remains, that from end to end of the generic series the variation is one of

degree only".

The present form is placed in *Triloculinella* here on the basis of the 3 externally visible chambers, suggesting triloculine coiling.

Family            SPIRILLINIDAE            Reuss & Fritsch, 1861  
Genus            SEJUNCTELLA            Loeblich & Tappan, 1957

*Sejunctella earlandi* Loeblich & Tappan

Plate 6, fig.6

*Sejunctella earlandi* Loeblich & Tappan, 1957, p.228, pl.73, fig.6;  
Murray, 1971, p.147, pl.61, fig.1.

#### Description

Test planispiral, evolute, comprising a proloculus followed by a single tubular chamber which tapers and becomes flattened around the periphery. Inner margin of the chamber with short radial ribs and smaller tubercles, giving way to short, slightly clavate spines around the periphery. Aperture a terminal slit, simple.

#### Dimensions

maximum diameter 345  $\mu$ m.

#### Material

Single specimen only.

#### Provenance

VE 56/-09/142 <sup>b</sup>/6 8-10 cm.

#### Remarks

The present form is very close to the specimen illustrated by Murray (1971) but differs somewhat from *Spirillina lateseptata* Terquem (1875) illustrated by Loeblich and Tappan (1988) from a water depth of 128 m. off the Faeroe Isles. Neotype material selected for *S.lateseptata* is conspecific with *S.earlandi* according to Levy *et al.* (1975, p.175) and thus *Sejunctella lateseptata* (Terquem) may prove to be a more suitable name for this form. However, since I have not had the opportunity to fully consult the literature, and since Loeblich and Tappan's illustration of *Sejunctella lateseptata* lacks the short radial ribs along the inner margin of the chamber, I have opted to assign the present form to Murray's clearly illustrated definition of this species.

It is interesting to note that Balkwill and Wright (1885) illustrate a specimen from Dalkey Sound, Ireland very similar to the present form which they assign to *Spirillina vivipara* and for which they note that it is "a curiously ciliated form".

#### Occurrence

Murray (1970) has recorded a single live specimen from the English Channel from water depths between 84-95 m..

Genus                    SPIRILLINA                    Ehrenberg, 1843

*Spirillina vivipara* Ehrenberg

Plate 6, fig.7

*Spirillina vivipara* Ehrenberg, 1841, p.442, pl.3, fig.441; 1843, pp.323,422, pl.3, fig.41; Harris, 1958, p.335, pl.29, fig.6 (with extensive synonymy); Murray, 1971, p.145, pl.60, figs.1,2.

Description

Test planispiral, evolute and flattened, comprising a proloculus and a single tubular chamber of  $4\frac{1}{2}$  whorls. Aperture terminal, simple. Test wall a series of irregular pits and small tubercles.

Dimensions

maximum diameter 340  $\mu$ m.

Material

Single specimen only.

Provenance

VE 57/-09/46 <sup>a</sup>/6 38-43 cm.

Remarks and Occurrence

This specimen is very close to the specimen illustrated by Murray (1971) although the spiral suture is less well defined here. It is reported living as an inner shelf species, clinging to hard substrates in current swept areas. It differs from *S.earlandi* Loeblich and Tappan in lacking the blunt spines and short radial ribs along its periphery.

I can find no Quaternary record of this delicate species.

Genus                    PATELLINA                    Williamson, 1858

*Patellina corrugata* Williamson

Plate 6, figs.8,9

*Patellina corrugata* Williamson, 1858, p.46, pl.3, figs.86-89; Loeblich & Tappan, 1953, p.114, pl.21, figs.4-5; Feyling-Hanssen, 1964, p.335, pl.18, fig.9; Murray, 1971, p.147, pl.61, figs.2-5; Haynes 1973, p.142, pl.16, figs.7-9, pl.15, fig.12.

Description

Test trochospiral, concavo-convex, sub-circular in outline. Periphery sub-angular, thin with  $1\frac{1}{2}$  to 2 chambers per whorl.

Chambers elongate to crescentic, biserially arranged with the internal septulae forming irregular chamberlets; earliest chamber continuous and non-septate. Dorsal side evolute and spiral; ventral side involute, umbilicate. Aperture on ventral side covered by a large flared-flap with secondary apertures visible. Test wall thin and transparent with small pits present along the outer margin of chambers on the dorsal side.

Dimensions

	9/12	9/13	L/20	16/24
maximum diameter	208 $\mu\text{m}$ .	211 $\mu\text{m}$ .	450 $\mu\text{m}$ .	140 $\mu\text{m}$ .

Material

Moderate numbers.

Provenance

L/20 Laugharne, Taf estuary, S.Wales. (not illustrated)  
fig.9 VE 57/09/89 1.8-1.9 m.  
fig.8 Aberdaron, A7

Remarks and Occurrence

This distinctive form compares well with material illustrated by many authors. Murray (1971) records this species as living an attached mode of life on the inner shelf around the British Isles. Haynes (1973) provides an extensive list of occurrences which appear to suggest it is widespread in the North Atlantic; however, he suggests that confusion with *P.advena* and *P.antarctica* may indicate a more cosmopolitan distribution than actually exists. Knudsen (1971) records single specimens in Late Quaternary deposits from Vendsyssel and the Oslofjord area (Feyling-Hanssen, 1964).

Family            NODOSARIIDAE            Ehrenberg, 1838

Genus             DENTALINA                Risso, 1826

*Dentalina frobisherensis* Loeblich and Tappan

Plate 6, fig.10

*Nodosaria mucronata* (Neugeboren) Cushman (part), 1923, p.80,  
pl.12, figs.5-7, pl.13, figs.7-9  
(not *Dentalina mucronata* Neugeboren,  
1865).

*Dentalina* sp. Cushman, 1948, p.45, pl.5, fig.6.

*Dentalina frobisherensis* Loeblich & Tappan, 1953, p.55, pl.10,  
figs.1-9; Knudsen, 1971, p.200,  
pl.3, fig.2 (with extended synonymy)

Description

Test large, elongate, nearly straight sided, tapering. Rounded in section, with 11 chambers visible, increasing in height

as added so that the final chamber is about  $1\frac{1}{2}$  times as long as it is broad. Sutures distinct, flush, very nearly horizontal but tending to become oblique and higher on the apertural side. Aperture terminal (broken), consisting of a series of radiating slits slightly eccentric of centre towards the shorter (inner) margin.

#### Dimensions

length 1.15 mm., maximum diameter 255  $\mu$ m.

#### Material

Limited numbers only.

#### Provenance

VE 57/-09/60 <sup>a</sup>/4 24-26 cm. 'inner'

#### Remarks and Occurrence

This form is distinguished by its nearly straight to slightly arcuate test, nearly horizontal sutures and eccentric terminal aperture. The typical test length is just over 1 mm. and is within the paratype length range of 0.81 mm. to 4.73 mm. quoted by Loeblich and Tappan (1953) for material from Frobisher Bay, Baffin Island and from off Point Barrow, Alaska. Other modern records confirm this arctic distribution eg. Saidova (1961) from the Okhotsk Sea and at Kamtchatka; Nagy (1965) off Spitsbergen; Leslie (1965) and Wagner (1968) from arctic waters.

Quaternary records include the Postglacial warm interval of eastern Spitsbergen (Feyling-Hanssen, 1964b) and the Quaternary of Siberia (Gudina, 1969). Knudsen (1971) reports a single specimen from boring no.V1 at Sandnes, Norway; from the Older *Yoldia* Clay of Hirtshals (zones A,C & D) and a single specimen from the *Portlandia arctica* Zone of the Skærumhede boring, Vendsyssel.

*Dentalina inornata bradyensis* (Dervieux)

Plate 6, fig.11

*Nodosaria communis* d'Orbigny, Brady, 1884, p.504, pl.62, figs.19, 20 (not *Nodosaria* (*Dentalina*) *communis* d'Orbigny, 1826).

*Nodosaria inornata* d'Orbigny var. *bradyensis* Dervieux, 1894, p.610

*Dentalina inornata* d'Orbigny var. *bradyensis* (Dervieux) Barker, 1960, p.310, pl.62, figs.19,20.

*Dentalina inornata bradyensis* (Dervieux) Feyling-Hanssen, 1964, p.272, pl.9, fig.8 (with extensive synonymy).

#### Description

Test large, elongate, gently arcuate. Chambers sub-ovate to rounded, about twice as long as wide, numbering 7 in total. Periphery slightly lobate along the inner margin, more distinctly so along the outer margin. Sutures distinct, incised, gently



curved and oblique to the periphery at approximately 45° to the horizontal. Aperture terminal, slightly off-set towards the inner margin.

Dimensions

length 2.35 mm., maximum diameter 408 μm.

Material

Single specimen only.

Provenance

VE 56/-09/142<sup>b</sup>/6 22-25 cm.

Remarks

The synonymy of this species is rather complex and I have retained Feyling-Hanssen's (1964) name here; although a binomial approach in the form of *Dentalina bradyensis* (Dervieux) might be preferable, but requires further investigation. However, unlike Feyling-Hanssen's specimens, the present form does not exhibit the almost horizontal sutures towards the aperture, as he describes, and in this respect is closer to *D.communis* d'Orbigny. Fortunately, d'Orbigny stressed some of the important features of the latter and Feyling-Hanssen (1964, p.272) has expanded upon these; suffice to say that the present form is precluded from *D.communis*, a species with which it has so often been confused in the past.

Occurrence

According to the literature this sub-species appears to be distributed in temperate waters at the present day; although Nørvang (1945, p.14) has recorded it as rare from north and north west Iceland. Feyling-Hanssen (1964) records it as rare in Holocene sediments (Zone F) of the Oslofjord area.

*Dentalina ittai* Loeblich and Tappan

Plate 6, fig.12

*Nodosaria calomorpha* Reuss, Earland, 1933, p.117, pl.4, fig.19  
(not *Nodosaria calomorpha* Reuss, 1866).

*Dentalina* cf. *calomorpha* (Reuss) Cushman, 1948, p.44, pl.5, figs. 4-5; Cushman & McCulloch, 1950, p.317, pl.41, fig.6 (not *Nodosaria calomorpha* Reuss, 1866).

*Dentalina ittai* Loeblich & Tappan, 1953, p.56, pl.10, figs.10-12; Feyling-Hanssen, 1964, p.273, pl.9, figs.1,2.

Description

Test elongate, arcuate, uniserial, consisting of 5 sub-ovate chambers. Sutures distinct, constricted normal to the long axis.

Chambers overlapping slightly at base and truncated. Test wall smooth, finely perforate. Aperture terminal, central, slightly produced, radiate.

Dimensions

length 355  $\mu\text{m}$ ., maximum diameter 70  $\mu\text{m}$ .

Material

Two specimens only.

Provenance

VE 56/-09/142 <sup>b</sup>/6 8-10 cm.

Remarks

This form, although somewhat smaller than the specimens described by Loeblich and Tappan (1953) from the west shore of Frobisher Bay and those of Feyling-Hanssen (1964) from the Late Quaternary of the Oslofjord area, is nearly identical in every other respect. In fact Feyling-Hanssen (1964) does quote the length of an unfigured, five chambered specimen from Zone F of boring no.3 at Fornebo to be 0.47 mm.. For further comments on this species the reader is referred to Loeblich and Tappan (1953) and Feyling-Hanssen (1964).

Occurrence

This would appear to be a cold water taxon with records from the Arctic (eg. Cushman & McCulloch, 1950; Cushman, 1948; Leslie, 1965; and Nagy, 1965) and sub-Antarctic waters around South Georgia (Earland, 1933). There are also other Pacific and South Atlantic records and Brady's (1884, pl.61, figs.23-27) *N.calomorpha* Reuss, for example, may belong here.

Quaternary records include the Late Quaternary of the Oslofjord area (Feyling-Hanssen, 1964) and zones C,D & F at Hirtshals.

*Dentalina pauperata* d'Orbigny

Plate 6, figs.13,14

*Dentalina pauperata* d'Orbigny, 1846, p.46, pl.1, figs.57-58;  
Loeblich & Tappan, 1953, p.201,  
pl.9, figs.7-9; Knudsen, 1971,  
p.201, pl.3, figs.3,4 (with  
extensive synonymy).

Description

Test large, elongate, cylindrical. Chambers inflated, somewhat wider than high, numbering 4 in total. Suture distinct, slightly impressed and nearly horizontal. Basal spine present, very small. Aperture terminal, consisting of 8 radiating slits. Test wall smooth, very robust, finely perforate.

Dimensions

length 1.47 mm., maximum diameter 533  $\mu\text{m}$ .

#### Material

Single specimen only.

#### Provenance.

VE 56/-09/142 f/6 10-12 cm.

#### Remarks

This robust form with its distinctive basal spine and horizontal sutures agrees well with Loeblich and Tappan's (1953) description and illustrations of material from the Arctic. Care should be taken if one wishes to distinguish it from *D. baggi* Galloway and Wissler, the latter is very similar to *D. pauperata* except that it lacks the small basal spine. The reader is referred to Barker's (1960, p.x-xi) "notes on species figured in text of Challenger report" for further discussion on this species and the possibility that *D. pauperata* of Loeblich and Tappan (1953), with its distinctive basal spine, is a new species. Barker suggests that d'Orbigny's species *pauperata*, as figured by Brady (1884, fig.14), properly belongs to the genus *Stilostomella* Guppy, 1894.

#### Occurrence

Equating the suggested modern boreo-arctic affinity of this species (Nørvang, 1945) with its supposed Miocene types of the Vienna Basin need not be problematic if Barker (1960) is correct in his view of this species as 'new'.

Quaternary records are rare and include: Gudina (1966) who reports two specimens from the "penultimate Interglacial of Siberia". Knudsen (1971) records a single specimen from boring no. VI at Sandnes, a few specimens from the Older *Yoldia* Clay and the *Portlandia arctica* zone of the Skærumhede boring of Vendsyssel. The Danish and Norwegian Quaternary occurrences of *D. baggi* are similar to those of *D. pauperata*, although the latter is somewhat less frequent.

*Dentalina subarcuata* (Montagu)

Plate 6, fig.15

*Nautilus subarcuatus* Montagu, 1803, p.198, pl.6, fig.5.

*Dentalina subarcuata* (Montagu) Murray, 1971, p.79, pl.30, figs.4-5

#### Description

Test elongate, slightly arcuate with a distinctly lobate outer periphery and a smoother inner periphery. The chambers, which number 5, are inflated, sub-ovate, produced apically and somewhat laterally compressed. Sutures distinct, deeply incised and oblique to the periphery at between 20°-40° to the horizontal. The final chamber is about 1 1/2 times as long as broad. Aperture terminal, eccentric and consists of a series of radiating, elongate slits.

#### Dimensions

length 860 μm., maximum diameter 160 μm.

Material

Limited numbers only.

Provenance

VE 57/-09/89 0.60-0.65 m.

Remarks and Occurrence

This specimen is nearly identical in size and form to *Dentalina subarcuata* (Montagu) as figured by Murray (1971). Unfortunately, I have not yet had the opportunity to view Montagu's (1803, pl.6, fig.5) illustration of *Nautilus subarcuatus* but on the basis of Murray's description and figures the present form is assigned here. As Haynes (1973) mentions, *D.subarcuata* as illustrated by Williamson (1885) probably belongs to the *D.trondheimensis* group; the latter species differs primarily in its distinctive basal spine.

The types come from Sandwich, Kent. Murray (1971) notes the occurrence of dead specimens from the English Channel, south of the Lizard.

*Dentalina trondheimensis* Feyling-Hanssen

Plate 6, fig.16

*Dentalina trondheimensis* Feyling-Hanssen, 1964, p.275, pl.9, figs.3-7.

*Dentalina* cf. *trondheimensis* Feyling-Hanssen, Haynes, 1973, p.80, pl.16, fig.11.

Description

Test elongate, nearly straight, consisting of 3 sub-ovate chambers. Test slightly compressed following the globular proloculus with its stout, tapering basal spine. Sutures distinct, incised, oblique at approximately 20°-30° from the horizontal. Inner margin nearly straight, outer margin slightly lobate. Aperture terminal, distinctly produced and slender, off-set along the inner margin.

Dimensions

length 400 μm., maximum diameter 90 μm.

Material

Limited numbers only.

Provenance

VE 56/-09/142<sup>b</sup>/6 89-91 cm.

Remarks

This form is tentatively assigned to Feyling-Hanssen's species on the assumption that the specimen described and illustrated here represents a juvenile. However, with a maximum diameter of only 90 μm. it may not belong here? It differs from

*D.drammenensis* Feyling-Hanssen in that its initial spine is well developed but otherwise, particularly in view of its size and number of chambers, would be equally well placed here.

#### Occurrence

The original description is of a specimen from the Holocene zone C of boring no.1 at Lademoen Church, Trondheim, Norway; hence the derivation of the name. Other Quaternary records include the Late Quaternary of the Oslofjord area (Feyling-Hanssen, 1964) and zones F3 and F4 of Eemian sediments at Fjøsanger, western Norway (Mangerud *et al.*, 1981). *D.drammenensis* occurs in the Holocene of the Oslofjord area and is discussed by Feyling-Hanssen (1964).

#### *Dentalina* sp.A

Plate 6, figs.17,18,19

#### Description (fig.17)

Test large, elongate, nearly straight but with a lobate periphery. Chambers inflated, numbering 8 in total, nearly spherical, final chambers tending to increase in height. Sutures distinct, impressed, sub-horizontal but somewhat oblique initially. Ornamented by longitudinal costae which are continuous from the initial small, basal spine. Aperture terminal, eccentric, as a series of elongate, radiating slits.

#### Dimensions

	fig.17	figs.18,19
length	1.95 mm.	677 $\mu$ m.
maximum diameter	364 $\mu$ m.	246 $\mu$ m.

#### Material

Two specimens only.

#### Provenance

figs.18,19	VE 57/09/32 <sup>a</sup> /6	0-10 cm.
fig.17	VE 57/10/17 <sup>a</sup> /4	50-55 cm.

#### Remarks

If one follows Loeblich and Tappan (1986, p.241) then this is the only species which rightfully belongs to the genus *Dentalina* in the present study, on the basis of its longitudinal costae.

Family            VAGINULINIDAE            Reuss, 1860  
 Genus            AMPHICORYNA            Schlumberger, 1881

*Amphicoryna scalaris* (Batsch)

Plate 7, figs.1,2,3,4

*Nautilus* (*Orthoceras*) *scalaris* Batsch, 1791, pp.1,4, pl.2, figs.4a,b.

*Nodosaria scalaris* (Batsch) Brady, 1884, pl.63, figs.28-31; Cushman, 1923, p.81; Buchner, 1940, p.404, pl.1, figs.1-19.

*Lagenonodosaria scalaris* (Batsch) Parker, 1958, p.258, pl.1, figs.32,33.

*Amphicoryna scalaris* (Batsch) Barker, 1960, pl.63, figs.28-31, pl.65, figs.7-9; Knudsen, 1971, p.204, pl.3, fig.8, pl.16, fig.1; Murray, 1971, p.77, pl.29, figs.1-4.

#### Description

Test elongate, circular in section. Chambers inflated, broadest near base with thin longitudinal costae which appear to be continuous from preceeding chambers. Chambers arranged uniseriably, following a large, globular proloculus with basal projection. Sutures distinct, constricted. Aperture terminal with very finely toothed phialine lip at the end of a long and slender neck (c. 1/2 length final chamber) which may be smooth or have fine, irregular transverse rings. Test wall calcareous, perforate hyaline.

#### Dimensions

	fig.3(broken)	3/25	3/26
length	375 $\mu$ m.	520 $\mu$ m.	520 $\mu$ m.
maximum diameter	195 $\mu$ m.	190 $\mu$ m.	175 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

VE 56/-09/142 <sup>b</sup>/6 63-67 cm.

#### Remarks

Nearly all the specimens examined were of the megalospheric generation and only a single, possibly microspheric form was observed (fig.4). The latter are beautifully illustrated by Buchner (1940, pl.1, figs.1-11) and are sometimes assigned to Jones and Parker's (1860) *Marginulina falx*. The broken specimen illustrated (fig.3) may well be derived from a larger specimen of the type illustrated by Buchner (pl.1, fig.16) and assigned by him to *N.scalaris* var. *seperans* Brady. However, the present form differs from Brady's (1884) "var. *seperans*", as illustrated by

Loeblich and Tappan (1988, pl.450, fig.15 = *A.seperans* (Brady) Holocene, Pacific), in that the longitudinal costae are continuous. The subdivision of Feyling-Hanssen's (1964) material from the Late Quaternary of the Oslofjord area into *A. cf. perversa* (Schwager) and *A.scalarlis* (Batsch) forma *compacta* Parr is not warranted here, although the degree of variation present might accomodate both these forms.

#### Occurrence

British records point to this being a shelf species and it appears to be widespread in its distribution. Quaternary records include the Holocene of the Oslofjord area and the Lateglacial of Vendsyssel, Denmark (Knudsen, 1971).

Family	LAGENIDAE	Reuss, 1862
Genus	LAGENA	Walker & Jacob, 1798

*Lagena clavata* (d'Orbigny)

Plate 7, fig.5

*Oolina clavata* d'Orbigny, 1846, p.24, pl.1, figs.2-3.

*Lagena vulgaris* Williamson var. *clavata* (d'Orbigny) Williamson, 1858, p.5, pl.1, fig.6.

*Lagena clavata* (d'Orbigny) Goës, 1894, p.75, pl.13, figs.725-727; Buchner, 1940, p.416, pl.2, figs.28-30; Feyling-Hanssen, 1964, p.285, pl.11, fig.4; Murray, 1971, p.81, pl.31, figs.1-3; Haynes, 1973, p.81, pl.12, fig.1, pl.13, fig.1.

#### Description

Test smooth, elongate, "shaped like a slender Greek amphora" (Haynes, 1973, p.81), about 4 times as long as wide. Rounded in section, greatest diameter  $\frac{1}{3}$  length from base. Aperture terminal, very small with a phialine lip at the end of a long, slender neck. Test calcareous, perforate hyaline and smooth.

#### Dimensions

length 660  $\mu\text{m}$ .; maximum diameter 170  $\mu\text{m}$ .

#### Material

A common taxon, but never abundant.

#### Provenance

VE 57/-09/46 <sup>a</sup>/6 47-51 cm.

#### Remarks

Although readily identified by its clavate outline, this species can sometimes be a difficult form to separate from specimens assigned to *Lagena* cf. *gracillima* of the present study. The latter species does tend to have a longer basal tube-like projection and a more symmetrical form. The long slender neck of this species is often broken, as with many of the species of this genus; this can make identification difficult.

I am in disagreement with Haynes' remarks (p.82), not with regards to the internal structure of the lamellar test wall, but that there is a possibility that *L.clavata* is synonymous with *L.laevis*. This seems unlikely, since the latter is nearly always more globose and tends to be basally inflated, as well as lacking the basal tube-like projection of *L.clavata*.

#### Occurrence

Haynes (1973) provides a useful list of British and foreign records and notes the tendency in distribution towards high latitudes.

*Lagena distoma* Parker and Jones, MS., Brady

Plate 7, fig.6

*Lagena laevis* Walker & Montagu, var. *striata* Parker & Jones, 1857, p.278, pl.11, fig.24.

*Lagena distoma* Parker & Jones, MS., Brady, p.467, pl.48, fig.6; Feyling-Hanssen, 1964, p.286, pl.11, figs.6-8 (with extensive synonymy).

#### Description

Test very slim and elongate, circular in section, very gently tapering assymmetric fusiform in side view with basal spine and neck (both broken). Fine longitudinal striae, numbering about 18-20 in any one section, are discontinuous and very slightly curving; they do not extend onto the neck or basal spine.

#### Dimensions

length 730  $\mu$ m.; maximum diameter 91  $\mu$ m.

#### Material

Limited numbers only.

#### Provenance

VE 56/-09/142 <sup>b</sup>/6 22-25 cm.

#### Remarks and Occurrence

This form can be difficult to distinguish from *L.mollis* and as discussed by Feyling-Hanssen (1964, p.286) these forms may simply represent morphological extremes within a transitional series. However, I feel sufficiently confident in being able to distinguish these forms as distinct, much as Feyling-Hanssen concluded. *Lagena mollis* appears to be the more common of the two



species.

There are few references to this form in the literature; it is a rare species in the Late Quaternary of the Oslofjord area (Feyling-Hanssen, 1964).

*Lagena elongata* (Ehrenberg)

Plate 7, fig.7

*Miliola elongata* Ehrenberg, 1844, p.274.

*Lagena clavata* (Ehrenberg) Brady, 1884, p.457, pl.56, fig.29.

*Lagena gracillima* (Seguenza) Brady, 1884, pl.56, figs.27,28 (not *L.gracillima* Seguenza, 1862).

*Lagena elongata* (Ehrenberg) Flint, 1899, p.306, pl.53, fig.1;  
Buchner, 1940, p.413, pl.2, figs.23,  
24; Feyling-Hanssen, 1964, p.287,  
pl.11, fig.9.

#### Description

Test highly elongate, slender. Sides obviously parallel over central portion, circular in section. Elongate neck and basal spine (broken). Aperture terminal with 4 digitate tooth structures extending over it. Surface smooth.

#### Dimensions

length 282  $\mu\text{m}$ .; maximum diameter 38  $\mu\text{m}$ .

#### Material

Single specimen only.

#### Provenance

VE 56/-09/142 <sup>a</sup>/6 67-69 cm.

#### Remarks

It is with interest that I read the synonymy of this species according to Feyling-Hanssen (1964) and noted that Brady's (1884) specimens, assigned to both *L.clavata* and *L.gracillima*, were included here. During the course of this study I have assigned this specimen to both these species, before finally placing it within *L.elongata*. In many ways this illustrates the variation and gradation in morphology that exists between these forms. However, *L.elongata* in this study is most easily distinguished by its parallel sides and distinctive aperture.

#### Occurrence

Knudsen (1971) reports a single broken specimen from the Older *Yoldia* Clay at Hirtshals, while Feyling-Hanssen (1964) reports a very few specimens from the Late Quaternary deposits of the Oslofjord area.

*Lagena flatulenta* Loeblich and Tappan

Plate 7, fig.8

*Lagena laevis* (Montagu) Cushman, 1913, p.5, pl.38, fig.5; 1948,  
p.47, pl.5, fig.11(?) (not  
*Vermiculum laeve* Montagu, 1803).

*Lagena flatulenta* Loeblich & Tappan, 1953, p.60, pl.11, figs.9,10  
(with extensive synonymy).

Description

Test globular, flask-shaped, with a broadly rounded base and moderately short, rather delicate neck. Aperture terminal, simple with a distinctive phialine lip. Test smooth, hyaline.

Dimensions

overall length 264  $\mu\text{m}$ .; chamber length 185  $\mu\text{m}$ .; maximum diameter 157  $\mu\text{m}$ .

Material

Single specimen only.

Provenance.

VE 56/-09/142 <sup>a</sup>/6 67-69 cm.

Remarks and Occurrence

The present form closely resembles the illustrated specimens of Loeblich and Tappan (1953) from Frobisher Bay, North Alaska, North West and North Greenland. The single specimen recorded here is, however, somewhat more globose and has a shorter neck. I can find no N.W. European record of this species and it may well be that similar specimens have been included with *L.laevis*. Loeblich and Tappan do not give the derivation of the species name!

*Lagena cf. gracilis* Williamson *sensu* Feyling-Hanssen

Plate 7, fig.9

*Lagena cf. gracilis* Williamson, Feyling-Hanssen, 1964, p.287,  
pl.11, fig.10.

Description

Test elongate, sub-fusiform with a long elongate neck (broken) and short basal spine. Greatest diameter below mid-point, tapering strongly towards sub-acuminate base. Some 20 moderately distinct longitudinal costae present, of which 8 are continuous from the base for some distance onto the neck. Aperture terminal, simple.

Dimensions

overall length 336  $\mu\text{m}$ .; chamber length 240  $\mu\text{m}$ .; maximum diameter 112  $\mu\text{m}$ .

Material

A single specimen only.

Provenance

VE 57/-10/17

Remarks

The present form bears a strong resemblance to the specimen illustrated by Feyling-Hanssen (1964; pl.11, fig.10) from the Postglacial zone E of Sandefjord and is somewhat atypical of *L.gracilis* s.s. in that it possesses a larger number of longitudinal costae (cf. Murray, 1971; pl.31, fig.5). It is readily distinguished from *L.mollis*, the nearest morphological type in this study, by its more inflated, assymmetrically fusiform test.

Occurrence

A number of Recent records exist from around the British Isles. It appears to be rare in Quaternary sediments as mentioned by Feyling-Hanssen (1964, p.288).

*Lagena gracillima* (Seguenza)

Plate 7, figs.10,11

*Amphorina gracillima* Seguenza, 1862, p.51, pl.1, fig.37.

*Lagena gracillima* (Seguenza) Brady, 1884, p.456, pl.56, figs.21-22 24-26; Buchner, 1940, p.415, pl.2, figs.26-27 (?25); Loeblich & Tappan, 1953, p.60, pl.11, figs.1,4 (?not 2, 3); Feyling-Hanssen, 1964, p.288, pl.11, fig.11; Knudsen, 1971, p.206, pl.4, fig.1.

Description (fig.10)

Test well developed fusiform (spindle-shaped) with extremely delicate, elongate neck and basal spine. Maximum diameter at mid-length, circular in section. Aperture terminal and simple with a thin phialine lip. Test smooth, finely perforate and very thin walled.

Dimensions

	fig.10	fig.11
length	435 $\mu$ m.	640 $\mu$ m.
maximum diameter	109 $\mu$ m.	130 $\mu$ m.

Material

Moderate numbers.

Provenance

VE 56/-09/142 <sup>e</sup>/6 23-25 cm.

#### Remarks and Occurrence

This would appear to be an essentially cold water taxon from its Recent and Quaternary records (see Knudsen, 1971, p.206 for a brief review); although it was originally described from the Tertiary sediments of Messina and subsequently recorded from the Mediterranean by Buchner (1940). Its distribution in the present study confirms the suggested cold water preference.

#### *Lagena hispida* Reuss

Plate 7, fig.12

#### Description

Test ovate with elongate neck. Greatest diameter at mid-length, base bluntly rounded, tapering towards the neck. Test wall finely hispid. Neck elongata, about  $\frac{1}{2}$  the length of the test, with an extremely fine, continuous spiral of costae along its whole length. Aperture terminal with well developed phialine lip.

#### Dimensions

length 700  $\mu\text{m}$ .; maximum diameter 200  $\mu\text{m}$ .

#### Material

Two specimens only.

#### Provenance

VE 57/-09/46 0.05-0.10 m.

#### *Lagena hispidula* Cushman

Plate 7, fig.13

#### Description

Test ovate, sub-globular with an elongate neck and fine hispid ornament. Greatest diameter near mid-length, base rounded, tapering towards and continuing to do so along the length of the neck. Aperture terminal and simple.

#### Dimensions

length 500  $\mu\text{m}$ .; maximum diameter 235  $\mu\text{m}$ .

#### Material

Single specimen only.

#### Provenance.

VE 56/-09/142 <sup>a</sup>/6 67-69 cm.

*Lagena laevis* (Montagu)

Plate 7, figs.14,15,16

*Vermiculum laeve* Montagu, 1803, p.524, pl.1, fig.9.

*Lagena laevis* (Montagu) Williamson, 1848, p.12, pl.1, figs.1-2;  
Loeblich & Tappan, 1953, p.61, pl.11  
figs.5-8; Feyling-Hanssen, 1964,  
p.289, pl.11, figs.13-15; Haynes,  
1973, p.84, pl.12, fig.2.

*Lagena vulgaris* Williamson, 1858, p.4, pl.1, figs.5,5a (as  
'typica' form).

#### Description

Test an assymmetric oval (egg-shaped) with tapering, long, slender neck. Test length over twice as long as wide, greatest diameter at about  $\frac{1}{3}$  length from base. Base broadly rounded, tapering chamber giving way to a long, slender neck with simple terminal aperture. Test wall calcareous, very finely perforate, hyaline and smooth.

#### Dimensions

	fig.15	fig.16	fig.14
length	550 $\mu\text{m}$ .	615 $\mu\text{m}$ .	460 $\mu\text{m}$ .
maximum diameter	240 $\mu\text{m}$ .	285 $\mu\text{m}$ .	180 $\mu\text{m}$ .

#### Material

Common, but never very abundant.

#### Provenance

VE 57/-09/46 <sup>a</sup>/6 72-75 cm.

#### Remarks

This species is readily distinguished from other forms of *Lagena* in this study by its simple outline. It differs from *L.flatulenta* in its more slender form, although some specimens included here are more globose than others and, as Loeblich and Tappan (1953, p.62) remark, these two species have been confused in the past. Deformed specimens, such as Murray (1971, pl.32, fig. 6) illustrates, may belong here but are atypical of the present material.

#### Occurrence

As discussed by Haynes (1973, p.85) there are a very large number of world-wide citations which, as yet, remain unvalidated. There does appear to be a concentration of North Atlantic and Arctic records. Quaternary records are discussed briefly by Knudsen (1971), although it never occurs in high frequencies.

*Lagena mollis* (Cushman)

Plate 7, figs.17,18,19

*Lagena distoma* Parker & Jones, Buchner, 1940, p.414, pl.2, fig.22  
(?20,21).

*Lagena gracillima* (Seguenza) var. *mollis* Cushman, 1944, p.21,  
pl.3, fig.3.

*Lagena mollis* Cushman, Loeblich & Tappan, 1953, p.63, pl.11,  
figs.25,27 (?26); Feyling-Hanssen,  
1964, p.290, pl.11, figs.16-19;  
Knudsen, 1982, pl.14:10, fig.12.

#### Description

Test elongate, fusiform with basal spine (broken) and long, slender neck. Sides nearly parallel over much of the central area with about 20 longitudinal, very fine costae which extend from the beginning of the basal spine to the base of the neck. Aperture terminal, broken.

#### Dimensions

	fig.17	fig.18
length	550 $\mu$ m.	420 $\mu$ m.
maximum diameter	90 $\mu$ m.	90 $\mu$ m.

#### Material

A few specimens only.

#### Provenance

VE 57/-09/89 2.25-2.35 m.

#### Remarks

The three species *L.mollis*, *L.distoma* and *L.gracilis* can be difficult to distinguish, and transitional forms do occur. The present form is distinguished from *L.gracilis* by its parallel sided central portion and more symmetrical test form. It differs from *L.distoma* in that the latter appears to have a longer, more elongate test which lacks the symmetry of *L.mollis*. As discussed by Feyling-Hanssen (1964, p.286) these forms may be synonymous, although as he states of his material from the Late Quaternary sediments of the Oslofjord area "there never arose any doubt about whether to place a specimen in *L.distoma* or in *L.mollis*". This view was partly aided by the exclusion of the elongate specimen illustrated by Loeblich and Tappan (1953; pl.11, fig.26) from his synonymy of *L.mollis* and its transfer into synonymy with *L.distoma*. The specimens illustrated here are very close in size and form to the broken specimens illustrated by Knudsen (1982) from zone 3, Solberga.

#### Occurrence

Moderate numbers were recovered by Feyling-Hanssen (1964) from the Quaternary deposits of the Oslofjord area. It is reported to be rare in the Older *Yoldia* Clay at Hirtshals, North Jutland (Knudsen, 1971). Loeblich and Tappan (1953) suggest that its modern distribution is within Arctic and sub-Arctic waters.

*Lagena parri* Loeblich and Tappan

Plate 7, fig.20

*Lagena laevis* (Montagu) var. *baggi* Cushman & Gray, Cushman & McCulloch, 1950, p.342, pl.45, fig.17 (not Cushman & Gray, 1946).

*Lagena parri* Loeblich & Tappan, 1953, p.64, pl.11, figs.11-13.

#### Description

Test sub-globose, elongate egg-shaped, with a slightly flaring, short basal spine and long slender neck. Greatest test diameter near basal  $\frac{1}{3}$ , tapering towards the neck; base broadly rounded. Aperture terminal with thickened, but rather poorly developed phialine lip. Test calcareous, finely perforate, hyaline and smooth.

#### Dimensions

length 470  $\mu\text{m}$ .; maximum diameter 150  $\mu\text{m}$ .

#### Material

Single specimen only.

#### Provenance

VE 57/-09/46 <sup>d</sup>/6 63-66 cm.

#### Remarks

The specimen illustrated closely resembles Loeblich and Tappan's Arctic material (especially fig.13) although it is somewhat smaller. It seems likely that specimens lacking the basal spine (due to damage) may be confused with *L.laevis*, although the latter can be distinguished in that it lacks the phialine lip of this form.

#### Occurrence

Infrequently recorded, the original description of this species by Loeblich and Tappan is based on material from the Bartlett collection from Frobisher Bay at water depths between 14 m. and 55 m.. The specimen illustrated by Cushman and McCulloch (1950) comes from the Allan Hancock collection of material from the Pacific. I can find no reference to this species occurring in Quaternary sediments from N.W. Europe.

*Lagena perlucida* (Montagu)

Plate 7, fig.21,22

*Vermiculum perlucidum* Montagu, 1803, p.525, pl.14, fig.3.

*Lagena perlucida* (Montagu) Brown, 1844, p.3, pl.56, fig.29; Murray, 1971, p.85, pl.33, figs.1-3; Haynes, 1973, p.86, pl.12, fig.5, pl.13, fig.5 (with extended synonymy).

#### Description

Sub-globular test with flattened base, tapering towards a stout neck. Greatest diameter below mid-point. Strong longitudinal costae, numbering 14, are most strongly developed towards the base but give way to a gently convex flattened area terminally. Costae vary in length, some continue onto and slowly spiral around the tapering neck. Aperture terminal with a distinctive phialine lip.

#### Dimensions

overall length 307  $\mu\text{m}$ .; chamber length 177  $\mu\text{m}$ .; maximum diameter 146  $\mu\text{m}$ .

#### Material

Two specimens only.

#### Provenance.

VE 57/-09/60 <sup>a</sup>/4 22-24 cm 'inner'

#### Remarks

As discussed by Haynes (1973), there is some confusion in the literature between *L.perlucida* and *L.semistriata*. Both forms are illustrated here and the latter is distinguished by its more elongate test, much finer and less continuous costae and narrower, smoother neck.

Buchner (1940; pl.3, figs.39-43 and 44-46) illustrates these two forms as *L.laevis* (Montagu) forma *semistriata* (Williamson) and *L.laevis* (Montagu) forma *sulcata* (Walker & Jacob); I interpret these two forms as representative of the present *L.semistriata* and *L.perlucida* respectively.

#### Occurrence

There are few records of this species outside the British Isles.

#### *Lagena semilineata* Wright

Plate 8, figs.1,2

*Lagena semilineata* Wright, 1886, p.320, pl.26, fig.7; Cushman & McCulloch, 1950, p.345, pl.46, fig. 11; Loeblich & Tappan, 1953, p.65, pl.11, figs.14-22; Feyling-Hanssen, 1964, p.291, pl.12, fig.2; Knudsen, 1971, p.209, pl.4, fig.3, pl.16, fig.2.

#### Description (fig.1)

Flask-shaped test, elongate, tapering towards an elegant neck which continues to taper towards the terminal aperture with its phialine lip. Short basal spine present. Upwards extending, broad and shallow grooves, numbering 16 in total, which extend to just over  $\frac{1}{3}$  test length from the base.



Dimensions

	fig.1	fig.2
length	600 $\mu\text{m}$ .	377 $\mu\text{m}$ .
Maximum diameter	170 $\mu\text{m}$ .	156 $\mu\text{m}$ .

Material

Moderate numbers.

Provenance

fig.1 VE 56/-09/142 <sup>b</sup>/6 89-91 cm.  
fig.2 origin unknown

Remarks

Care should be taken to observe that the longitudinal ornamentation of this species is negative and takes the form of shallow grooves (rather than costae). This feature is clearly illustrated by Knudsen (1971; pl.16, fig.2); it is readily distinguished from *L.semistriata* once this is established. The somewhat abraded specimen illustrated here lacks the basal spine and also exhibits light costae near the base of the neck; a feature which Loeblich and Tappan illustrate in some of their specimens from the Arctic.

Occurrence

Originally described from off Belfast, Northern Ireland, this form is also known from the Arctic and Pacific. Quaternary records include the Pleistocene deposits of Vendsyssel (Knudsen, 1971) and zone C of Brastad (Knudsen, 1982).

*Lagena semistriata* (Williamson)

Plate 8, fig.3

*Lagena striata* (Montagu) var *B semistriata* Williamson, 1848, p.14, pl.1, figs.9,10.

*Lagena semistriata* (Williamson) Goës, 1894, p.76, pl.13, fig.737; Haynes, 1971, p.87, pl.12, fig.6, pl.13, fig.4.

*Lagena semistriata* Williamson, Feyling-Hanssen, 1964, p.292; Murray, 1971, p.85, pl.33, figs.4-8.

*Lagena laevis* (Montagu) forma *semistriata* (Williamson) Buchner, 1940, p.418, pl.3, figs.39-43.

Description

Test elongate, ovate with flattened only slightly convex base. Greatest diameter at mid-point, tapering to a slim, elongate neck. About 20 longitudinal costae, separated by much finer and shorter costae, extend upwards from the margins of the basal area, where they are blade-like, before they fade-out at about the mid-point. The chamber remains smooth until near the base of the neck where fine, irregular costae re-appear and extend up to the

simple terminal aperture. The flattened basal area is smooth as is the remainder of the finely perforate test.

Dimensions

overall length 590  $\mu\text{m}$ .; chamber length 387  $\mu\text{m}$ .; maximum diameter 215  $\mu\text{m}$ .

Material

Rare.

Provenance

VE 57/-09/46 <sup>a</sup>/6 47-51 cm.

Remarks

As discussed earlier, this species has been confused with *L.perlucida* in the past, although in the study the two forms are readily distinguished (refer to notes on *L.perlucida*).

Occurrence

This is a shelf species with live records from S.W. Britain (Murray, 1971). Records from elsewhere include the North Sea (Voorthuysen, 1960; Haake, 1962); the Arctic and Skagerak (Goës, 1894); and the Barents Sea (Jarke, 1960).

*Lagena setigera* Millett

Plate 8, figs.4,5,6

*Lagena clavata* d'Orbigny var. *setigera* Millett, 1901, p.491, pl.8, fig.9.

*Lagena perlucida* (Montagu) var. Cushman, 1933, p.20, pl.4, figs.6-8 (not *Vermiculum perlucidum* Montagu 1803).

*Lagena setigera* Millett, ? Loeblich & Tappan, 1953, p.66, pl.11, figs.23-24; Feyling-Hanssen, 1964, p.292, pl.12, fig.3.

*Lagena gracillima* (Seguenza) Loeblich & Tappan, 1953, p.60, pl.11, fig.3 (not *Amphorina gracillima* Seguenza, 1862).

Description

Test elongate, fusiform but lacking longitudinal symmetry. Greatest diameter just below mid-length, tapering towards a robust neck. Base produced with a feint ring-like circle (possibly the remains of basal spines?). Aperture terminal with a simple phialine lip.

Dimensions

	fig.6	fig.4	fig.5
length	730 $\mu\text{m}$ .	615 $\mu\text{m}$ .	820 $\mu\text{m}$ .
maximum diameter	200 $\mu\text{m}$ .	150 $\mu\text{m}$ .	200 $\mu\text{m}$ .

#### Material

Never abundant, but reasonably common.

#### Provenance

fig.6 VE 57/-09/46 <sup>b</sup>/6 79-82 cm.  
fig.4 VE 57/-10/17 <sup>c</sup>/4 10-20 cm.  
fig.5 VE 57/-10/21 <sup>d</sup>/5 52-55 cm.

#### Remarks and Occurrence

I have followed Feyling-Hanssen's (1964) interpretation of this species which is based upon Millett's original figure of a long and slender form. I do not consider Loeblich and Tappan's (1953) figured specimens to be representative, although they do mention flask-shaped forms in their description (*op. cit.*, p.66). The present forms do however closely resemble the elongate specimen illustrated by Loeblich and Tappan (pl.11, fig.3) as *L.gracillima*; as remarked upon by Feyling-Hanssen (p.292).

This species was originally described from material collected from the Malay Archipelago. The specimen illustrated as *L.gracillima* by Loeblich and Tappan came from the Bartlett collection and was recovered from 142 m. in Frobisher Bay. I can find no British records of this species.

Quaternary records are rare; Feyling-Hanssen (1964) records it from Postglacial "warm" sediments of the Oslofjord area, while Knudsen (1971) records it from the Older *Yoldia* Clay at Hirtshals.

#### *Lagena striata* (d'Orbigny)

Plate 8, figs.7,8

*Oolina striata* d'Orbigny, 1839b, p.21, pl.5, fig.12

*Lagena striata* (d'Orbigny) Reuss, 1863, p.327, pl.3, fig.44 (not fig.45), pl.4, figs.46-47; Buchner, 1940, p.424, pl.4, figs.58-61 (not figs.54-57); Feyling-Hanssen, 1964, p.293, pl.12, figs.4-5.

*Lagena cf. striata* (d'Orbigny) Haynes, 1973, p.89, pl.12, fig.12, pl.13, figs.7-8.

*Lagena interrupta* Williamson, Murray, 1971, p.83, pl.32, figs.1-5.

#### Description

Test sub-globose, ovate in outline and circular in section. Base broadly rounded, neck slightly tapering, about  $\frac{1}{2}$  as long as the chamber. Ornament of numerous (about 36-40) fine longitudinal costae of varying length, some bifurcating, giving way to a ring of fine tubercles at the base; some extending onto the neck but quickly giving way to an hexagonal pattern. Neck hexagonal in sectional view with a terminal aperture surrounded by a slight lip.

## Dimensions

	3/2	3/3	3/4	S/19
overall length	600 $\mu\text{m}$ .	540 $\mu\text{m}$ .	515 $\mu\text{m}$ .	514 $\mu\text{m}$ .
chamber length	370 $\mu\text{m}$ .	335 $\mu\text{m}$ .	335 $\mu\text{m}$ .	328 $\mu\text{m}$ .
maximum diameter	245 $\mu\text{m}$ .	245 $\mu\text{m}$ .	220 $\mu\text{m}$ .	228 $\mu\text{m}$ .
<hr/> chamber length				
<hr/> maximum diameter	1.51	1.37	1.52	1.4

## Material

Not abundant, but fairly common.

## Provenance.

figs.7,8 VE 56/09/142 <sup>b</sup>/<sub>6</sub> 89-91 cm.  
3/4 VE 56/09/142 <sup>a</sup>/<sub>6</sub> 67-69 cm. (not illustrated)  
S/19 Holocene, Celtic Sea. (not illustrated)

## Remarks

Within the present species concept I have included forms with nearly straight longitudinal costae over the neck as well as those with a hexagonal pattern, the latter being very close to specimens illustrated by Murray (1971 = *L.interrupta*). The chambers of these specimens are somewhat more elongate than the globose type specimens, with lengths reaching up to approximately 1<sup>1</sup>/<sub>2</sub> times the diameter.

They are distinguished from the closely related forms, assigned here to *Lagena* cf. *striata*, in that the latter are more elongate and have costae composed of a double row of denticles, much as illustrated by Haynes (1973; pl.13, fig.8).

## Occurrence

Murray (1971) notes that this form is rare from S.W. Britain. Feyling-Hanssen (1964) reports its occurrence only from Holocene sediments of the Oslofjord area, while Knudsen (1971) records it as infrequent in the Late Quaternary sediments of Vendsyssel, Denmark.

*Lagena* cf. *striata* (d'Orbigny) *sensu* Haynes

Plate 8, figs.9,10

*Lagena* cf. *striata* (d'Orbigny) Haynes, 1973, p.89, pl.12, fig.12, pl.13, figs.7-8.

## Description

Test elongate, approximately 1<sup>2</sup>/<sub>3</sub> - 1<sup>3</sup>/<sub>4</sub> as long as wide, rounded in section. Base rounded, tapering slightly towards the neck. Fine longitudinal costae, numbering approximately 40, consist of a double row of denticles and join up at the base, merging into an hexagonal ornament at the base of the neck. Aperture terminal, simple.

Dimensions

	fig.10	fig.9
overall length	333 $\mu\text{m}$ .	410 $\mu\text{m}$ .
chamber length	275 $\mu\text{m}$ .	266 $\mu\text{m}$ .
maximum diameter	166 $\mu\text{m}$ .	154 $\mu\text{m}$ .
<u>chamber length</u>		
<u>maximum diameter</u>	1.66	1.73

Material

Limited numbers only.

Provenance

fig.9 VE 57/-09/46 <sup>b</sup>/6 79-82 cm.

Remarks

These specimens differ from the typical *L.striata* of this study in their more elongate tests and tend more towards an intermediate form with *L.substriata* (= *L.striata* (d'Orbigny) forma *substriata* (Williamson) of Feyling-Hanssen, 1964). Such intermediate forms have been noted previously and may yet prove to be a distinct species. The taxonomic significance of the double row of denticles along the costae also requires further investigation, but are unfortunately not readily resolved by light microscope.

*Lagena sulcata* (Walker & Jacob) var. *torquiformis* Haynes

Plate 8, fig.11

*Lagena sulcata* Wright, 1877, p.103, pl.4, fig.10; Balkwill & Wright, 1885, p.338, pl.14, figs. 1-2; Cushman, 1923, p.57, pl.11, fig.1 (not Walker & Jacob).

*Lagena sulcata* (Walker & Jacob) var. *torquiformis* Haynes, 1973, p. 93, pl.12, fig.14, pl.13, figs.9,12.

Description

Test ovate, round in section. Base broadly rounded, greatest diameter below mid-point, tapering towards a short, robust neck. Between 24 to 26 longitudinal costae, sharp near the base, flattened over the equator and towards the neck; variable length. Costae stop before meeting at base which is denticulate. The straight-sided neck is ornamented by 8 costae in a gentle spiral; aperture terminal, simple. Test wall perforate and very finely tuberculate between costae.

Dimensions

length 515  $\mu\text{m}$ .; maximum diameter 490  $\mu\text{m}$ .

Material

Single specimen only.

Provenance

Laugharne, Taf Estuary, S.W. Wales.

Remarks and Occurrence

I have had some difficulty in distinguishing members of the two species groups: *L.sulcata* (Walker & Jacob) and *L.striata* (d'Orbigny) and include this very elegant specimen, collected not from this study but from the macrotidal Taf estuary, S. Wales, as typical of the former. This particular variety, as described by Haynes (1973), appears to be restricted to the Irish Sea and Cardigan Bay; other occurrences no doubt exist and are probably listed as *L.sulcata*.

Torquiform specimens of *L.striata*, for example the beautiful illustrations of Buchner (1940; pl.4, figs.58,59), are distinguished by generally more elongate tests, longer necks and more numerous, fine longitudinal costae.

*Lagena* sp.A

Plate 8, fig.12

Description

Test an elongate oval, about twice as long as wide, with sub-rounded base and broadly rounded apex; nearly circular in section. Apertural neck short, off-set from the apex, with irregular, discontinuous costae and simple terminal opening. Longitudinal costae about as broad as high, extending from the base of the off-set neck in a gentle curve towards the base, where they give way to a ring of small spines.

Dimensions

overall length 270  $\mu\text{m}$ .; chamber length 220  $\mu\text{m}$ .; maximum diameter 120  $\mu\text{m}$ .

Material

Single specimen only.

Provenance

VE 57/-10/17

Remarks

This single specimen, possibly deformed during growth, bears some affinity to *L.striata*, although the form of the neck is very different.

*Lagena* sp.B

Plate 8, fig.13

Description

Test elongate, ovate with 6 distinctive, blade-like longitudinal costae. These costae do not meet but extend from the broadly rounded base, where they are most pronounced, onto the neck where they end to produce a pronounced 'step'. Aperture terminal (broken).

Dimensions

length 184  $\mu$ m.; maximum diameter 65  $\mu$ m.

Material

Single specimen only.

Provenance

VE 56/-09/142 <sup>a</sup>/6 67-69 cm.

Remarks

The present form is very close to the specimen illustrated by Buchner (pl.4, fig.62) and assigned by him to *L.gracillis*. However, this specimen differs considerably from the type description of the the latter species and to quote Feyling-Hanssen (1964, p.288) "Buchner (1940, p.426, pl.4, figs.62,63) described and figured an entirely different form as *L.gracilis*". However, Murray (1971, pl.31, fig.5) does figure a specimen which he assigns to *L.gracilis* and to which the present form bears some affinity, particularly in its general outline and in possessing 6 major longitudinal ribs.

Occurrence

Apart from Buchner's record which may possibly represent this form from the Sicilian coastline at depths from 28-900 m., I can find no other record of this species.

Family            POLYMORPHINIDAE    d'Orbigny, 1839  
Genus             GLOBULINA             d'Orbigny, 1839

*Globulina gibba* d'Orbigny

Plate 8, fig.15

*Polymorphina (Globulina) gibba* d'Orbigny, 1826, p.266

*Globulina gibba* (d'Orbigny) Cushman & Ozawa, 1930, p.60, pl.16,  
figs.1-4; Cushman, 1944, p.22, pl.3,  
figs.18-19; Murray, 1971, p.91,  
pl.36, figs.1-3.

#### Description

Test globose with indistinct, overlapping chambers of uncertain number; sutures flush. Test wall smooth, finely perforate. Aperture terminal, consisting of 8 radiating slits.

#### Dimensions

maximum diameter 355  $\mu$ m.

#### Material

Few specimens.

#### Provenance

VE 57/-09/60 <sup>a</sup>/4 16-18 cm. 'outer'.

#### Remarks

This species is very close to material in the Heron-Allen and Earland Type Slide Collection from the Clare Island Survey, housed at the British Museum (N.H.). These forms were variously recorded as *Polymorphina myristiformis* and *Polymorphina gibba*. The smooth, globular specimens with radiate apertures, such as the present form, clearly belong to d'Orbigny's type and are readily distinguished from the longitudinally costate, multi-apertured tests of Williamson's type material.

#### Occurrence

Knudsen (1971, p.216) discusses the fossil distribution of this taxon which appears to have an Eocene record (Cushman & Ozawa, 1930). Murray (1971) remarks on its inner shelf distribution; while Harris (1958) records it as most "regularly present" on the Scottish Shelf at water depths between 20 m. and 230 m..



*Globulina myristiformis* (Williamson)

Plate 8, figs.16,17,18

*Polymorphina myristiformis* Williamson, 1858, p.73, pl.6, figs.156, 157; Brady, 1884, p.571, pl.73, figs.9-10; Heron-Allen & Earland, 1913, p.103, pl.8, figs.18-19; Cushman, 1923, p.158, pl.41, figs.9-12.

*Globulina gibba* d'Orbigny var. *myristiformis* Williamson, Cushman, 1930, p.66, pl.16, fig.8, pl.20, fig.6; Murray, 1971, p.91, pl.36, figs.4-8.

Description

Test sub-spherical, broadly rounded at the base, truncated at apertural end. Broad, longitudinal costae, numbering 17 complete, extend from the base towards the apertural face but stop short to leave an imperforate circle with 8 apertural pores arranged inside it. Test highly perforate, hyaline.

Dimensions

	fig.16	fig.17	fig.18
length	493 $\mu$ m.	----	494 $\mu$ m.
maximum diameter	426 $\mu$ m.	425 $\mu$ m.	365 $\mu$ m.

Material

Moderate numbers.

Provenance

figs.16,17 VE 57/-09/60 <sup>a</sup>/4 16-18 cm. 'outer'  
fig.18 VE 57/-09/60 <sup>a</sup>/4 22-24 cm. 'inner'.

Remarks

There is some variation between the typically spherical form with nearly symmetrically arranged, broader costae and the somewhat more elongate, sub-ovate in section specimens which tend to exhibit irregular and discontinuous costae. It is interesting to note that Heron-Allen and Earland (1913) record this species as a typical west of Ireland species and frequently very abundant; the normal, round type with stronger costae was noted to occur in deeper water. I have compared the present species with material from the Clare Island Survey in the Heron-Allen and Earland Collection at the British Museum (N.H.) and find that the spherical forms of this study agree well with what they note as "the best specimens of the normal form" (re.ts.99).

Occurrence

This is an inner shelf species according to Murray (1971) who reports it living off Plymouth at depths between 10 m. and 60 m.. Equally, Heron-Allen and Earland's records of it from Clare Island suggest a presence in shallower waters. However, Harris (1958) reports a similar form, accounting for up to 5% of the benthic foraminifera, from the Scottish Shelf area.

Genus                   GUTTULINA                   d'Orbigny, 1839

*Guttulina* (?*Laryngosigma*) *harrisi* Haynes

Plate 8, fig.19

*Guttulina lactea* (part) Cushman & Ozawa, 1930, p.43, pl.10,  
figs.2-4 (not 1)(not Walker & Jacob)

*Guttulina* (?*Laryngosigma*) *harrisi* Haynes, 1973, p.100,  
text-fig.21, nos.1-5.

#### Description

Test elongate-ovate, about twice as long as wide; compressed and sub-ovate in sectional view. Tapering at both ends, greatest width at mid-height. Chambers inflated, 'tear-drop' shaped, increasing gradually in size as added in a guttuline (?) spiral initially, tending to become biserial. Sutures distinct, flush at first, impressed later. Test wall smooth, very finely perforate, hyaline. Aperture terminal, consisting of eight radiating slits with an internal entosolenian tube.

#### Dimensions

length = 705  $\mu$ m.                   width = 310  $\mu$ m.

#### Material

Limited numbers only.

#### Provenance

VE 57/-09/60 0.16-0.18 m.'outer'.

#### Remarks and Occurrence

Haynes (1973, p.102) discusses the problems associated with assigning a valid generic name to this form and I have simply followed his treatment here. The initial flattened guttuline spiral, followed by a later sigmoid-biserial chamber arrangement, and the distinctive entosolenian tube all agree with Haynes' description of this species. This appears to be widespread around the British Isles eg. Harris (1958) and many records of *G.lactea* may belong here.

Family                   ELLIPSOLAGENIDAE Silvestri, 1923

Genus                   OOLINA                   d'Orbigny

*Oolina acuticosta* (Reuss)

Plate 8, figs.21,22

*Lagena acuticosta* Reuss, 1862, p.305, pl.1, fig.4; Buchner, 1940,  
p.429, pl.4, figs.68,69.

*Lagena apiopleura* Loeblich & Tappan, 1953, p.59, pl.10, figs.14,

15; Feyling-Hanssen, 1964, p.284, pl.11, fig.3.

*Oolina apiopleura* (Loeblich & Tappan) Todd & Low, 1967, p.28, pl.3, fig.24.

*Oolina acuticosta* (Reuss) Knudsen, 1971, p.222, pl.6, fig.1, pl.17, fig.1.

#### Description (fig.21)

Test pyriform with flattened base, tapering upwards to a smooth collar with a short projecting neck and simple, circular aperture. Ornament of robust longitudinal costae which extend from a basal ring and are broadest at about mid-height; shorter costae may be present between them.

#### Dimensions

	2A/26	fig.21	fig.22
length	333 $\mu\text{m}$ .	400 $\mu\text{m}$ .	-----
maximum diameter	258 $\mu\text{m}$ .	250 $\mu\text{m}$ .	275 $\mu\text{m}$ .

#### Material

Moderate numbers.

#### Provenance

VE 57/09/60 <sup>a</sup>/4 35-39 cm.

#### Remarks

I have not, unfortunately, had the opportunity to view Reuss' original figure of this species which he describes from the Maastrichtian of the Netherlands. Loeblich and Tappan (1953) exclude Reuss' original form from their synonymy of *L. apiopleura* from Northern Alaska, although they do allow later assignments by other authors to this same species.

The present material, while exhibiting a distinctive entosolenian tube characteristic of *Oolina*, clearly belong to Loeblich and Tappan's species but, following arguments by Knudsen (1971, p.223) that *L. apiopleura* is a junior synonym of *L. acuticosta*, I here tentatively assign the present form to *O. acuticosta*. This is an unsatisfactory state-of-affairs in that the specific name *acuticosta* is applicable to both Late Cretaceous as well as modern Arctic specimens.

This species does exhibit some variation in the number of both primary and secondary longitudinal costae as well as the degree to which the neck and truncated base project.

#### Occurrence

It is rare in the Late Quaternary of the Oslofjord area, a few specimens are known from borings in Sandnes, Jæren and also from Karmøy (Feyling-Hanssen, 1964). It also occurs at Løkken and Hirtshals (Knudsen, 1971).

*Oolina borealis* Loeblich & Tappan

Plate 9, fig.1

*Entosolenia costata* Williamson, 1858, p.9, pl.1, fig.18.

*Lagena costata* (Williamson) Wright, 1877, p.103, pl.4, figs.11-13.

*Oolina costata* (Williamson) Parker, 1952a, p.409, pl.4, figs.20, 21; Loeblich & Tappan, 1953, p.68, pl.13, figs.4-6 (not *Oolina costata* Egger, 1857).

*Oolina borealis* Loeblich & Tappan, 1954, p.384; Feyling-Hanssen, 1964, p.310; Knudsen, 1971, p.223, pl.6, fig.2 ?, pl.17, figs.2-4 ?; Haynes, 1973, p.105, pl.14, fig.6.

#### Description

Test sub-globose, ovate with about 18 longitudinal grooves confined to the lower  $\frac{2}{3}$  of the test. Base rounded with a plugged circular area; upper part smooth with a simple, slightly produced aperture.

#### Dimensions

length 350  $\mu\text{m}$ .; maximum diameter 320  $\mu\text{m}$ .

#### Material

Single specimen only (possibly more).

#### Provenance

VE 57/-09/60 <sup>a</sup>/4 24-26 cm. 'outer'.

#### Remarks

This single specimen closely resembles the specimen described and illustrated by Haynes (1973). The detail of the apertural lip, the globose test and the relatively broad area of smooth test differs somewhat from the descriptions and illustrations of Loeblich and Tappan (1953) and subsequent authors (see Knudsen, 1971 in particular). However, I am inclined to follow Haynes and include the present form in *O. borealis*, particularly in view of the fact that our knowledge of the effects of bilocular growth and subsequent detachment on morphology is very limited and may act to change the nature of the aperture for example.

#### Occurrence

Recent records appear to be restricted to the North Atlantic (see Haynes, 1973, p.106). Quaternary records are limited in number and include subzone Am of the Oslofjord area (Feyling-Hanssen, 1964), the Older *Yoldia* Clay at Hirtshals, the Sandnes Clay and submorainic clay of the Nygaard brickworks, Karmøy (Knudsen, 1971) as well as Holocene sediments of the Kattegat (Nordberg, 1989).

*Oolina caudigera* (Wiesner)

Plate 9, figs.2,3

*Lagena* (*Entosolenia*) *globosa* (Montagu) var. *caudigera* Wiesner, 1931, p.119, pl.18, fig.214.

*Lagena* (*Entosolenia*) *ovata* (Terquem) var. *caudigera* Wiesner, 1931, p.119, pl.18, fig.215.

*Entosolenia lineata* Williamson, Cushman, 1948, p.64, pl.7, fig.5 (not *E.lineata* Williamson, 1848).

*Oolina caudigera* (Wiesner) Loeblich & Tappan, 1953, p.67, pl.13, figs.1-3; Feyling-Hanssen, 1964, p.310, pl.15, fig.3; Knudsen, 1971, p.224, pl.6, fig.3.

#### Description

Test ovate, sub-globose with distinctive basal spine and slightly raised apertural area which consists of a central depression with radiating grooves. Test smooth, finely perforate with beautiful entosolenian tube, nearly straight, extending down to the basal spine.

#### Dimensions

length 380  $\mu\text{m}$ .; maximum diameter 280  $\mu\text{m}$ .

#### Material

Relatively common.

#### Provenance

VE 57/-09/60<sup>d</sup>/4 30-33 cm.

#### Remarks

The present form is very close to *O.lineata* in general outline and internal structure, but differs in lacking the faint longitudinal striations of the latter. I am in general agreement with Loeblich and Tappan's (1953, p.67) conclusion that Wiesner's globular and ovate forms are homotypic and find similar variation within the present material.

#### Occurrence

Originally described from the Antarctic by Wiesner, subsequent records have also come from Arctic waters (eg. Cushman, 1948; Loeblich & Tappan, 1953). Knudsen (1971) notes it as commonly occurring, although always in low numbers, in the Late Quaternary sediments of Vendsyssel, Denmark; while Feyling-Hanssen (1964) reports its occurrence in Postglacial samples from Barents Island, Spitsbergen and as extremely rare in boring no.1 at Sauøya, Halden.

*Oolina* cf. *globosa* (Montagu)

Plate 9, fig.4

see *Vermiculum globosum* Montagu, 1803, p.523.

see *Lagena globosa* Montagu, Madsen, 1895, p.189.

see *Lagena globosa* (Montagu) Cushman, 1923, p.20, pl.4, figs.1-2.

see *Oolina globosa* (Montagu) Barker, 1960, pl.56, figs.1-3;  
Knudsen, 1971, p.224.

#### Description

Test globose, broadly rounded base, greatest diameter at about mid-length, tapering to a short neck and simple, circular terminal aperture. Surface appears to be smooth but S.E.M. photographs reveal an extremely fine longitudinal lineation over the central belt.

#### Dimensions

length 390  $\mu\text{m}$ .; maximum diameter 300  $\mu\text{m}$ .

#### Material

Single specimen only

#### Provenance

VE 57/-10/17

#### Remarks.

As far as I can ascertain, the faint lineation seen here has not previously been reported from this species and is only visible at high magnifications. Material in the Heron-Allen and Earland collection (= *L. globosa* Montagu) from Clare Island is very close to the present form, although lacking such a pronounced aperture.

#### Occurrence

Quaternary records are rare, although Knudsen (1971) records a few specimens from the Lateglacial *Zirfaea* layers of Vendsyssel, Denmark.

*Oolina heronalleni* Haynes

Plate 9, figs.5,6

*Lagena costata* part Heron-Allen & Earland, 1916a, p.243, pl.41, figs.17-18; part Cushman, 1923, p.12, pl.3, fig.8, after Heron-Allen & Earland (not Williamson).

*Oolina heronalleni* Haynes, 1973, p.106, pl.14, fig.7.

#### Description

Test ovate, broadly rounded base and short, very stocky neck,

bluntly terminated. Ornament of approximately 20 robust longitudinal costae which extend onto the basal area but stop before the neck. Aperture terminal, simple circular depression, test thickened around it. Large pores irregularly scattered.

#### Dimensions

	fig.5	fig.6
length	225 $\mu\text{m}$ .	238 $\mu\text{m}$ .
maximum diameter	169 $\mu\text{m}$ .	175 $\mu\text{m}$ .

#### Material

Two specimens only.

#### Provenance

VE 57/-10/17<sup>b</sup>/4 30-35 cm.

#### Remarks

The specimens illustrated here clearly exhibit longitudinal costae rather than grooves as in *O.borealis* as described above. These two species have been confused in the past as illustrated in the synonymy of *O.borealis* and discussed by Haynes (1973, p.106).

#### Occurrence

The distribution of this species is difficult to determine as a result of a failure to distinguish it from *O.borealis*. It is interesting to note that it was first recorded from the west of Scotland and subsequently by Haynes in B.M. core no.14 from Cardigan Bay.

*Oolina hexagona* (Williamson)

Plate 9, figs.7,8

*Entosolenia squamosa* (Montagu) var. *y hexagona* Williamson, 1848, p.20, pl.2, fig.23.

*Lagena hexagona* (Williamson) Brady, 1884, p.472, pl.58, figs.32,33

*Oolina hexagona* (Williamson) Voorthuysen, 1950, p.56, pl.1, fig.12; Loeblich & Tappan, 1953, p.69, pl.14, figs.1-2; Feyling-Hanssen, 1964, p.311, pl.15, fig.4; Murray, 1971, p.93, pl.37, figs.1-3; Knudsen, 1971, p.224, pl.17, fig.6; Haynes, 1973, p.107, pl.14, figs.12, 13, pl.15, figs.3,6 (with extended synonymy).

#### Description (fig.7)

Test ovate, broadly rounded base and somewhat produced neck. Ornament of well defined, regularly branching costae which give rise to an hexagonal pattern. Aperture terminal, round, surrounded by a small lip.

Dimensions

	fig.7	fig.8
length	190 $\mu\text{m}$ .	170 $\mu\text{m}$ .
maximum diameter	150 $\mu\text{m}$ .	150 $\mu\text{m}$ .

Material

Moderate numbers.

Provenance

fig.7 VE 57/10/17 <sup>a</sup>/4 20-25 cm.  
fig.8 VE 57/09/60 <sup>d</sup>/4 3-6 cm.

Remarks

The two specimens illustrated clearly belong here as do most specimens assigned to this species in the present study. However, there are problems associated with the correct identification of specimens exhibiting tiny hexagonal patterns and after comparison with illustrations by Loeblich and Tappan (1953; pl.14, figs.1,2) it may be possible to include some of the specimens described and illustrated as *O.squamosa* from the present study here?

Occurrence

A cosmopolitan taxon with an apparent preference for cooler waters as reported by Haynes (1973), who also provides a comprehensive list of its distribution. Quaternary records are limited to infrequent occurrences.

*Oolina laevigata* d'Orbigny

Plate 9, figs.9,10

*Oolina laevigata* d'Orbigny, 1839c, p.19, pl.5, fig.3; Haynes, 1973, p.108, pl.14, fig.11.

Description

Test pear-shaped, sub-globular, with broadly rounded base, tapering towards the apertural end. Maximum diameter below mid-length. Aperture terminal, produced, consisting of 8 digitate projections, separated by 8 radiating slits. Test wall smooth and glassy.

Dimensions

	fig.10(near)	fig.10(far)	fig.9
length	250 $\mu\text{m}$ .	280 $\mu\text{m}$ .	317 $\mu\text{m}$ .
maximum diameter	210 $\mu\text{m}$ .	200 $\mu\text{m}$ .	233 $\mu\text{m}$ .

Material

Limited numbers only.

Provenance

VE 57/-09/46 <sup>a</sup>/6 47-51 cm.

Remarks

Haynes (1973) proposes that the apparent lack of British



records of this species may be accounted for by confusion with *O.globosa*; although these two species differ markedly in the form of the aperture. *Oolina* cf. *globosa* of the present study differs in that it possesses a short, simple round, aperture and extremely faint longitudinal lineation over much of the chamber.

I have included a figure of a fused pair here which also show signs of having had a third specimen attached.

#### Occurrence

Originally described from the Falkland Islands and subsequently from other areas of the South Atlantic (Heron-Allen & Earland, 1932; Earland, 1934); it has also been recorded from the Scillies (Atkinson, 1970) and Cardigan Bay (Haynes, 1973). I can find no previous record from Quaternary sediments.

#### *Oolina lineata* (Williamson)

Plate 9, fig.11

*Entosolenia lineata* Williamson, 1848, p.18, pl.2, fig.18; not Cushman, 1948, p.64, pl.7, fig.5.

*Entosolenia globosa* var. *lineata* Williamson, 1858, p.9, pl.1, fig.17.

*Lagena lineata* (Williamson) Brady, 1884, p.461, pl.57, fig.13 (not *Entosolenia lineata* Williamson, 1848?); Balkwill & Wright, 1885, p.336, pl.14, figs.13-16.

*Oolina lineata* (Williamson) Loeblich & Tappan, 1953, p.70, pl.13, figs.11-13; Haynes, 1973, p.109, pl.14, figs.8-10.

#### Description

Test ovate, apertural end truncated and slightly produced, base rounded but tapering to a small spine (broken). Numerous irregular and discontinuous fine longitudinal striae cover the entire surface but are weaker towards the aperture. Apertural area raised and flattened in side view with a central depression and radiating grooves; internal tube extends down to the basal spine.

#### Dimensions

length 345  $\mu$ m.; maximum diameter 273  $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

VE 57/-10/17

#### Remarks and Occurrence

This species is readily distinguished from *O.caudigera* of the present study by its distinctive surface ornamentation of fine,

longitudinal striae. These two forms have, however, been confused in the past. Haynes (1973) reviews the distribution of this species which is well known from the Recent of the British Isles as well as occurring in the Arctic (Loeblich & Tappan, 1953; Leslie, 1965).

Knudsen (1971) records a few specimens from the Older *Yoldia* Clay of Vendsyssel as well as from Sandnes and Karmøy.

*Oolina melo* d'Orbigny

Plate 9, figs.12,13

*Oolina melo* d'Orbigny, 1839b, p.20, pl.5, fig.9; Loeblich & Tappan, 1953, p.71, pl.12, figs.8-15; Feyling-Hanssen, 1964, p.312, pl.15, figs.6-7; Knudsen, 1971, p.226, pl.6, fig.5, pl.17, fig.9; Murray, 1971, p.93, pl.37, figs.4-6.

*Entosolenia squamosa* (Montagu) var. *catenulata* Williamson, 1848, p.19, pl.2, fig.20; 1858, p.13, pl.1, fig.31.

*Entosolenia squamosa* (Montagu) var. *scalariformis* Williamson, 1848 p.20, figs.21,22.

*Lagena squamosa* (Montagu) Brady, 1884, p.471, pl.58, figs.28-31.

*Lagena catenulata* (Williamson) Cushman, 1923, p.9, pl.11, fig.11.

*Lagena melo* (d'Orbigny) Buchner, 1940, p.437, pl.6, fig.84.

*Entosolenia hexagona* Williamson var. *scalariformis* Williamson, Cushman, 1948, p.64, pl.7, fig.6a&b.

Description (fig.12)

Test globose, sub-ovate with a broadly rounded base, tapering slightly towards the terminal aperture at the end of a short, simple, circular neck. Basal depression with about 14 robust, longitudinal costae extending upwards from it; these are linked by upwardly convex, finer horizontal costae.

Dimensions

	fig.13 <sup>1</sup>	fig.13 <sup>2</sup>	fig.12
length	180 μm.	260 μm.	350 μm.
maximum diameter	140 μm.	180 μm.	300 μm.

Material

Moderate numbers.

Provenance

fig.12 VE 57/-10/17  
fig.13 VE 57/-09/46 <sup>c</sup>/6 82-87 cm.

#### Remarks

As the synonymy demonstrates, there has been considerable confusion surrounding this species arising as a result of gradational series in the number and size of both longitudinal and horizontal costae (cancelli). In this study I have followed Loeblich and Tappan's (1953) interpretation of the species and the reader is referred to the latter (pp.71-72) for further discussion of their species concept.

The present form is distinct from *O.squamosa* of this study and is readily distinguished by its nearly straight longitudinal costae and fewer horizontal costae. Thus, Haynes' (1973, p.111) view that *O.melo* as "merely a variety with straight bars instead of rounded loops" of *O.squamosa* is rejected, although gradational forms do exist.

#### Occurrence

This species appears to be widespread with records from the Arctic to the Mediterranean and is well known from British waters where Murray (1971), for example, records it as a stenohaline, inner shelf species. This appears to be an infrequent member of Late Quaternary foraminiferal assemblages from the Oslofjord area and from Vendsyssel, Denmark although occasional specimens are reported.

*Oolina scalariforme-sulcata* (Wiesner)

Plate 9, fig.14

*Lagena* (*Entosolenia*) *scalariforme-sulcata* Wiesner, 1931, p.120, pl.18, fig.219.

*Oolina scalariforme-sulcata* (Wiesner) Loeblich & Tappan, 1953, p.72, pl.13, fig.7.

#### Description

Test ovate, sub-globular in outline, octagonal in sectional view. Base broadly rounded with eight broad and robust longitudinal costae extending upwards to about  $\frac{3}{4}$  height, giving way to a sub-hexagonal ornamentation separated by strongly curved, flattened, horizontal costae. Aperture terminal, slightly produced, circular.

#### Dimensions

length 390  $\mu$ m.; maximum diameter 310  $\mu$ m.

#### Material

Single specimen only.

#### Provenance

VE 57/-09/89 1.6-1.7 m.

#### Remarks

The specimen illustrated here differs from *O.williamsoni* of this study in possessing fewer longitudinal costae, having an

octagonal rather than circular sectional view and in its broad and shallow, sub-hexagonal ornamentation at the apertural end of the test. It differs somewhat from Loeblich and Tappan's illustration in possessing a more regular ornamentation at the apertural end.

Material figured as *O. williamsoni* by Feyling-Hanssen (1964) and Knudsen (1971) appears to be closer to the present form than *O. williamsoni* of this study. Figures of the latter species by Haynes (1973) from Cardigan Bay and by Murray (1971) from S.W. Britain are distinct from this form.

#### Occurrence

Wiesner (1931) originally described this species from Antarctica, while Loeblich and Tappan's hypotype comes from Bartlett's collection from the Arctic.

#### *Oolina squamosa* (Montagu)

Plate 9, fig.15; Plate 10, figs.1,2

*Vermiculum squamosum* Montagu, 1803, p.526, pl.14, fig.2.

*Entosolenia squamosa* (Montagu) Williamson, 1848, p.18, pl.2, fig.19.

*Lagena squamosa* (Montagu) Cushman, 1923, p.51, pl.10, fig.3 (not fig.4).

*Oolina squamosa* (Montagu) Loeblich & Tappan, 1953, p.73, pl.13, figs.9-10; Haynes, 1973, p.110, pl.14, fig.14, pl.15, figs.4,5.

#### Description

Test ovate to sub-globular, with rounded base and tapering, produced apertural end. Ornament variable, consisting of numerous fine cancelli which form a nearly hexagonal pattern of randomly arranged depressions. Aperture simple, terminal, circular opening at the end of a short, smooth neck.

#### Dimensions

	fig.15	fig.1	fig.2
length	371 $\mu$ m.	400 $\mu$ m.	307 $\mu$ m.
maximum diameter	267 $\mu$ m.	260 $\mu$ m.	230 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

fig.15	VE 57/-09/60	<sup>c</sup> /4	15-18 cm.
fig.1	VE 57/-10/21	<sup>d</sup> /5	52-55 cm.
fig.2	VE 57/-09/46	<sup>a</sup> /6	47-51 cm.

#### Remarks

The specimens illustrated here are readily distinguished from *O. melo* of the present study, a species with which it has

repeatedly been confused in the past (see remarks on *O.melo*), on the basis of their randomly arranged, sub-hexagonal ornament. However, they can be difficult to separate from *O.hexagona* and a continuous series does appear to exist between these two species; cf. pl.9, fig.15 as a transitional form. *O.hexagona* does typically possess stronger cancelli, a much more readily distinguished and regular hexagonal pattern as well as lacking the produced apertural end and 'tear-drop' outline of *O.squamosa*.

I have examined specimens from the Heron-Allen and Earland Collection (Clare Island Survey, 1913) and find that material labelled *L.squamosa* fall within each of the 3 closely related species of *O.squamosa*, *O.hexagona* and *O.melo* of the present study. The specimen illustrated by Knudsen (1971; pl.17, fig.10) from the Lateglacial of Løkken has extremely thickened cancelli which give it a pitted appearance and this is atypical of the present form.

#### Occurrence

Common in the inner shelf waters surrounding the British Isles, this species also has records from the Arctic, Antarctic, South Atlantic and Pacific as listed by Haynes (1973). Care should be taken when consulting the latter author, who considers *O.melo* as simply a variety of *O.squamosa*.

Quaternary records are rare, although single specimens assigned to this species are reported by Knudsen (1971) from the *Yoldia* Clay and Older *Yoldia* Clay from the Løkken area, Vendsyssel.

*Oolina williamsoni* (Alcock)

Plate 10, figs.3,4

*Entosolenia williamsoni* Alcock, 1865, p.193.

*Lagena williamsoni* (Alcock) Wright, 1877, p.104, pl.4, fig.14.

*Oolina williamsoni* (Alcock) Voorthuysen, 1951, p.24, pl.1, fig.14; Murray, 1971, p.95, pl.38, figs.4-6; Haynes, 1973, p.111, pl.14, figs.15-17, pl.15, figs.1,2,7.

#### Description

Test ovate with broadly rounded base and produced apertural end. Approximately 22 longitudinal, relatively robust costae extend from a basal ring and may bifurcate before giving way to a 'meshed' ornament at the apertural end. Aperture terminal at the end of a slightly produced ring of smooth test.

#### Dimensions

	fig.3	fig.4
length	400 $\mu$ m.	382 $\mu$ m.
maximum diameter	280 $\mu$ m.	218 $\mu$ m.

#### Material

Moderate numbers.

Provenance

fig.3 VE 57/-09/89 1.6-1.7 m.

fig.4 Laugharne, Taf estuary, S. Wales.

Remarks

The specimens illustrated are very close to the material illustrated by Haynes (1973) from Cardigan Bay. The number of longitudinal costae may vary, but about 22 is normal; the thickness of these costae and the degree of incision of the intervening sutures also varies. I have included an illustration of a specimen from the Taf estuary, South Wales which has 'squared-off' costae and lacks the basal ring; the latter is somewhat atypical of the species.

The present species differs from *O.cf.scalariforme-sulcata* (Wiesner) of this study in having double the number of longitudinal costae, a circular sectional view and much smaller 'meshed' ornament at the apertural end.

Specimens illustrated by Feyling-Hanssen (1964; pl.15, fig.8) from the Late Pleistocene subzone Am of a boring from Sarpsborg and by Knudsen (1971; pl.18, figs.1,2) from a sample labelled "Fossiliførende melemlag" and collected by Øyen in 1904 from the Nygaard brickworks, Karmøy differ from the present form. The latter are closer to *O.cf.scalariforme-sulcata* of the present study (see remarks above), although it might be argued that the present species concept of *O.williamsoni* should be broader?

*Oolina* sp.A

Plate 10, fig.5

Description

Test elongate, ovate with strongly tapering sides towards the apertural end, base broadly rounded with slightly produced, truncate costal ring. Longitudinal costae, numbering 16 and strongly undercut, extend upwards from the basal ring, merging in the upper 1/4 of the test to produce an overlapping, flanged surface which finally gives way to a finely tuberculate surface. The costae are separated by moderately deep sutures with 9 large (c.5 µm.) pores aligned centrally. Aperture a terminal opening surrounded by a frilled collar.

Dimensions

	fig.5	2B/9
length	323 µm.	445 µm.
maximum diameter	195 µm.	236 µm.

Material

Two specimens only.

Provenance

fig.5 VE 57/-09/60 <sup>a</sup>/4 22-24 cm. 'inner'

2B/9 VE 57/-10/17 (not illustrated)

#### Remarks

While counting the samples of this study, these specimens were assigned to *Oolina* aff. *striatopunctata*; however upon closer inspection they do not appear to belong to Parker and Jones' species. As clearly illustrated by Loeblich & Tappan (1953; pl.12, figs.2-5) and Knudsen (1971; pl.17, fig.11) the latter has a row (or rows?) of pores which are intimately associated with the longitudinal costae rather than distinct from it as illustrated by the present form. Clearly then, this form requires further investigation and may possibly prove to be a distinct species.

Genus                      FISSURINA                      Reuss, 1850

*Fissurina danica* (Madsen)

Plate 10, figs.6,7

*Lagena danica* Madsen, 1895, p.196, pl.1, fig.4.

*Lagena castanea* Flint, 1899, p.307, pl.54, fig.3; Cushman, 1923, p.9, pl.1, figs.12-13; Buchner, 1940, p.496, pl.18, figs.369-373.

*Fissurina castanea* (Flint) Voorthuysen, 1950a, p.36, pl.1, fig.7, text-fig.2; Feyling-Hanssen, 1964, p.313, pl.15, figs.9-14.

*Fissurina danica* (Madsen) Knudsen, 1971, p.228, pl.6, figs.6-7, pl.18, fig.3.

#### Description

Test sub-trigonal, inflated with distinctive basal frill consisting of a double row which curves around and joins up at the sub-angular margin. Aperture a terminal slit with a distinctive, twisted entosolenian tube which flares at the end.

#### Dimensions

	fig.6	fig.7	16/15
length	180 $\mu$ m.	135 $\mu$ m.	135 $\mu$ m.
maximum diameter	170 $\mu$ m.	96 $\mu$ m.	96 $\mu$ m.

#### Material

Moderate numbers, but never common.

#### Provenance

fig.7 Aberdaron A12  
fig.6 VE 57/-09/46<sup>a</sup>/6 72-75 cm.

#### Remarks and Occurrence

The present form is placed within Madsen's species as Knudsen (1971) proposes after Voorthuysen (1950) noted similarities with *F.castanea*.

The original description was based upon material from a

number of Danish sites, including the Older *Yoldia* Clay, the Lateglacial *Yoldia* Clay and *Zirfaea* layers. It is also known from the Postglacial of the Oslofjord area (Feyling-Hanssen, 1964) and as widespread from the Quaternary deposits of Vendsyssel and zone 1 of the Sandnes Clay, but always in low frequencies.

*Fissurina elliptica* (Cushman)

Plate 10, figs.8,9,10

*Lagena orbignyana* (Seguenza) var. *elliptica* Cushman, 1923, p.42, pl.6, figs.10-12.

*Fissurina orbignyana* Seguenza, Murray, 1971, p.99, pl.40, figs.1-5

*Fissurina elliptica* (Cushman) Haynes, 1973, p.94, pl.14, fig.5, text-fig.19.

#### Description

Test sub-circular in outline with a produced and truncated apertural end. Periphery strongly carinate with a single sharp keel bordered by two secondary ones which are flared and blade-like at base becoming thickened and merging at apertural end. These secondary keels extend onto the short neck and give way to fine tuberculate ornament immediately below the everted apertural lip. Finer ridges define the changing test thickness. A basal pit with a small plug is present. Aperture terminal, lensoid and rather small, peripheral keel bifurcates around it.

#### Dimensions

	fig.8	fig.9	fig.10
length	200 $\mu$ m.	270 $\mu$ m.	277 $\mu$ m.
breadth	150 $\mu$ m.	223 $\mu$ m.	215 $\mu$ m.

#### Material

Numerous specimens.

#### Provenance

fig.8 VE 51/-07/199

figs.9,10 VE 57/-09/46 <sup>a</sup>/6 0-5 cm.

#### Remarks

This species has been confused with *F.orbignyana* in the past, but differs from that species in its well developed subsidiary keels. Both pedunculate and non-pedunculate forms occur in this study and are included within *F.elliptica*. Murray (1971; pl.40, fig.5) figures a specimen as *F.orbignyana* with well developed subsidiary keels and a basal peduncle which I consider synonymous with the present form. Buchner's (1940; pl.10, figs.157,158) '*Lagena pseudoorbignyana nov.spec. forma typica*' may also belong here?

#### Occurrence

Owing to confusion with *O.orbignyana* this is yet to be worked out in detail!



*Fissurina lagenoides* (Williamson)

Plate 10, fig.11

*Entosolenia marginata* (Montagu) var. *lagenoides* Williamson, 1858,  
p.11, pl.1, figs.25,26.

*Lagena lagenoides* (Williamson) Brady, 1884, p.479, pl.60, figs.6,  
9,12 (not 7); Buchner, 1940, p.452,  
pl.8, figs.123-126 (with extensive  
synonymy).

*Fissurina lagenoides* (Williamson) Harris, 1958, p.244, pl.21,  
fig.5.

#### Description

Test small, sub-ovate, compressed. Base broadly rounded, indented. Periphery with a sharp double keel, linked by bridges which create a series of open cells along the periphery. Additional sharp ridge on either side of the test forming a complete oval which joins the keel via the basal indentation and is linked to the neck by fine costae. Aperture terminal at the end of a short neck with a distinctly everted lip.

#### Dimensions

length 237  $\mu$ m.; width 144  $\mu$ m.

#### Material

Single specimen only.

#### Provenance

VE 57/-10/17 <sup>b</sup>/4 5-10 cm.

#### Remarks and Occurrence

This is a very distinctive form, although care should be taken to distinguish it from the more elongate, tapering *F.serrata*. Brady's (1884) specimens, although superficially similar, lack the secondary ridges and may not belong here? Buchner (1940) illustrates very similar forms from a depth of 60-90 m. from the Gulf of Naples and Harris (1958) has recorded it from off N. Scotland.

*Fissurina lucida* (Williamson)

Plate 10, figs.12,13

*Entosolenia marginata* (Montagu) var. *lucida* Williamson, 1848,  
p.17, pl.2, fig.17.

*Entosolenia lucida* (Williamson) Cushman & Cole, 1930, p.98, pl.13,  
figs.11,12.

*Lagena lucida* (Williamson) Reuss, 1862, p.324, pl.2, figs.25,26.

*Fissurina lucida* (Williamson) Bandy, 1950, p.274, pl.41, figs.12a, b; Loeblich & Tappan, 1953, p.76, pl.14, fig.4; Feyling-Hanssen, 1964, p.315, pl.15, fig.21; Haynes, 1973, p.95, pl.14, figs.1-2, text-fig.20, nos.3,4.

Description (fig.13)

Test sub-circular, compressed, periphery rounded. Base with slight peduncle, apertural end slightly produced. Test wall smooth, finely perforate; perforation densely arranged, forming a horse-shoe area which is open towards the aperture. Aperture an elongate, curved slit between flaps.

Dimensions

fig.13 length 336  $\mu\text{m}$ .; fig.12 length 272  $\mu\text{m}$ .

Material

Numerous specimens.

Provenance

fig.13 VE 57/-09/46 <sup>a</sup>/6 33-38 cm.  
fig.12 VE 57/-10/17

Remarks

This is a variable form and specimens may be nearly circular, as described, or more elongate and pyriform as illustrated. The basal peduncle is a variable feature and is often more strongly developed. This form differs from *F.semimarginata* in that the latter has a fine peripheral keel and is typically more elongate with a narrower aperture.

Occurrence

The modern distribution is discussed by Haynes (1973) who observes that there is a concentration of cool temperate to cold water records. Quaternary records include the Older *Yoldia* Clay and Lateglacial *Yoldia* Clay of Vendsyssel, Denmark (Knudsen, 1971).

*Fissurina marginata* (Walker & Boys)

Plate 10, fig.14

*Serpula (Lagena) marginata* Walker & Boys, 1784, p.3, tab.1, fig.7.

*Vermiculum marginatum* Montagu, 1803, p.524.

*Fissurina marginata* (Walker & Boys) Feyling-Hanssen, 1964, p.315, pl.15, fig.22; Haynes, 1973, p.97, text-fig.20, nos.7,8 (with extensive synonymy).

#### Description

Test small, sub-circular, biconvex, compressed. Peripheral keel blunt, thickened, bifurcating around a slight basal hollow and around the slightly produced, flattened aperture, which consists of a simple slit. Test smooth, finely perforate.

#### Dimensions

maximum diameter 250  $\mu\text{m}$ .

#### Material

Numerous specimens.

#### Provenance

VE 57/-10/17

#### Remarks

This form is distinguished by its sub-circular, biconvex test with a single, thickened peripheral keel. Specimens exhibit some variation in the degree to which the flattened aperture projects and in the development of the basal hollow, the latter may be absent in some specimens. Many authors have assigned this species to Montagu; here I follow Feyling-Hanssen (1964) in assigning it to Walker & Boys as discussed by Haynes (1973, p.98).

#### Occurrence

Murray (1971) notes this species as living on the shelf of S.W. Britain and it appears to be widespread in the North Atlantic area and Arctic. Arctic records include Cushman (1948), Loeblich and Tappan (1953), Leslie (1965) and Nagy (1965).

Quaternary records include the Late Quaternary deposits of the Oslofjord area (Feyling-Hanssen, 1964); the Sandnes Clay, Norway, the Older *Yoldia* Clay and Lateglacial *Yoldia* Clay of Vendsyssel (Knudsen, 1971).

*Fissurina quadrata* (Williamson)

Plate 10, fig.15

*Entosolenia marginata* (Montagu) var. *quadrata* Williamson, 1858, p.11, pl.1, fig.28.

*Fissurina quadrata* (Williamson) Harris, 1958, p.249, pl.21, fig.8.

#### Description

Test quadrate, compressed. Base broadly rounded with slight notch; apertural end rounded with a narrow slit. Periphery rounded, somewhat more compressed than the more inflated central area.

#### Dimensions

length 277  $\mu\text{m}$ .; breadth 170  $\mu\text{m}$ .

#### Material

Single specimen only.

Provenance

VE 56/-09/142 <sup>b</sup>/6 63-67 cm.

Remarks

This form is tentatively assigned to Williamson's species, largely on the basis of its quadrate outline. It differs from *Fissurina* sp.B of the present study which is a far more elongate form with a larger apertural slit.

*Fissurina serrata* (Schlumberger)

Plate 11, figs.1,2

*Lagena serrata* Schlumberger, 1894, p.258, pl.3, fig.7

*Entosolenia serrata* (Schlumberger) Cushman, 1948, p.63, pl.7, fig.3.

*Fissurina serrata* (Schlumberger) Loeblich & Tappan, 1953, p.78, pl.14, fig.5; Knudsen, 1971, p.231, pl.6, fig.9, pl.18, figs.4,5.

Description

Test elongate, compressed, pyriform (melon seed); lensoid in sectional view. Base broadly rounded, blunt, giving way to a sharp and narrow double keel. The keeled periphery is bridged by a number of cross connections which form a series of elongate pits; tapering towards the aperture at the end of a long, almost straight but internally concealed neck. The aperture is terminal with a fine everted lip.

Dimensions

	fig.1	fig.2
length	275 $\mu$ m.	341 $\mu$ m.
width	125 $\mu$ m.	167 $\mu$ m.

Material

Two specimens only.

Provenance

fig.1 VE 57/-10/17  
fig.2 VE 57/-09/46 <sup>b</sup>/6 68-71 cm.

Remarks and Occurrence

The present form agrees well with the figured and measured specimens of Knudsen (1971) from the Older *Yoldia* Clay of Frederikshavn and Hirtshals. As noted by Loeblich and Tappan (1953), this species bears a resemblance to *F.lagenoides* (Williamson) but is distinguished by its tapering rather than elongate neck and, as defined here, by the absence of a secondary oval ridge.

The Recent distribution includes the original description from the Arctic Ocean off Russia; from northeast Greenland by Cushman (1948); and northern Alaska at 223 m. and at shallower

depths (>21 m.) from elsewhere in the Arctic (Loeblich & Tappan, 1953).

*Fissurina* sp.A

Plate 11, fig.3

Description

Test ovate, compressed with a rounded periphery and projecting apertural end. Periphery distinctly carinate, flaring slightly towards the base, with secondary ribs bordering the periphery on either side of the test but not connected at the base or apertural end. Apertural end blunt with an elongate slit bordered by slightly everted lips, internal tube short and flared at free end.

Dimensions

length 230  $\mu$ m.

Material

Numerous specimens.

Provenance

VE 57/-10/17

Remarks

This form is far less elaborately ornamented than *F.elliptica* of the present study and is distinguished from *F.marginata* by its secondary ribs, which the latter lacks. This form may have been included with *F.marginata* (Montagu) by some authors.

*Fissurina* sp.B

Plate 11, fig.4

Description

Test quadrate, elongate, about 3 times as long as broad. Base flattened, with a small peduncle; sides sub-parallel, slightly sinuous. Apertural end broadly rounded with a large apertural slit which extends over the entire apertural breadth of the test; short and straight entosolenian tube.

Dimensions

length 293  $\mu$ m.; breadth 100  $\mu$ m.

Material

Single specimen only.

Provenance

VE 56/-09/142 <sup>b</sup>/6 89-91 cm.

Remarks

This form bears a close resemblance to *F. quadrata* of the present study but is considered a distinct form on the basis of its broad apertural slit. These rarer forms of the genus *Fissurina* clearly require further taxonomic study.

*Fissurina* sp.C

Plate 11, fig.5

Description

Test ovate, compressed. Base broadly rounded, periphery sub-rounded, tapering towards the slightly produced and truncated apertural end. Periphery bordered on either side by two elongate slits. Aperture terminal, an elongate slit bordered by two slightly everted lips.

Dimensions

length 206  $\mu$ m.

Material

Single specimen only.

Provenance

VE 57/-10/17

Remarks

This form bears a superficial similarity to *Fissurina* sp.A of the present study; the bordering peripheral slits can at first glance be easily mistaken for the secondary ridges of the latter. These two forms also differ in that the periphery of this form is rounded while that of sp.A is sharply keeled; the general test outline is very similar.

*Parafissurina fusuliformis* Loeblich and Tappan

Plate 11, fig.6

*Parafissurina fusuliformis* Loeblich & Tappan, 1953, p.79, pl.14, figs.18-19; Knudsen, 1971, p.232, pl.18, fig.6.

Description

Test elongate, slender, over 3 times as long as broad. Base rounded, greatest breadth at  $\frac{1}{3}$  test length, tapering towards the sub-acute apertural end. Aperture sub-terminal, an oval opening bordered by a large flap.

Dimensions

length 244  $\mu$ m.; breadth 75  $\mu$ m.

Material

Limited numbers.

Provenance

VE 57/-09/44 <sup>d</sup>/4 40-56 cm.

Remarks

This elongate, sometimes slightly curved form is distinguished by its oval aperture. It differs from *P.tectulostoma* in its more elongate test, rounded base and sub-ovate, eccentric aperture. A very similar form occurs in the present material and is assigned to *P. aff. fusuliformis*; it differs from this species in that the aperture is a terminal slit.

Occurrence

Described by Loeblich and Tappan from off Canada in Frobisher Bay between 24 m. and 142 m. water depth. Quaternary records include the Late Quaternary deposits of Læso, Denmark (Michelsen, 1967) and the Older *Yoldia* Clay at Hirtshals (Knudsen, 1971).

*Parafissurina aff. fusuliformis* Loeblich and Tappan

Plate 11, fig.7

Description

Test elongate, slender, 3 times as long as broad. Base rounded, greatest breadth below mid-height, tapering towards a bluntly rounded apertural end. Aperture terminal as an elongate arched slit bordered by two asymmetrical flaps.

Dimensions

length 233  $\mu$ m.; breadth 78  $\mu$ m.

Material

Single specimen only.

Provenance

VE 57/-10/17 <sup>a</sup>/4 20-25 cm.

Remarks

This form is close to the present *P.fusuliformis* but differs in its terminal, slit-like aperture. It bears some similarity to Buchner's (1940; pl.26, figs.548,549) specimens of *Lagena fornasinii* except that the apertural slit is larger in the present form. This may represent a new form.

*Parafissurina tectulostoma* Loeblich and Tappan

Plate 11, fig.8

*Parafissurina tectulostoma* Loeblich & Tappan, 1953, p.81, pl.14,  
fig.17; Knudsen, 1971, p.233, pl.6,  
fig.14.

Description

Test an inflated fusiform, widest just below mid-height, nearly circular in section, length greater than twice breadth. Base and apertural end pointed; aperture a high crescentic slit with a large, overhanging flap on one side. Test smooth, finely perforate.

Dimensions

length 300  $\mu\text{m}$ .; breadth 138  $\mu\text{m}$ .

Material

Limited numbers only.

Provenance

VE 57/-09/60 <sup>a</sup>/4 26-28 cm.

Remarks and Occurrence

This form bears a close resemblance to Loeblich and Tappan's specimens described from Frobisher Bay, Baffinn Island at a depth of 100 m.. It differs from *P.fusuliformis* of the present study in being more inflated and pointed at both ends. It also resembles *Parafissurina lateralis* (Cushman) as illustrated by Barker (1960) from the east of the Shetlands, Scotland; originally referred by Brady to *Lagena apiculata* (Reuss).

Quaternary records include the Lateglacial *Yoldia* Clay and the Older *Yoldia* Clay of Vendsyssel, Denmark (Knudsen, 1971) and the Quaternary of Siberia (Gudina, 1969). Thus, together with its present faunal associations, its affinities would appear to be that of an arctic water species.



Family CERATOBULIMINIDAE Cushman, 1927

Genus LAMARCKINA Berthelin, 1881

*Lamarckina haliotidea* (Heron-Allen and Earland)

Plate 11, figs.9,10,11,12

*Pulvinulina haliotidea* Heron-Allen & Earland, 1911, p.338, pl.11, figs.6-11.

*Lamarckina haliotidea* (Heron-Allen & Earland) Murray, 1971, p.205, pl.86, figs.1-6.

#### Description (fig.10)

Test a low trochospire. Dorsal side gently convex with distinctive, impressed, radial sutures; ventral side flattened, with deeply excavated umbilical area. Proloculus and subsequent chambers visible in a 'string of sausages' spiral on the ventral surface. Chambers inflated, longer than high, numbering 6 in the final whorl. Test wall smooth, very finely perforate. Periphery rounded. Aperture beneath a flap, extending along the basal suture of the final chamber (intraumbilical).

#### Dimensions

	12/20	fig.9	12/24	fig.10	fig.12	fig.11
diameter	291 $\mu$ m.	200 $\mu$ m.	227 $\mu$ m.	301 $\mu$ m.	284 $\mu$ m.	217 $\mu$ m.

#### Material

Numerous specimens.

#### Provenance

12/20	VE 57/-09/46 <sup>a</sup> /6	5-10 cm. (not illustrated)
fig.9 & 12/24	VE 57/-09/44 <sup>c</sup> /4	40-60 cm.
fig.10,12	VE 57/-09/46 <sup>f</sup> /6	66-69 cm.
fig.11	Aberdaron, A10	

#### Remarks and Occurrence

These very distinctive specimens closely resembles the figured specimens of Murray (1971), except that the acute and keeled periphery is not developed in the present material. The single specimen from the Upper Diamict Association at Aberdaron is somewhat more typical, but this species appears to show considerable variation (cf.pl.11, figs.9,10,11). Murray (1971) records it living as an inner shelf species and Cushman (1949), who records it from the Belgian coast, states that it is confined to the west European area.

Family            EPISTOMINIDAE            Wedekind, 1937  
Genus            HOEGLUNDINA            Brotzen, 1948

*Hoeglundina elegans* (d'Orbigny)

Plate 11, fig.13

*Rotalia (Turbinulina) elegans* d'Orbigny, 1826, p.276, no.54.

*Pulvinulina elegans* (d'Orbigny) Brady, 1884, p.699, pl.105,  
figs.3-6.

*Epistomina elegans* (d'Orbigny) Martinotti, 1926, p.3; Cushman,  
1931, p.65, pl.13, fig.6.

*Höglundina elegans* (d'Orbigny) Phleger, Parker & Pierson, 1953,  
p.43, pl.9, figs.24,25; Feyling-  
Hanssen, 1964, p.342, pl.20,  
figs.1-6.

*Hoeglundina elegans* (d'Orbigny) Knudsen, 1971, p.251.

#### Description

Test a low trochospire, biconvex with an acute, keeled periphery, nearly circular in outline. Spiral side exhibiting c.2<sup>1</sup>/<sub>2</sub> whorls, slightly less convex than the umbilical side, with some 7<sup>1</sup>/<sub>2</sub> chambers visible in the final whorl. Sutures distinct, but only very slightly depressed between later chambers. Surface smooth, very finely perforate. Aperture an elongate, curving slit along the ventral peripheral margin, bordered dorsally by the distinctive peripheral keel and ventrally by an extremely thin lip.

#### Dimensions

maximum diameter 660  $\mu$ m.

#### Material

Single specimen only

#### Provenance

VE 56/-09/142 <sup>b</sup>/6 8-10 cm.

#### Remarks and Occurrence

This is a very distinctive form and has a beautifully smooth, translucent test wall and very sharp peripheral keel. Feyling-Hanssen (1964) notes that this species is widely distributed in temperate waters; however, it is rare in the Quaternary deposits of Norden (Feyling-Hanssen, 1964; Knudsen, 1971).

I have followed the Loeblich and Tappan (1988) generic spelling of *Hoeglundina* Brotzen, 1948. I have not seen the latter publication, which was an attempt to separate Tertiary and Recent forms (range=Paleocene-Holocene) from Jurassic/Lower Cretaceous forms assigned to *Epistomina* Terquem, 1883.

Family	ROBERTINIDAE	Reuss, 1850
Genus	ROBERTINOIDES	Höglund, 1947

*Robertinoides pumilum* Höglund

Plate 11, fig.14

*Robertinoides pumilum* Höglund, 1947, p.227, pl.18, fig.5; Feyling-Hanssen, 1964, p.343, pl.19, fig.15; Knudsen, 1971, p.251, pl.8, figs.10-11.

Description

Test small, fusiform, about twice as long as broad. Chambers inflated, arranged in a sinistral, elongate spiral; final chamber about  $\frac{1}{3}$  length of test. Sutures distinct, markedly impressed. Aperture with a flaring 'spoon-shaped' upper slit which extends upwards  $\frac{1}{3}$  of apertural face height from the basal suture, with a slightly narrower, tapering lower slit along the basal suture. No obvious supplementary opening visible.

Dimensions

length 214  $\mu\text{m}$ ., maximum width 112  $\mu\text{m}$ .

Material

Limited numbers only, rare.

Provenance

VE 56/-09/142 <sup>b</sup>/<sub>6</sub> 8-10 cm.

Remarks and Occurrence

Specimens of the genus *Robertinoides* are difficult to differentiate. The present form is assigned to *R.pumilum* largely on the basis of its fusiform test and apertural details. It differs from *R.suecicum* in being more elongate and in its wider apertural slits.

Höglund (1947) recorded five specimens of this species from the Gullmar Fjord (20-22 m.) and from the Skagerrak (249-700 m.). Feyling-Hanssen (1964) records it in Holocene sediments from the Oslofjord area; Knudsen (1971) records two specimens from the Older *Yoldia* Clay at Hirtshals, Vendsyssel.

*Robertinoides suecicum* Höglund

Plate 11, fig.15

*Bulimina subteres* Göes (part) 1894, p.46, pl.9, figs.448-449? (not Brady, 1884).

*Robertinoides suecicum* Höglund, 1947, p.225, pl.18, fig.4, pl.19, fig.2, text-figs.200-202,204.

#### Description

Test medium, sub-ovate, about  $1\frac{1}{2}$  times as long as broad. Inflated chambers arranged in a dextral, high trochospire, final chamber nearly equal to  $\frac{1}{2}$  test length. Sutures distinct, highly impressed. Aperture consists of two narrow, roughly equal slits, one extending over  $\frac{1}{2}$  the apertural face, the other along the basal suture. No obvious supplementary opening visible.

#### Dimensions

length 512  $\mu\text{m}$ ., width 282  $\mu\text{m}$ .

#### Material

Limited numbers only, rare.

#### Provenance

VE 57/-10/17 <sup>a</sup>/4 0-5 cm.

#### Remarks and Occurrence

This specimen is assigned to *R.suecicum* on the basis of its rounded test form and roughly equally elongate apertural slits. Höglund (1947) places material from the North Sea and Norwegian coasts, collected and assigned to *Bulimina subteres* by Goës (1894), in synonymy with this species. Examining Brady's (1884, pl.50, figs.17,18) figures of *B.subteres*, I am in agreement with Höglund's view that Goës' (1894) specimens do belong there. In fact, Brady's (1884) figures are closer to *R.pumilum* than *R.suecicum*.

Höglund (1947) records 10 specimens of this species from the Gullmar Fjord (70-88 m.), the Skagerrak (360-700 m.) and the Koster Channel (85-200 m.).

Family            BOLIVINIDAE            Glaessner, 1937

Genus            BOLIVINA            d'Orbigny, 1839

*Bolivina alata* Seguenza

Plate 11, figs.16,17

*Bolivina beyrichi* Reuss var. *alata* Seguenza, Brady, 1884, pl.53, figs. 2-4.

*Bolivina alata* Seguenza, Barker, 1960, p.108, pl.53, figs.2-4.

#### Description (fig.16)

Test elongate, highly compressed, tapering biserial; 8 pairs of chambers visible, increasing gradually but becoming higher as added. Periphery serrated, carinate with peripheral base of chambers blade like and overhanging. Sutures distinct, gently depressed and strongly curved to form an initially sub-horizontal arch which intersects the periphery at a notch with an angle of  $60^\circ$  from the horizontal. Test wall distinctly perforate except for proloculus, peripheral keel, sutural lines and a small area at the

top of each chamber adjacent to the central suture. Aperture not clearly visible (final chamber broken), located on mid-line; remnants of internal tooth-plate possibly present.

Dimensions

fig.16 length 720  $\mu\text{m}$ . Max. width 280  $\mu\text{m}$   
fig.17 length 606  $\mu\text{m}$ . Max. width 270  $\mu\text{m}$ .

Material

Two specimens only

Provenance

VE 57/-10/17 <sup>d</sup>/4 55-65cm.

Remarks

These specimens agree with the illustrations by Brady (1884) which Barker (1960) places with *B.alata* Seguenza. I can find few references to this form and it would appear to characterize deeper water, Brady illustrates specimens from the N. Pacific (1465 m.) and from the Philippines (180 m.). Iaccarino (1967, 1969) is reported to have recorded *Brizalina alata* from S. Italy and Murray (1991, p.183) reports it as a common additional species in the *Valvulineria complanata* association; the depth range quoted is 30-100 m., muddy sand and 10-25°C.

*Bolivina difformis* (Williamson)

Plate 11, fig.18; Plate 12, fig.1

*Textularia variabilis* Williamson var. *difformis* Williamson, 1858, p.77, pl.6, figs.166, 167.

*Bolivina difformis* (Williamson) Cushman, 1922, p.32, pl.4, figs.1a,b; Cushman, 1937, p.164, pl.15, figs.13-17; Cushman, 1949, p.34, pl.6, fig.10; Harris, 1958, p.295, pl.27, fig.3.

Description (fig.18)

Test biserial, with 7 pairs of chambers, slightly compressed. Periphery irregular, crenulate. Sutures distinct, slightly limbate, impressed and reaching the periphery at an angle of 30°-40° from the horizontal. Chamber ends tending to become strongly acuminate during later growth. Aperture a small arch with a short tooth-plate (not clearly visible).

Dimensions

	fig.18	fig.1
length	365 $\mu\text{m}$	215 $\mu\text{m}$
Max. width	191 $\mu\text{m}$	155 $\mu\text{m}$

Material

Moderate numbers.

Provenance

VE 57/-10/17 c/4, 10-20cm.

Remarks

This is a highly compressed species of *Bolivina*; it differs from *B. pygmaea* Brady, a species which it closely resembles, in being more compressed and possessing faintly limbate sutures. It also resembles *B. gramen* (d'Orbigny), but the latter is again reported by be more inflated and to possess more horizontal sutures. I have compared my specimens with illustrations of *B. pygmaea* from Sandefjord (Feyling-Hanssen, 1964) and ?*B. gramen* from the Gullmar Fjord (Höglund, 1974) and find the general outline of the 3 species as illustrated very similar. However, I have also inspected Williamson's species at the British Museum (tray H.40, No. 96.8.13.43) and find very close agreement with my material. Material in the A. M. Norman collection (1878) from Øster Fjord, Norway - appears to be more inflated and possess a more complex sutural pattern (station 2, 100-200 fms, tray F.2, {19}15.4.1.1824).

This is of interest since Höglund notes that Goës in his Synopsis (1894, p.50) records Williamson's species from the Øster Fjord, Norway - although he himself states "I have not yet obtained in my investigation any form referable to *B. difformis*".

Occurrence

There are no living records from around the British Isles (Murray, 1971), although there are numerous records from S. W. Britain, especially from deeper water. Records may be confused for the taxonomic reasons discussed above?.

*Bolivina pseudoplicata* Heron-Allen & Earland

Plate 12, figs.2,3

*Bolivina pseudoplicata* Heron-Allen & Earland, 1930, p.81, pl.3, figs.36-40; Cushman, 1937c, p.166, pl.19, figs.12-20 (with extensive synonymy); Höglund, 1947, p.263, pl.24, fig.2, pl.32, figs.8-11, text-fig. 287; Knudsen, 1971, p.243, pl.7, fig.16, pl.18, fig.11; Murray, 1971, p.107, pl.43, figs.1-7; Haynes, 1973, p.132, pl.10, fig.3, pl.11, fig.7, text-fig.25, nos.20-21.

*Bolivina plicata* Brady, 1870, p.302, pl.12, fig.7 a,b; Goës, 1894, p.51, pl.9, figs.487-488 (not d'Orbigny).

Description (fig.2)

Test elongate, biserial, compressed. Periphery sub-angular, tapering towards a bluntly rounded initial portion, wedge-shaped. Sutures indistinct, impressed, obscured by thickened and irregular test ornament which gives rise to two discontinuous, longitudinal

costae (double row) either side of median suture; final chambers with reticulate ornament and pores within pits. Aperture a high arch with internal toothplate.

Dimensions

	5/30	fig.2	fig.3
length	340 $\mu$ m	300 $\mu$ m	182 $\mu$ m
maximum width	170 $\mu$ m	185 $\mu$ m	118 $\mu$ m

Material

Numerous.

Provenance

5/30 57/-09/60 d/4, 30-33 cm. (not illustrated)

fig.2 57/-10/17 d/4, 55-65 cm.

fig.3 Aberdaron, A1

Remarks & Occurrence

This is the most readily identified species of *Bolivina* in the present study, having the distinctive double row of "plications" which formed the basis for Heron-Allen & Earland's (1930) distinction of it from d'Orbigny's Pacific species. The reader is referred to Haynes (1973) for further discussion. It is distinguished from *B. variabilis* of the present study by its wider wedge-shaped form and much stronger ornament.

In summary its distribution appears to be concentrated in the N.E. Atlantic and the Mediterranean; listed occurrences from elsewhere may be doubtful.

*Bolivina pseudopunctata* Höglund

Plate 12, figs.4,5,6

*Bolivina pseudopunctata* Höglund, 1947, p.273, pl.24, fig.5, pl.32, figs. 23,24, text-figs.280, 281, 287; Loeblich & Tappan, 1953, p.111, pl.20, figs.13,14; Feyling-Hanssen, 1964, p.319, pl.16, fig.7.

*Bolivina (Brizalina) pseudopunctata* Höglund, Haynes, 1973, p.134, pl.10, fig.4, pl.11, figs.4-6, text-fig.25, nos.3-5.

*Brizalina* cf. *B. pseudopunctata* (Höglund) Murray, 1971, p.109, pl.44, figs.3-6.

*Bolivina punctata* Goës (part) 1894, p.49, pl.9, figs.478,480 not 475-477 (not d'Orbigny).

Description (fig.5)

Test elongate, biserial slightly compressed, 6 pairs chambers, about 3 times as long as broad. Periphery evenly rounded, slightly lobate. Sutures distinct, only slightly impressed. Chambers with perforation only over lower half.

Aperture a high arch extending from basal suture of final chamber, tooth-plate present.

#### Dimensions

	fig.4	fig.5	fig.6
length	367 $\mu$ m	340 $\mu$ m	256 $\mu$ m
max. width	116 $\mu$ m	118 $\mu$ m	75 $\mu$ m

#### Material

Moderate numbers.

#### Provenance

figs.4,5 VE 57/-10/17 °/4 10-20 cm.  
fig.6 Aberdaron, A10.

#### Remarks

The present material is typical of specimens illustrated as belonging to this species. There is some variation in the proloculum size and in the number of chambers but it is readily distinguished by the concentration of pores over the basal area of each chamber. As discussed by Höglund (1947, p.274) this form has been confused with *B. punctata* d'Orbigny in the past.

#### Occurrence

As discussed by Haynes (1973) the records of this species suggest an Arctic and cool temperate distribution. Knudsen (1971) records two specimens from the Older *Yoldia* Clay of Vendsyssel while Feyling-Hanssen (1964) records it from the Late Quaternary of the Oslofjord; and Mangerud *et al* (1981) record it from zones F3-F5: Eemian sediments at Fjøsanger, western Norway.

*Bolivina skagerrakensis* Qvale & Nigam

Plate 12, figs.7,8,9

*Bolivina* cf. *robusta* Brady, Höglund, 1947, p.270, pl.24, figs.8,9, pl.32, figs.16-18, text-fig.287; Feyling-Hanssen, 1964, p.321. pl.16, fig.9; Knudsen, 1971, p.244, pl.7, fig.17. (not *B.robusta* Brady, 1884).

*Bolivina skagerrakensis* Qvale & Nigam, 1985,

#### Description

Test elongate, about twice as long as broad, broadly tapering, compressed. Chambers wide, about 3 times as long as high, increasing slowly in size. Sutures distinct, only slightly impressed, with an indentation in the basal margin, close to median line; slightly curved with an angle of about 45° from the horizontal. Periphery sharp, feintly keeled, particularly well developed towards the base. Test coarsely perforate, thickened and irregular along central suture. Aperture an elongate oval extending from the basal suture of the final chamber and aligned on the mid-line; thin, internal toothplate (?) projecting



slightly.

#### Dimensions

	fig.7	5/33	fig.9	fig.8
length	512 $\mu\text{m}$ .	470 $\mu\text{m}$ .	370 $\mu\text{m}$ .	266 $\mu\text{m}$ .
maximum width	275 $\mu\text{m}$ .	235 $\mu\text{m}$ .	233 $\mu\text{m}$ .	150 $\mu\text{m}$ .

#### Material

Numerous specimens.

#### Provenance

figs.7,9 & 5/33 VE 57/-10/17<sup>d</sup>/4 55-65 cm.  
fig.8 Aberdaron, A12

#### Remarks

Höglund (1947) describes and illustrates this form very clearly with material from the Skagerrak. It is in fact very similar to Brady's (1884) species *B.robusta* illustrated from the Pacific, but lacks the strong basal spine and multiple indentations along the basal margin.

Microspheric specimens of the present form (pl.12, fig.9), although rare, can bear a strong resemblance to *B.spathulata* (Williamson), but are distinguished from the latter in possessing an indentation in the basal margin of each chamber and have a thicker, more robust test wall, particularly along the median line.

#### Occurrence

Murray (1991, p.158) summarizes the ecological requirements of this species from the Atlantic seaboard of Europe and Africa based upon only two references (Mackensen *et al.*, 1985 from Møre off the Norwegian coast; Qvale & Van Weering, 1985 from the Skagerrak) as the *Brizalina skagerrakensis* association:

salinity	3% to 35%.
temperature	-0.81°C to >6°C
substrate	mud, 2% to 3% organic carbon
depth	Møre = 3490 m. Skagerrak = 75 m. to 700 m.

The occurrence of this species in Quaternary sediments prior to Qvale and Nigam's (1985) work suggested that it was rare (Knudsen, 1971). However, this may be due to a failure to recognize this species as a distinct form?

*Bolivina spathulata* (Williamson)

Plate 12, figs.10,11

*Textularia variabilis* Williamson var. *spathulata* Williamson, 1858, p.76, pl.6, figs.164,165.

*Bolivina spathulata* (Williamson) Macfadyen, 1930, p.57, pl.4, figs.20a,b; Cushman, 1937, p.162, pl.15, figs.20-24; Höglund, 1947,

p.271, pl.24, fig.7, pl.32, figs.21, 22; Feyling-Hanssen, 1964, p.321, pl.16, fig.10.

*Bolivina (Brizalina) spathulata* (Williamson) Haynes, 1973, p.135, text-fig.25, nos.10-13.

*Brizalina spathulata* (Williamson) Hedley, Hurdle & Burdett, 1965, p.21, pl.6, fig.23, text-figs.6a-g; Murray, 1971, p.111, pl.45, figs.1-4

#### Description (fig.10)

Test elongate, biserial with 10 pairs of chambers visible, over twice as long as wide. Periphery sharp, sagittate. Sutures distinct, slightly impressed, gently curving to the periphery which they intersect at an angle of about 40° from the horizontal. Median suture a regular, straight sided zig-zag. Aperture a long, narrow slit extending upwards from the basal suture with an elongate, projecting toothplate. Test wall smooth, perforate.

#### Dimensions

	fig.10	fig.11
length	500 µm.	490 µm.
maximum width	230 µm.	220 µm.

#### Material

Moderate numbers.

#### Provenance

fig.10 VE 57/-10/17<sup>a</sup>/4 20-25 cm.

fig.11 VE 57/-09/46<sup>a</sup>/6 43-47 cm.

#### Remarks

There is considerable variation exhibited by this form in the general outline of the test, the degree to which the periphery is serrated and in the curvature of the sutures. Specimens with nearly straight sutures are included here which tend towards Brady's (1884) *B.dilatata* Reuss from the west of Ireland, but as Cushman and subsequent authors (eg. Haynes, 1973, p.136) have demonstrated, these specimens belong to Williamson's species. I have illustrated two morphological extremes from the present material, one with a serrated periphery reminiscent of *B.alata*, the other with a smoother outline.

This species differs from *B.alata* of the present study in that the chamber height increases rapidly in the latter; *B.skagerrakensis* differs in having a far more robust and thickened test wall as well as in possessing an indentation on the basal margin of each chamber.

#### Occurrence

The reader is directed to Haynes (1973, p.136) for a comprehensive treatment of this species' distribution; Murray (1971) records it as a shelf species from around the British Isles. Quaternary records are few, Feyling-Hanssen (1964) records a few specimens from the Holocene of the Oslofjord area and Knudsen (1971) notes its rare occurrence in the Sandness Clay, Norway.

*Bolivina subaenariensis* Cushman

Plate 12, figs.12,13,14

*Brizalina aenariensis* Costa, 1856, p.297, pl.15, fig.1.

*Bolivina aenariensis* (Costa) Brady, 1884, pl.53, figs.10-11;  
Harris, 1958, p.292, pl.27, fig.1.

*Bolivina subaenariensis* Cushman, 1922, p.46, pl.7, fig.6; Barker,  
1960, p.110, pl.53, figs.10-11  
(after Brady, 1884).

*Brizalina subaenariensis* (Cushman) Murray, 1971, p.111, pl.45,  
figs.5-7.

Description (fig.12)

Test elongate, biserial, compressed, about 3 times as long as wide, very gently tapering. Sutures distinct, imperforate and increasingly limbate as a high arch meeting the keeled periphery at an angle of c.60° from the horizontal. The peripheral keel is best developed around the base which has a small, but distinctive basal spine. Strong longitudinal costae extend up over 1/2 the test. Chambers are elongate, more than twice as broad as high, tapering at both ends and perforate. The aperture extends as an elongate arch from the basal suture onto the apertural face and has a slender tooth-plate.

Dimensions

	fig.12	fig.13	5/29	fig.14
length	1.02 mm.	820 μm.	488 μm.	250 μm.
maximum width	311 μm.	310 μm.	244 μm.	140 μm.

Material

Four specimens.

Provenance

fig.14	VE 57/ 09/89	<sup>d</sup> /6	20-25 cm.
fig.12	VE 57/ 10/17	<sup>b</sup> /4	5-10 cm.
fig.13 & 5/29	VE 57/-09/60	<sup>a</sup> /4	35-39 cm.

Remarks

There is some doubt raised by Harris (1958, p.293) concerning the validity of *B.subaenariensis* Cushman in view of Costa's (1856) failure to illustrate his *Brizalina aenariensis*, from the Pliocene of Italy, clearly. Harris states that he has "examined, in London, Brady's specimens of *B.aenariensis*" and found them to be identical to his material (incidentally a single specimen from 130 m. water depth on the Scottish Shelf). However, it appears from Barker's (1960) work that Brady's specimens from water depths of 2,250 m. and 2,985 m. from the west of Ireland do belong in Cushman's species. I have therefore followed the currently accepted concept of this species and placed it within *B.subaenariensis*.

Occurrence

This would appear to be an outer shelf and deeper water taxon. Murray (1970) has recorded it living in the Celtic Sea at

depths of 128-138 m., while *B.aenariensis* as illustrated by Cushman (1937, pl.12, figs.24-26) occurs in Pliocene deposits of Siena, Italy. The only other Quaternary record I have encountered of *B.subaenariensis* is at a depth of >310 cm. in a piston core (82-022-78) from the Scotian Rise at a depth of 4,046 m.(Thomas et al.,1990).

*Bolivina variabilis* (Williamson)

Plate 12, figs.15,16

*Textularia variabilis* Williamson, 1858, p.76, pl.6, figs.162-163.

*Bolivina variabilis* (Williamson) Chaster, 1892, p.59; Haynes, 1973, p.141, pl.10, fig.8, pl.11, fig.8, text-fig.25, no.16.

*Brizalina variabilis* (Williamson) Murray, 1971, p.113, pl.46, figs.1-3.

#### Description (fig.16)

Test elongate, about  $2\frac{1}{2}$  times as long as broad, six pairs of chambers visible, tapering gently. Chambers rounded, somewhat inflated and tending to become slightly undercut along the basal suture. Sutures distinct, impressed, periphery evenly lobate. Surface ornament of hexagonal reticulation with thickened muri and relatively coarse (c.2.5  $\mu\text{m}$ .) pores at the base of each pit; surface tends to become increasingly pitted in appearance rather than reticulate as later chambers are added. Aperture not clearly visible (final chamber broken) but appears to be located on the median line.

#### Dimensions

	fig.16	fig.15	6/27
length	350 $\mu\text{m}$ .	460 $\mu\text{m}$ .	440 $\mu\text{m}$ .
maximum width	150 $\mu\text{m}$ .	170 $\mu\text{m}$ .	180 $\mu\text{m}$ .

#### Material

Moderate numbers.

#### Provenance

fig.16 VE 57/-09/89, 3.1-3.2 m.  
fig.15 VE 57/-09/89, 0.6-0.65 m.  
6/27 VE 57/-09/60<sup>a</sup>/4 16-18 cm. 'outer' (not illustrated)

#### Remarks

The present form is very close to material illustrated by Murray (1971) and shows the same tendency towards a 'honeycombed' appearance around the base of each chamber. *B.variabilis* is readily distinguished from the other species of *Bolivina* in this study by its distinctive ornament; *B.pseudoplicata* differs in its more strongly tapering and flattened test as well as its raised and irregular costae.

### Occurrence

This would appear to be an inner shelf species in its distribution around the British Isles (Murray, 1971) and Haynes (1973) suggests a cool temperate distribution.

Family            CASSIDULINIDAE        d'Orbigny, 1839  
Genus            CASSIDULINA            d'Orbigny, 1826

### *Cassidulina laevigata* d'Orbigny

Plate 12, fig.17

*Cassidulina laevigata* d'Orbigny, 1826, p.282, pl.15, figs.4,5; Nørvang, 1945, text-fig.9; Knudsen, 1971, p.246, pl.7, figs.20,21, pl.18, fig.12; Mackensen & Hald, 1988, p.17, pl.1, figs.1-7 (with extensive synonymy).

*Cassidulina laevigata* d'Orbigny var. *carinata* Cushman, 1922, pl.25, figs.6,7.

*Cassidulina laevigata* *carinata* Cushman, Colom, 1952, pl.4, figs.25,26.

*Cassidulina carinata* Silvestri, Murray, 1971, p.187, pl.78, figs.1-5.

### Description

Test lenticular, biserially arranged chambers enrolled into an involute planispire. Periphery acute, slightly carinate and sub-circular. Chambers elongate, curved backwards and tapering towards the periphery, alternating and overlapping in umbilical area to form an eccentric umbo. Test wall smooth, chambers distinctly perforate. Aperture an interio-marginal low arch parallel to the periphery with an elongate and crenulate apertural plate extending from the proximal side and covering most of the aperture; a very fine ridge borders the distal margin of the aperture.

### Dimensions

	14/25	14/26	fig.17	15/2
maximum diameter	320 $\mu$ m	306 $\mu$ m	288 $\mu$ m	538 $\mu$ m

### Material

Numerous specimens.

### Provenance

fig.17 & 14/25,26 VE 57/-10/17 <sup>d</sup>/4, 55-65 cm.  
15/2 VE 57/-09/89 <sup>d</sup>/6, 90-95 cm.

#### Remarks

As Mackensen & Hald (1988) have demonstrated very convincingly *C. laevigata* has been much confused in the literature, particularly with the colder water taxon *C. teretis* Tappan. I have followed these authors in their broad species concept and include carinate and 'frilled' forms here. However, I have failed to recognize *C. teretis* in the present study and subsequent investigation may reveal that some of the specimens assigned to *C. laevigata*, particularly in association with typically arctic assemblages, may belong there.

#### Occurrence

The reader is directed to the discussion on the modern distribution and ecology of this species by Mackensen & Hald (1988) which in summary states that it "coincides with the sea floor areas covered by warm and relatively saline bottom water of Atlantic origin". Quaternary records are equally complicated by the problems associated with its taxonomy and are discussed by Knudsen (1971).

#### *Cassidulina obtusa* Williamson

Plate 12, figs.18,19,20

*Cassidulina obtusa* Williamson, 1858, p.69, pl.6, figs.143,144;  
Murray, 1971, p.189, pl.79, figs.1-6; Sejrup & Guilbault, 1980, p.81, figs.2a-e (with extensive synonymy).

*Cassidulina crassa* d'Orbigny, Brady, 1884, p.429, pl.54, figs.4-5;  
Heron-Allen & Earland, 1932, p.357, pl.9, figs.29-31, not 26-28, 32-37;  
Nørvang, 1945, p.41, text-figs.6a-d;  
Cushman, 1949, p.49, pl.10, fig.2 (not d'Orbigny).

#### Description

Test biserial throughout, planispirally enrolled, compressed. Chambers inflated, numbering 8 in the final whorl, increasing gradually; sutures distinct, narrow and impressed. Test wall smooth, finely perforate. Aperture interiomarginal, parallel to the periphery as an elongate slit with a fine lip along its proximal border and a slight notch on its distal side giving it a 'tripartite' appearance (*sensu* Nørvang, 1958).

#### Dimensions

	fig.20	14/32	figs.18,19
maximum diameter	310 $\mu$ m.	257 $\mu$ m.	225 $\mu$ m.

#### Material

Numerous specimens.

#### Provenance

VE 57/-10/17 <sup>a</sup>/4 20-25 cm.

#### Remarks

This species, while resembling *C.reniforme*, is readily distinguished by its inflated chambers and deeply incised sutures. The tripartite aperture is not always fully developed, although the apertural lip along the proximal border is always much finer than in *C.reniforme*. The present material closely resembles the specimens figured by Murray (1971). The question of the taxonomic relationship of the species *C.obtusa* and *C.reniforme* to *C.crassa* d'Orbigny has been commented upon by various authors and these views, together with their own, are summarised by Sejrup and Guilbault (1980).

#### Occurrence

There are numerous records of this species living around the British Isles (eg. Murray, 1971) and in general, *C.obtusa* appears to prefer temperate climates. An exception is its co-occurrence in limited numbers with *C.reniforme* in the Barents Sea (Jarke, 1960). Its occurrence in the present study, often increasing in frequency as *C.reniforme* declines, particularly at the base of the Holocene, also suggests that it is a temperate species. Murray (1991) summarizes the ecological requirements of the *C.obtusa* association from the North Atlantic margin as follows:

salinity	35 %.
temperature	7°C - 13°C
substrate	sandy and silty mud
depth	177 m. - 3299 m.

#### *Cassidulina reniforme* Nørvang

Plate 13, figs.1,2,3,4

*Cassidulina crassa* d'Orbigny var. *reniforme* Nørvang, 1945, p.41, text-fig.6e-h.

*Cassidulina crassa* d'Orbigny, Cushman, 1948, p.74, pl.8, fig.9; Nørvang, 1958, p.36, pl.9, figs.24-25; Feyling-Hanssen, 1964, p.322, pl.16, figs.11-13; Knudsen, 1971, p.245, pl.7, figs.18-19; Cronin, 1977, pl.1, fig.13.

*Cassidulina islandica* Nørvang, Loeblich & Tappan, 1953, p.118, pl.24, fig.1; Cooper, 1964, p.102, pl.6, fig.21.

*Cassidulina barbara* Buzas, 1965, p.25, pl.25, figs.2a-b,3.

*Cassidulina* cf. *reniforme* Nørvang, Haynes, 1973, p.194, text-fig. 43, nos.1-4.

*Cassidulina reniforme* Nørvang, Sejrup & Guilbault, 1980, p.79, figs.2f-k (with extensive synonymy).

### Description

Test biserial throughout, planispirally enrolled, compressed. Periphery rounded, somewhat lobate, sub-circular, with 7 chambers visible in the final whorl. Sutures moderately distinct, slightly impressed. Surface smooth, finely perforate. Aperture interior-marginal, sub-parallel to the periphery with a single elongate tooth-plate on the proximal side which tapers somewhat to its anterior end.

### Dimensions

	14/28	fig.1	fig.2	16/9
maximum diameter	327 $\mu\text{m}$ .	293 $\mu\text{m}$ .	293 $\mu\text{m}$ .	115 $\mu\text{m}$ .
	16/10	15/21		
maximum diameter	183 $\mu\text{m}$ .	314 $\mu\text{m}$ .		

### Material

An abundant species.

### Provenance

figs.1,2 & 14/28	VE 57/-10/17 <sup>d</sup> /4	55-65 cm.
fig.3 & 15/21	VE 57/-09/89 <sup>e</sup> /6	80-90 cm.
16/9,10	Aberdaron, A8 & A9 (not illustrated)	

### Remarks

The outline synonymy (above), based largely upon information in Sejrup and Guilbault (1980), partially illustrates the problems that authors have had with this species. It has been most commonly assigned to *C.crassa* d'Orbigny although the latter is regarded as a distinct form, much as Haynes (1973) suggested.

*Cassidulina reniforme* is distinguished from *C.obtusa* by its larger apertural tooth-plate, compressed test, generally less inflated chambers and less distinctively incised sutures. While examining TS.77, sample number 1, Mulranny, Clew Bay, Ireland from the Heron-Allen and Earland collection at the British Museum(N.H.), I have observed that in square no.53 specimens assigned to *Cassidulina crassa* include forms which in the present study have been assigned to *C.reniforme*, *C.obtusa* and *Globocassidulina subglobosa*.

### Occurrence

Records of this species' distribution are numerous and the reader is directed to the paper by Sejrup and Guilbault (1980) for a summary of the modern and Quaternary records of *C.reniforme* and *C.obtusa*. This species is recorded mostly from Arctic waters or in sediments associated with arctic depositional environments; it is typically associated with normal marine salinities and water depths generally in excess of 30 m..



Genus CASSIDULINOIDES Cushman, 1927

*Cassidulinoides bradyi* (Norman)

Plate 13, figs.5,6,7

*Cassidulina bradyi* Norman, 1881, p.59; Brady, 1884, p.431, pl.54, figs.6-9,? 10; Cushman, 1922, p.128, pl.23, figs.6, 7.

*Cassidulinoides bradyi* (Norman) Cushman, 1930, p.58; Voorthuysen, 1950b, p.63, pl.3, fig.5 (with extensive synonymy); Feyling-Hanssen, 1964, p.325, pl.16, figs.18,19 Murray, 1971, p.113, pl.46, figs.4-7.

#### Description

Test elongate, compressed, biserial throughout. Early chambers planispirally enrolled, later chambers uncoil and increasing in height considerably. Periphery rounded, initial end broadly so, terminal/apertural end somewhat produced. Sutures indistinct, slightly depressed. Surface smooth, finely perforate. Aperture sub-terminal, loop-shaped with a distinctly folded & feintly crenulate tooth-plate.

#### Dimensions

	fig.5	fig.7	fig.6
length	308 $\mu$ m.	370 $\mu$ m.	285 $\mu$ m.
width	208 $\mu$ m.	203 $\mu$ m.	157 $\mu$ m.

#### Material

Moderate numbers

#### Provenance

fig.7 VE 56/-09/142<sup>b</sup>/6, 89-91 cm.  
fig.6 VE 57/-10/17<sup>a</sup>/4, 0-5 cm.  
fig.5 VE 57/-09/46<sup>a</sup>/6, 43-47 cm.

#### Remarks & Occurrence

This form is readily identified as Norman's species although there is some variation in the degree of uncoiling of the later chambers. Murray (1970) records it living as an outer shelf species at depths of 420-1002 m. by the Western Approaches to the English Channel; while Brady (1884) records it from south of Ireland. It would appear to be a deep water, Lusitanian species. Feyling-Hanssen (1964) records a single specimen from the Postglacial deposits south of Oslo.

Genus                    GLOBOCASSIDULINA Voloshinova, 1960

*Globocassidulina subglobosa* (Brady)

Plate 13, figs.8,9,10

*Cassidulina subglobosa* Brady, 1881, p.60; Brady, 1884, p.430,  
pl.54, fig.17; Heron-Allen &  
Earland, 1916, p.44; Cushman, 1922,  
p.127, pl.24, fig.6; Le Calvez,  
1958, p.186.

*Globocassidulina subglobosa* (Brady) Murray, 1970, p.484(list)

*Globoassidulina* aff. *G. subglobosa* (Brady) Murray, 1971, p.191,  
pl.80, fig.1-4.

#### Description

Test small, sub-globular, enrolled biserial, 6 chambers visible in final whorl. Sutures distinct impressed. Surface smooth, finely perforate. Aperture a short slit extending upwards from the basal suture onto the apertural face, bordered on the anterior side by a thin lip.

#### Dimensions

	fig.8	fig.9	fig.10
maximum diameter	172 $\mu$ m.	172 $\mu$ m.	167 $\mu$ m.

#### Material

Numerous

#### Provenance

VE 57/-09/89

#### Remarks & Occurrence

The present material are larger than specimens illustrated by Murray (1971) which he described as living on the outer shelf at depths of 128-138 m. from the Celtic Sea. The faunal associations of this species in the present study suggest that it is a temperate, deeper water form. However, Jarke (1960) has recorded it dead from the Barents sea.

Genus                    ISLANDIELLA                    Nørvang, 1959

*Islandiella helenae* Feyling-Hanssen & Buzas, 1976

Plate 13, figs.11,12

*Cassidulina laevigata* d'Orbigny, Parker & Jones, 1865, p.377,  
pl.15, figs.2-4.

*Cassidulina teretis* Tappan, Loeblich & Tappan, 1953, p.121, pl.24,  
figs.3-4.

*Islandiella teretis* (Tappan) Feyling-Hanssen, 1964, p.326, pl.16, fig.17.

*Cassandra teretis* (Tappan) Gudina, Saidova & Troitzkaya, 1968, p.226 (with extensive synonymy).

*Islandiella helenae* Feyling-Hanssen & Buzas, 1976, p.155, text-figs.1-4, pl.1, figs.9-10; Knudsen, 1978, p.34(list).

#### Description

Test medium, lenticular, bioconvex. Periphery sub-acute, thickened, sub-circular in outline. Chambers biserially arranged, plane of biseriality planispirally enrolled, slightly evolute so that earlier whorls are visible through the thickened but clear umbilical area. Chambers are moderately inflated, sub-rhomboidal and produce an alternating pattern as they extend as an oval towards the umbilicus on one side and are sub-triangular on the other side. Test wall smooth, perforate. Aperture an elongate, broad slit sub-parallel to the periphery (interiomarginal) with a projecting cristate toothplate, one margin of which continues to form a narrow cristate lip which borders almost the entire periphery of the aperture; a possible secondary tongue may be present here.

#### Dimensions

	fig.11	fig.12
maximum diameter	533 $\mu\text{m}$ .	430 $\mu\text{m}$ .

#### Material

Numerous specimens.

#### Provenance

VE 48/-09/148, Celtic Sea

#### Remarks

The reader is directed to Feyling-Hanssen & Buzas' (1976) paper on this species and on the emendation of the genus *Cassidulina* in which the significance of wall structure at the generic level is discussed further and the confused synonymy unravelled. The figures included here fail to illustrate the distinctive internal features, particularly the large, globular proloculus and biserial chamber arrangement, of this species, but do clarify the apertural features. The fragile secondary apertural tongue is often broken and is only very rarely seen as in the specimen figured from vibrocore 48/-09/148 from the southwest Celtic Sea.

It is distinguished from *I.norcrossi*, the nearest form in the present study, by its inflated, sub-ovate chambers & large proloculus.

#### Occurrence

The recent distribution of this species appears to be Arctic, generally at depths exceeding 10 m. and often considerably deeper, most commonly >20 m. (Mangerud *et al.*, 1981; Feyling-Hanssen, 1976). It's occurrence in Quaternary sediments is well documented

and it occurs, for example, in the Lateglacial sediments of the Oslofjord area (Feyling-Hanssen, 1964), Middle Weichselian of Denmark & S.W. Norway (Feyling-Hanssen *et al.*, 1971).

The reader is directed to Loeblich and Tappan's (1953) excellent illustrations of this species, which exhibit the characteristic internal detail.

*Islandiella islandica* Nørvang, 1945

Plate 13, figs.13,14,15,16

*Cassidulina islandica* Nørvang, 1945, p.41, fig.7.

*Islandiella islandica* (Nørvang) Nørvang, 1958, p.27, pl.6, figs.1-5, pl.7, figs.6,7; Knudsen, 1971, p.247, pl.7, figs.22-25.

#### Description

Test medium, inflated, sub-ovate slightly compressed with broadly rounded, lobate periphery. Chambers sub-quadrate, somewhat inflated with distinctive, impressed sutures. Chamber arrangement biserial, planispirally enrolled with 3<sup>1</sup>/<sub>2</sub> pairs (7 chambers) visible in the final whorl. Surface smooth, finely perforate. Aperture interio-marginal, sub-parallel to the periphery, a large, crenulate tooth projecting posteriorly and bordered by a thin, crenulate lip.

#### Dimensions

	14/22	14/23	14/24	15/8	15/9
max. diam.	400 μm.	500 μm.	410 μm.	450 μm.	400 μm.

#### Material

Moderate numbers

#### Provenance

VE 48/-09/148 (all measured specimens, slide A)

#### Remarks

The present material closely resemble the specimens illustrated by Nørvang (1945) from northeast Iceland and, as mentioned by him, it is easily distinguished from *Cassidulina reniforme* (= *C. crassa* d'Orbigny) by the apertural form. The chamber arrangement being very similar, even when the apertures are damaged, as they often are, the latter always tends to be more inflated and possess a thicker test, particularly noticeable along the sutures. It differs from *C. obtusa*, which it also resembles in general chamber arrangement, in that the latter is typically far more compressed and has a narrow apertural slit.

#### Occurrence

This would appear to be an arctic species and it is possible that some records of *C. crassa* d'Orbigny from arctic and high boreal waters belong here. Nørvang's (1945) records from northeast Iceland are from 38-220 m.

Quaternary records include the Older *Yoldia* Clay of Vendsyssel (Knudsen, 1971) and the Middle & Late Weichselian of Nørre Lyngby, Denmark (Knudsen, 1978).

*Islandiella norcrossi* (Cushman)

Plate 14, figs.1,2

*Cassidulina norcrossi* Cushman, 1933, p.7, pl.2, fig.7; Loeblich & Tappan, 1953, p.120, pl.24, fig.2.

*Islandiella norcrossi* (Cushman) Nørvang, 1958, p.32, pl.7, figs.8-13, pl.8, fig.14; Feyling-Hanssen, 1964, p.325, pl.16, fig.20, pl.17, fig.1; Knudsen, 1971, p.248, pl.8, figs.1,2 (with recent synonymy).

#### Description

Test biserially enrolled, lenticular, sub-circular in outline. Periphery sub-acute. Chambers trigonal on both sides, alternating slightly larger and smaller, slightly evolute following a small proloculus; 4 pairs chambers in final whorl. Aperture an elongate oval, interior marginal with a projecting, crenulate toothplate and bordered by a fine crenulate lip. Test smooth, finely perforate.

#### Dimensions

1) 360 336 300 300 360 300 432 372 390 396 390 408 378 336 324  
2) 6 12 6 6 6 54 90 72 72 84 78 96 72 66 6

1)= max. diam. 2)= proloculus diam. (all 57/-10/17, <sup>d</sup>/4 55-65cm.)  
Measurements in microns.

#### Material

Numerous specimens

#### Provenance

figs.1,2 VE 57/-09/89 2.9-3.0 m.

#### Remarks

The present form is very distinctive and both microspheric and megalospheric forms occur; see measurements included. It is readily distinguished from *I.helenae* even in the megalospheric form, by the trigonal, pointed chambers and by the tendency towards uniserial chamber arrangement. The confusion of *I.norcrossi* (Cushman) with *I.teretis* (Tappan) (= *I.helenae*) in the past has resulted in problems associated with any review of the distribution of this species.

#### Occurrence

Nørvang (1945) records this species from north & east Iceland, while Loeblich and Tappan (1953) record it at depths in excess of 13 m. from Arctic Alaska, Canada & Greenland, while Nagy (1965) records it off Spitsbergen at depths of 0-50 m.. A number of other records (see Knudsen, 1971) further suggest that its distribution is arctic in affinity.

Quaternary records are numerous and it accounts for up to 20% of the total fauna from the Older *Yoldia* Clay at Hirtshals, Denmark (Knudsen, 1971).

Family            STAINFORTHIIDAE    Reiss, 1963  
 Genus            STAINFORTHIA       Hofker, 1956

*Stainforthia (Fursenkoina) fusiformis* (Williamson)

Plate 14, figs.3,4,5,6

*Bulimina pupoides* var. *fusiformis* Williamson, 1858, p.63, figs. 129,130.

*Bulimina fusiformis* (Williamson) Brady, 1887, p.897.

'*Bulimina*' *fusiformis* (Williamson) Höglund, 1947, p.232, pl.20, fig.3, text-figs.219-233.

*Virgulina fusiformis* (Williamson) Parker, 1952a, p.417, pl.6, figs.3-6; Feyling-Hanssen, 1964, p.308, pl.14, figs.15-18; Knudsen, 1971, p.237.

*Fursenkoina fusiformis* (Williamson) Murray, 1965a, p.503 (list), pl.1, pair o; 1971, p.185, pl.77, figs.1-5.

'*Stainforthia*' *fusiformis* (Williamson) Haynes, 1973, p.124, pl.5, figs.7,8.

#### Description

Test elongate, biserial, sub-fusiform. Chambers inflated, increasing very rapidly in size after the 3<sup>rd</sup> chamber and then gradually as subsequent chambers are added. Sutures distinct, impressed. Test smooth, finely perforate. Aperture showing ontogenetic variation: juveniles possessing a simple, high arch above the basal suture of the final chamber; adult specimens possessing a terminal aperture with raised collar and internal structure (not clearly visible).

#### Dimensions

	5/6	5/7	5/8	5/9
length	323 µm.	293 µm.	286 µm.	285 µm.
maximum diameter	138 µm.	136 µm.	150 µm.	150 µm.
	5/10	5/11	5/13	5/14
length	250 µm.	163 µm.	352 µm.	338 µm.
maximum diameter	81 µm.	92 µm.	123 µm.	123 µm.

Specimens measured all from VE 57/-09/89 2.35-2.40 m.

#### Material

Very numerous.

#### Provenance

VE 57/-09/89 2.35-2.40 m.

#### Remarks

Care should be taken with juveniles of this species which bear a close resemblance to *Stainforthia concava* (Höglund), particularly in the form of the aperture. Unfortunately, I failed to recognize this fact during the counting process; this taxonomic error is dealt with in the discussion relating to the relevant samples.

Loeblich and Tappan (1988) describe the characteristic features of *Fursenkoina* which appears to be characterised by the ontogenetic development of the aperture exhibited by the present species. Haynes (1973, p.125) discusses the question of the validity of *Stainforthia* as applied to this particular form; many recent publications refer this species to *Fursenkoina* eg. Thomas *et al.* (1990); Andrews *et al.* (1990).

Haynes (1973) has stated that the test wall is optically radial in this species, while Loeblich and Tappan's genus *Fursenkoina* is reported to be optically granular. This group requires further investigation, as Haynes has already suggested, to establish the importance of apertural development. I include *Fursenkoina* in parentheses here to indicate my uncertainty over the correct generic affinity.

#### Occurrence

The reader is referred to Haynes (1973, p.125) for a comprehensive account of the distribution of this species which he suggests is within temperate to cold water. Murray (1971) suggests that it is a stenohaline marine shelf species and is locally very abundant around S.W. Britain. Feyling-Hanssen (1964) reports it from the Late Quaternary deposits of the Oslofjord area and records it as particularly frequent in the Postglacial. Andrews *et al.* (1990) record certain stratigraphic levels in cores from the S.E. Baffin Shelf which are dominated by this species (*F. fusiformis*) and which they interpret, after proposals by Scott *et al.* (1984), as indicative of quiet, low oxygen conditions with slightly lowered salinities during the Younger Dryas chron.

*Stainforthia loeblichii* (Feyling-Hanssen)

Plate 14, figs.7,8,9

*Virgulina complanata* Egger, Parker, 1952a, p.417, pl.6, fig.2 (not fig.1)(not *V. schreibersiana* var. *complanata* Egger, 1893).

*Bulimina excilis* Brady, Loeblich and Tappan, 1953, p.110, pl.20, figs.4,5 (not *B. elegans* var. *excilis* Brady, 1884).

*Virgulina loeblichii* Feyling-Hanssen, 1954, p.191, pl.1, figs.14-18 text-fig.3; Feyling-Hanssen, 1964, p.308, pl.14, figs.12-14; Knudsen, 1971, p.238, pl.7, figs.1-5 (with extensive synonymy).



*Stainforthia loeblichii* (Feyling-Hanssen) Gudina, 1969, p.42, pl.14, figs.5-6, pl.16, fig.5; Feyling-Hanssen *et al.*, 1983, pl.1, fig.14.

*Stainforthia concava* (Höglund) var. *loeblichii* (Feyling-Hanssen) Haynes, 1973, p.123, pl.5, fig.10.

#### Description

Test elongate, slender; initially triserial becoming a biserial spiral, final chamber very high. Chambers slightly inflated, sutures distinctive, impressed. Base acuminate with small basal spine. Aperture an elongate arch, bordered by a fine, narrow lip. Test finely perforate, smooth.

#### Dimensions

	fig.7	fig.9	fig.10	fig.8
length	594 $\mu\text{m}$ .	661 $\mu\text{m}$ .	440 $\mu\text{m}$ .	750 $\mu\text{m}$ .
maximum diameter	194 $\mu\text{m}$ .	185 $\mu\text{m}$ .	150 $\mu\text{m}$ .	200 $\mu\text{m}$ .

#### Material

Numerous specimens.

#### Provenance

fig.7	VE 56/-09/142	<sup>e</sup> /6 23-25 cm.
fig.9	VE 57/-09/46	<sup>d</sup> /6 63-66 cm.
fig.10	VE 57/-09/89	2.35-2.40 m.
fig.8	VE 56/-09/142	<sup>e</sup> /6 23-25 cm.

#### Remarks

The present forms are close to Feyling-Hanssen's species but show some variation in the development of the basal spine and the degree of chamber inflation. They appear to be accommodated within the variation illustrated by Knudsen (1971, pl.7, figs.1-5) for this species. The transitional forms with basal spines, as discussed by Feyling-Hanssen (1964), which tend towards *S.concava* (Höglund) are not common in the present material, except for the specimen illustrated in pl.14, fig.8, and I have therefore retained *S.loeblichii* as a distinct form.

This species is distinguished from the juvenile forms of *S.fusififormis* of the present study by its more elongate, slender test and high-arched aperture with its distinctive narrow lip.

#### Occurrence

This appears to be an Arctic species; the reader is referred to Knudsen (1971) for notes on its modern distribution. It is well known from Quaternary sediments and is the primary diagnostic form of the Late Quaternary zones B1 and C of the Oslofjord area (Feyling-Hanssen, 1964) and is also a characteristic species of zone 1 of the Sandnes Clay and also occurs in the Older *Yoldia* Clay of Vendsyssel, Denmark (Knudsen, 1971).

*Stainforthia schreibersiana* (Czjzek)

Plate 14, figs.11,12

*Virgulina schreibersiana* Czjzek, 1848, p.11, pl.13, figs.18-21; Cushman, 1937, p.13, pl.2, figs.11-20 (with extensive synonymy); Feyling-Hanssen, 1964, p.309, pl.14, figs.19-21; Knudsen, 1971, p.240, pl.7, figs.6-8.

*Stainforthia schreibersiana* (Czjzek) Michelsen, 1967, p.226, pl.2, fig.12.

Description

Test elongate, fusiform, triserial. Chambers very high, final chamber nearly  $\frac{1}{2}$  length test, slightly spirally enrolled. Sutures distinct, only slightly impressed so that the periphery is slightly lobate. Test smooth, finely perforate. Aperture a simple, sub-circular opening on the upper  $\frac{1}{2}$  of the apertural face.

Dimensions

	fig.11	fig.12
length	240 $\mu$ m.	240 $\mu$ m.
maximum diameter	70 $\mu$ m.	75 $\mu$ m.

Material

Not very abundant.

Provenance

VE 57/-09/89 2.9-3.0 m.

Remarks

There appears to be some confusion in the literature regarding this species, particularly in view of the fact that Czjzek originally described it from Tertiary strata. The present material appears to differ considerably in the form of the simple aperture exhibited when compared to the figured specimens of Feyling-Hanssen (1964) and Knudsen (1971) although it is otherwise very close to the latter.

This species is readily distinguished from *Stainforthia* (*Fursenkoina*) *fusiformis* of the present study by its smaller, more elongate and slender test as well as its apertural form.

Murray's (1971, p.185, pl.77, figs.6-10) figured specimens of *Fursenkoina schreibersiana* (Czjzek) do not belong here.

Occurrence

This appears to be a colder water species with records from the Oslofjord at water depths between 30-100 m. (Risdal, 1964) and Spitsbergen at depths of 5 m., 11 m. and 37 m. (Nagy, 1965). Knudsen (1971) notes that it appears to be more frequent in the Lateglacial rather than Postglacial zones of the Oslofjord area and illustrates specimens from the Older *Yoldia* Clay and Lateglacial deposits of Vendsyssel, but equally notes that it is generally scarce.

Family            BULIMINIDAE            Jones, 1875  
Genus            BULIMINA            d'Orbigny, 1826

*Bulimina* cf. *alazanensis* Cushman *sensu* Murray

Plate 14, figs.13,14

*Bulimina* cf. *B. alazanensis* Cushman, Murray, 1970, p.484 (list),  
pl.1, figs. 18,19; Murray, 1971,  
p.115, pl.47, figs.1-7.

#### Description

Test triserial, about one and a half times as long as wide. Sutures distinct, impressed and traversed by distinctive, blade-like longitudinal costae, some of which extend over two whorls. Costae taper down onto final chamber surface and are higher towards base of the test. Test wall otherwise smooth, finely perforate. Aperture nearly terminal, loop-shaped bordered by a slight lip with a distinctive, crenulate tooth-plate projecting from it.

#### Dimensions

	fig.13	fig.14
maximum length	444 $\mu$ m.	365 $\mu$ m.
maximum diameter	255 $\mu$ m.	200 $\mu$ m.

#### Material

Two specimens only.

#### Provenance

fig.13 VE 57/-09/46 <sup>a</sup>/6, 43-47 cm.  
fig.14 VE 57/-10/17 <sup>a</sup>/4, 20-25 cm.

#### Remarks

The present form is very close to material illustrated by Murray (1970, 1971), particularly with respect to the continuity of the ribs from chamber to chamber; a feature which Murray notes in common with specimens described by Phleger & Parker (1951) from the Gulf of Mexico. Closely related forms appear to be *B.costata* d'Orbigny and *B.striata* d'Orbigny, although there appears to be some confusion in the literature regarding these forms.

#### Occurrence

Murray (1971) records it as an outer shelf species and it appears to occur at depths >110 m. from S.W. Britain.

*Bulimina elongata* d'Orbigny

Plate 14, figs.15,16,17

*Bulimina elongata* d'Orbigny, 1846 (not 1826), p.187, pl.11, figs. 19-20; Haynes, 1973, p.116, pl.10, figs.9,11, pl.11, fig.10, text-fig. 23, text-fig.24, nos.1-7.

*Bulimina elegans* Brady, 1884, p.398, pl.50, figs.3-4 (not 1,2) (not d'Orbigny).

Description

Test trochospiral, elongate, twice as long as wide, tapering at both ends. Pointed basal end with small, blunt spines and possibly one longer one; apex bluntly produced. Sutures distinct, impressed, chambers slightly inflated. Aperture an elongate arch, nearly terminal, bordered by a collar with an internal tooth-plate present. Test otherwise smooth, finely perforate.

Dimensions

	fig.15	fig.16	fig.17	S/12
length	538 $\mu$ m.	420 $\mu$ m.	400 $\mu$ m.	462 $\mu$ m.
maximum diameter	250 $\mu$ m.	210 $\mu$ m.	180 $\mu$ m.	212 $\mu$ m.

Material

Moderate numbers.

Provenance.

figs.15,16 VE 57/-10/17<sup>d</sup>/4, 55-65 cm.

fig.17 Laugharne, Taf estuary, S. Wales.

Remarks

The present forms are close to material described and illustrated by Haynes (1973) from Cardigan Bay. Transitional forms do exist in a series between *B.elongata*, *B.marginata* and *B.gibba* of this study and the reader is directed to the remarks section of *B.marginata* for further discussion.

The rather unusual specimen illustrated here from the Taf estuary, South Wales is tentatively assigned to *B.elongata* but appears to exhibit a nearly biserial chamber arrangement.

Occurrence

Haynes (1973, p.117) gives an expanded list detailing the distribution of this species but emphasises the need to practice caution in the case of listed references; he concludes that "there is thus a concentration of records in cool, temperate waters in mid latitudes".

*Bulimina gibba* Fornasini

Plate 14, fig.18

*Bulimina gibba* Fornasini, 1902, p.378, pl.10, figs.32,?34; Barker, 1960, pl.50, figs.1,2 (not 3,4) after Brady, 1884; Haynes, 1973, p.121, pl.10, fig.14, text-fig.24, nos.10-17.

Description

Test triserial, somewhat longer than wide with large, inflated chambers. Sutures distinct, impressed. Surface smooth, finely perforate, except around the base which has small spines. Aperture an oval loop bordered by a distinctive collar which extends from the basal suture onto the distinctly curved apertural face.

Dimensions

length 380  $\mu$ m.; maximum diameter 250  $\mu$ m.

Material

Limited numbers only?

Provenance

VE 57/-10/17<sup>d</sup>/4, 55-65 cm.

Remarks

The present form may well belong here, however it does differ somewhat from the typical form of this species but this may be in part due to its being a juvenile specimen. Transitional forms exist, particularly in a series with *B.elongata* of the present study. In my definition of this species I have confined myself to specimens exhibiting a stout and broadly tapering test with inflated chambers. See remarks under *B.marginata* regarding transitional forms.

Occurrence

A cool temperate distribution is suggested by Haynes (1973) who discusses further the distribution of this species.

*Bulimina marginata* d'Orbigny

Plate 14, figs.19,20; Plate 15, figs.1,2

*Bulimina marginata* d'Orbigny, 1826, p.269, pl.12, figs.10-12; Brady, 1884, p.405, pl.51, figs.3-5; Feyling-Hanssen, 1964, p.303, pl.14, figs.2-5; Knudsen, 1971, p.235, pl.6, figs.17-20; Murray, 1971, p.119, pl.49, figs.1-7; Haynes, 1973, p.122, pl.10, fig.18, text-fig.24, nos.18,19.

### Description (fig.1)

Test triserial, a high spire, about twice as long as wide. Chambers inflated with an overhanging, characteristic spiny lower margin where chamber attains maximum width. Sutures distinct, impressed. Aperture at the base of the terminal chamber face as an elongate, curved oval with an amphitheatre shaped depression with a flanged (periapertural) lip on one side and a slightly projecting internal tongue on the other side.

### Dimensions

	fig.19	fig.20	fig.1	S/11	15/30
length	378 $\mu\text{m}$ .	444 $\mu\text{m}$ .	425 $\mu\text{m}$ .	360 $\mu\text{m}$ .	278 $\mu\text{m}$ .
maximum diameter	208 $\mu\text{m}$ .	244 $\mu\text{m}$ .	246 $\mu\text{m}$ .	190 $\mu\text{m}$ .	200 $\mu\text{m}$ .

### Material

Very numerous.

### Provenance

figs.19,20,1	VE 57/-10/17 <sup>d</sup> /4 55-65 cm.
S/11	VE 51/-07/199 (not illustrated)
15/30	Aberdaron, A3 (not illustrated)
fig.2	southern Celtic Sea

### Remarks

d'Orbigny's species is readily identified and the holotype specimen, described from the Adriatic, is necessarily a distinctive form!! However, when numerous specimens are examined together, as in the present study, gradational forms exist between a number of recognized species. These may have numerous spines around the basal area, much as described and illustrated by Höglund (1947, text-figs.205-208) which he considered as gradational to *B.aculeata* d'Orbigny. I have seen specimens of this type from the southern Celtic Sea and some of the illustrated specimens here exhibit strong basal spines but these are generally broken.

Equally, smoother, more elongate test forms occur (re.6/21) which Höglund (text-figs.215-217) also described and which he considered transitional to *B.elegans* d'Orbigny as illustrated by Brady (1884, pl.50, fig.3 - not d'Orbigny); although these specimens were subsequently, after a somewhat tortuous route (see Barker 1960, p.102), placed in *B.gibba* Fornasini by Cushman and Parker (1947). My view of these elongate transitional forms (Brady's pl.50, figs.3-4 and Höglund's text-figs.215-217 being good examples, as well as 6/21) is that they are closer to *B.elongata* d'Orbigny; a form which is recognized as distinct in the present study. Furthermore, with regards to the shorter, less acutely tapering forms, a transitional series to *B.gibba* Fornasini occurs; the latter is however recognised as a distinct form in the present study.

As a result of this apparently continuous variation between the distinctive forms mentioned, I have illustrated a number of specimens which show this variation in test morphology. It should be emphasised that during the counting procedure many of these specimens were 'lumped' under the heading *B.gr.marginata*, much as Höglund (1947) and Knudsen (1971) have suggested.

### Occurrence

The reader is referred to Haynes (1973, p.123) for an extended list on the distribution of this species. Murray (1971) records it as living as a shelf species from around the British Isles and rare at the shelf-edge. However, Brady (1884) records it from nearly 3000 m. water depth west of Ireland. In summary (Murray, 1991) it appears to typically prefer normal marine salinity (35‰), temperatures between 5.5°C and 13°C, a muddy to sandy substrate and depths between 20 m. and 1400 m..

Genus                    GLOBOBULIMINA            Cushman, 1927

*Globobulimina auriculata* (Bailey) forma *arctica* Höglund

Plate 15, figs.3,4

*Bulimina ellipsoides* Goës (part), 1894, p.45 (not Costa).

*Globobulimina auriculata* (Bailey) forma *arctica* Höglund, 1947,  
p.254, text-figs.266,267,270,271.

*Globobulimina auriculata arctica* Höglund, Feyling-Hanssen, 1964,  
p.305, pl.14, fig.6; Knudsen, 1971,  
p.236, pl.6, fig.22.

### Description

Test sub-ovate in outline, sub-circular in sectional view. Greatest breadth below mid-height, about 1 1/2 times as long as broad. Base somewhat produced, rounded. Chambers are inflated and strongly enveloping; final whorl accounting for nearly 1/5 test length. Sutures distinct, slightly impressed. Aperture terminal, with a suture immediately below it and connecting via a narrow slit; distinctly curved and protruding tooth-plate, bordered by a delicate lip.

### Dimensions

	fig.3	fig.4
length	547 µm.	629 µm.
maximum diameter	320 µm.	371 µm.

### Material

Limited numbers only.

### Provenance

fig.3 VE 57/-09/46 a/6, 5-10 cm.  
fig.4 VE 56/-09/142 a/6, 17-19 cm.

### Remarks

This form is assigned to Höglund's arctic form '*arctica*' only tentatively and largely on the basis that it has a suture associated with the aperture. However, it does not exhibit the broadly rounded base which typically characterizes '*arctica*' forms and its occurrence in surficial Holocene sands in the present

study further implies that these specimens belong elsewhere?

#### Occurrence

Höglund (1947) states that all Arctic specimens designated by Goës (1894) to *Bulimina ellipsoides* belong here; its modern distribution also includes Spitzbergen (Nagy, 1965 at 37 m.), Hudson Bay (Leslie, 1965 between 100-230 m.) and off Alaska (Loeblich & Tappan, 1953 between 37-223 m.).

Feyling-Hanssen (1964) notes it as rare in the Oslofjord area and restricted to Pleistocene and early Holocene deposits. Knudsen (1971) records it from the Older *Yoldia* Clay and the Lateglacial *Yoldia* Clay of the Løkken area, Vendsyssel.

*Globobulimina auriculata* (Bailey) cf. forma *gullmarensis* Höglund

Plate 15, fig.5

see *Bulimina ellipsoides* Goës (part.), 1894, p.45 (not Costa).

see *Globobulimina auriculata* (Bailey) forma *gullmarensis* Höglund, 1947, p.252, pl.20, fig.6, pl.21, fig.5, pl.22, fig.6, text-figs.258-265,268,269,271.

see *Globulina auriculata gullmarensis* Höglund, Feyling-Hanssen, 1964, p.305, pl.14, figs.7,8.

#### Description

Test ovate to inflated fusiform, circular in section. Greatest breadth at mid-height, length about  $1\frac{1}{3}$  breadth. Base broadly rounded, chambers enveloping, final whorl accounting for  $\frac{1}{5}$  test length. Sutures distinct, nearly flush. Aperture terminal, without suture, with a small, flared tooth-plate and bordered by a slightly raised collar.

#### Dimensions

length 640  $\mu$ m., maximum diameter 416  $\mu$ m.

#### Material

Single specimen only.

#### Provenance

VE 57/-10/21 <sup>b</sup>/5, 88-91 cm.

#### Remarks

This specimen is assigned to Höglund's (1947) Gullmar Fjord form on the basis that it lacks a suture below the aperture, although the broadly rounded base is more typical of the Arctic forms. This specimen is therefore distinguished from the other species of *Globobulimina* in this study by its more regularly ovate test and lack of a suture below the aperture.

#### Occurrence

Described as abundant from the deepest parts of the Gullmar



Fjord on the Swedish west coast but as extremely rare from the Skagerrak (Höglund, 1947). Feyling-Hanssen (1964) describes it as infrequent in Holocene sediments of the Oslofjord area.

Family            BULIMINELLIDAE      Hofker, 1951  
 Genus            BULIMINELLA        Cushman, 1911

*Buliminella elegantissima* (d'Orbigny)

Plate 15, figs.6,7

*Bulimina elegantissima* d'Orbigny, 1839, p.51, pl. 7, figs. 13, 14;  
 Williamson, 1858, p.64, pl.5,  
 figs.134, 135; Brady, 1884, p.402,  
 pl.50, figs. 20-22.

*Buliminella elegantissima* (d'Orbigny) Cushman, 1911, p.88;  
 Höglund, 1947, p.215, pl.18, fig.1,  
 text-figs. 196, 197; Feyling-  
 Hanssen, 1964, p.302, pl.14, fig.1 ;  
 Knudsen, 1971, p.234, pl.6, fig.15;  
 Revets, 1990, p.337, pl.1,  
 figs.1-11, pl.2, figs.1-15, pl.3,  
 figs.1-11.

*Buliminella borealis* Haynes, 1973, p.114, pl.22, figs.1-3.

Description (fig.6)

Test small, elongate, about twice as long as wide, sub-fusiform. Chambers numerous, very high and narrow, final whorl c.10 chambers and comprising most of the test. Sutures distinct only very slightly depressed and gently sinuous. Wall finely perforate, smooth, except along sutures and around apertural face which extends for over half the test length. Aperture oval within the upper third of apertural face and bordered by a closed and everted periapertural lip ( partly obscured by sediment ).

Dimensions

	fig.6	fig.7	(6/9)
maximum length	179 $\mu$ m.	200 $\mu$ m.	190 $\mu$ m.
maximum diameter	77 $\mu$ m.	100 $\mu$ m.	90 $\mu$ m.

Material

Moderate numbers, not very common.

Provenance

fig.6 Aberdaron, A/10.  
 fig.7 VE 57/-09/60<sup>d</sup>/4, 30-33 cm.  
 6/9 Aberdaron, A12 (not illustrated).

Remarks

The reader is directed to Revets' (1990) paper on the revision of *Buliminella* and a through treatment of the type species *B.elegantissima* (d'Orbigny). The present form is, however, typical of the smaller N. Atlantic type which Haynes assigned to *B.borealis* and which, according to Revets, "represents nothing but an ontogenetic stage of *B. elegantissima*"; the present forms do show signs of the periapertural lip - a feature which Haynes considered important in separating these forms. And again (Revets, 1990) "the smaller specimens are indistinguishable from *B. borealis*, proving beyond doubt the validity of synonymizing *B. borealis*" - talking of the ontogenetic sequence in S. American specimens, from the type locality: Payta, Chile, Recent.

Occurrence

The species appears to be widespread (Haynes 1973, Revets 1990) with even Arctic records by Leslie (1965), Todd & Low (1967). For Quaternary records see Knudsen (1971), although this species never occurs in any great abundance eg. <1% in Quaternary deposits of Vendsyssel, Denmark.

Family	UVIGERINIDAE	Haeckel, 1894
Genus	UVIGERINA	d'Orbigny, 1826

*Uvigerina peregrina* Cushman

Plate 15, figs.8,9,10

*Uvigerina peregrina* Cushman, 1923, p.166, pl.42, figs.7-10; Höglund, 1947, p.279, pl.23, fig.9, text-figs.291-304; Feyling-Hanssen, 1964, p.316, pl.15, figs.27-29; Murray, 1971, p.121, pl.50, figs.1-7

Description

Test elongate, more than twice as long as broad, triserial but tending towards biserial in later stages. Chambers inflated, ornamented by blade-like longitudinal costae which extend over a single chamber and just onto the preceeding one. Sutures distinct, strongly impressed. Aperture terminal, circular, at the end of a short neck and bordered by a distinctive, everted phialine lip with an open, cone-shaped tooth plate with crenulate margin.

Dimensions

	4/23	fig.9	fig.8
length	840 μm.	307 μm.	766 μm.
maximum diameter	540 μm.	215 μm.	333 μm.

Material

Numerous specimens

Provenance

figs.8,10 VE 56/-09/142 <sup>a</sup>/6, 17-19 cm.  
fig.9 VE 56/-09/142 <sup>b</sup>/6, 63-67 cm.  
4/23 VE 57/-09/89 <sup>a</sup>/6, 10-20 cm.

Remarks

I have adopted rather a broad species concept in dealing with this form, much as outlined and beautifully illustrated by Höglund (1947), and present only the most basic synonymy here. Various, this form has been designated *U.pigmea* d'Orbigny, *U.pygmaea* Goës (not d'Orbigny), *U.mediterranea* Hofker, *U.acuticosta* Harris and *U.finisterrensis*.

The apertural view illustrated (pl.15, fig.10) shows a particularly well developed apertural toothplate, these are normally damaged, and a fold in the phialine lip, which is normally circular, is visible.

Occurrence

Recorded from the outer shelf around S.W. Britain (Murray, 1971), its distribution is widespread. Murray (1991) records its ecological requirements from the Atlantic seaboard of Europe and Africa as follows: *U.peregrina* association, salinity: 34.9-35.1 p.p.t, temperature: 6-15°C, substrate: sand and mud rich in organic carbon, depth: 201-3000 m.. It may be locally abundant (up to 30%) on the Norwegian shelf in association with fine grained sediments (Sejrup *et al.*, 1981). It's occurrence in Quaternary deposits is discussed by Knudsen (1971).

Genus TRIFARINA Cushman, 1923

*Trifarina angulosa* (Williamson)

Plate 15, figs.11,12,13

*Uvigerina angulosa* Williamson, 1858, p.67, pl.5, fig. 140.

*Angulogerina angulosa* (Williamson) Cushman, 1927, p.69; Höglund, 1947, p.283, pl.23, fig.8, text-figs. 305-308; Feyling-Hanssen, 1964, p.137, pl.16, figs.1-3.

*Trifarina angulosa* (Williamson) Loeblich & Tappan, 1964a, C571, fig.450,1-3; Knudsen, 1971, p.241, pl.18, figs.8,9; Murray, 1971, p.123, pl.51, figs.1-6.

Description

Test elongate, more than twice as long as broad, trigonal in sectional view. Triserial initially, tending towards uniserial chamber arrangement as final chambers are added. Chambers inflated centrally but tapering towards the aperture and at the base, triangular in section. Ornamentation consists of longitudinal costae, three strongly developed at edges and continue over

sutures to form keels (carinae), others feinter and less continuous. Sutures distinct, impressed; test perforate. Aperture terminal, at the end of a short neck with everted phialine lip and internal toothplate.

#### Dimensions

	5/19	fig.13	fig.11	fig.12	4/30	4/32
(1)	428 $\mu\text{m}$ .	280 $\mu\text{m}$ .	646 $\mu\text{m}$ .	629 $\mu\text{m}$ .	629 $\mu\text{m}$ .	692 $\mu\text{m}$ .
(2)	220 $\mu\text{m}$ .	120 $\mu\text{m}$ .	246 $\mu\text{m}$ .	286 $\mu\text{m}$ .	228 $\mu\text{m}$ .	213 $\mu\text{m}$ .

#### Material

Numerous specimens

#### Provenance

fig.13 VE 57/-09/60 <sup>a</sup>/4, 35-39 cm.  
 fig.11 VE 56/-09/142 <sup>b</sup>/6, 63-67 cm.  
 fig.12 VE 57/-10/17 <sup>b</sup>/4, 70-75 cm.  
 4/30 & 32 VE 48/-09/97  
 5/19 VE 57/-09/60 <sup>a</sup>/4, 22-24 cm. "inner".

#### Remarks

The present form shows variation in the development of longitudinal costae which may be almost entirely absent from the chamber faces (as in 5/19) or very numerous and strong (as in 4/30). Transitional forms exist between this species of *T.fluens*, although the latter is distinguished by its more inflated chambers, more weakly developed longitudinal costae and most importantly its lack of carinae which give *T.angulosa* its triangular appearance in sectional view. *T.bradyi*, although triangular in section, is distinguished from this form by its distinctive uniserial chamber arrangement in later growth stages.

The size ranges of the present material appears to be somewhat larger than the values typically quoted for this species although Cushman quotes lengths of up to 1 mm.; See discussion by Haynes (1973), p.127). Maximum lengths of 700  $\mu\text{m}$ . were observed here and are considered acceptable within the species concept as specified by Cushman's (1923) paratype material; although there is a problem therein in that this includes Pacific material.

#### Occurrence

There is a little confusion in the literature regarding this species which Haynes (1973) suggests is "widespread in the N. Atlantic and Arctic. Records from warmer waters and the Pacific appear to refer to other species". Feyling-Hanssen (1964, p.318), on the other hand, states "According to Nørvang (1945, p.37) this species is in Recent time mainly distributed in Boreal & Lusitanian parts of the Atlantic and the Pacific, which is in good keeping with its occurrence in the Holocene deposits of the Oslofjord area". Murray, in an attempt to summarise its ecological requirements from the Atlantic Seaboard of Europe & Africa says of the *T.angulosa* association :- salinity 35 ppt; temperature 1-2°C; substrate gravel/sand/silty mud; depth 128-801 m..

While it occurs in late Quaternary sediments from the Oslofjord area and elsewhere in Vendsyssel, it is never very frequent.

*Trifarina bradyi* Cushman

Plate 15, fig.14

*Trifarina bradyi* Cushman, 1923, p.99, pl.22, figs.3-9; Barker, 1960, p.140, pl.67, figs.1-3 (with comments); Murray, 1971, p.125, pl.52, figs.1-6.

Description

Test elongate, about one and a half times as long as wide, triangular in cross-section throughout. Initially triserial, later chambers uniserial with three very distinct angles and slightly concave faces with faint lineation. Sutures indistinct and curving down onto the carinate margins forming low arches as they cross each face. Aperture terminal, bordered by a thickened lip; no toothplate observed.

Dimensions

length 285  $\mu$ m.            maximum diameter 160  $\mu$ m.

Material

Single specimen only.

Provenance

VE 57/-09/46 <sup>e</sup>/6, 79-82 cm.

Remarks & Occurrence

There is considerable difficulty in assigning specimens to this form, in that *T.angulosa* shows a tendency towards uniserial growth and may often lack distinct longitudinal costae. However, the tendency towards uniserial growth in the latter appears to come only as the final two or three chambers are added whereas most of the growth in the present form is uniserial. This form is not as strongly carinate as Brady's illustrated species from Bermuda (= *Rhabdogonium tricarinatum* (d'Orbigny); according to Cushman (1923) this species is not synonymous with *Vaginulina tricarinata* d'Orbigny.

Murray (1971) records this species as belonging to the outer shelf and as rare on the shelf edge by the Western Approaches to the English Channel.

*Trifarina fluens* (Todd)

Plate 15, figs.15,16,17,18

*Angulogerina fluens* Todd, in Cushman & Todd, 1947, p.67, pl.16, figs. 6,7; Loeblich & Tappan, 1953, p.112, pl.20, figs.10-12p.112, pl.20, figs.10-12; Feyling-Hanssen, 1964, p.318, pl.16, figs.4,5.

*Angulogerina angulosa* (Williamson) Cushman, 1948, p.66, pl.7, fig.8 (not *Uvigerina angulosa*)

Williamson, 1858).

*Trifarina fluens* (Todd) Michelsen, 1967, p.227, pl.2, fig.14;  
Knudsen, 1971, p.242, pl.7,  
figs.12-15, pl.18, fig.10.

Description (fig.16)

Test elongate, about twice as long as broad, triserial throughout. Chambers inflated with rounded surface and faint longitudinal costae which may extend over more than one chamber. Sutures distinct, impressed. Greatest diameter over final whorl, tapering towards a terminal aperture with a thick lip. Distinctly perforate, surface uneven.

Dimensions

	fig.16	fig.15	fig.18(?)	fig.17
length	290 $\mu$ m	260 $\mu$ m	350 $\mu$ m	370 $\mu$ m
maximum diameter	177 $\mu$ m	180 $\mu$ m	175 $\mu$ m	170 $\mu$ m

Material

Moderate numbers.

Provenance

fig.17	Aberdaron, A12 <sub>f</sub>
fig.16	VE 56/-09/142 <sup>f</sup> /6, 10-12 cm.
fig.15	VE 57/-09/46 <sup>e</sup> /6, 68-73 cm.
fig.18	VE 57/-09/46 <sup>e</sup> /6, 17-20 cm.

Remarks & Occurrence

This form is distinguished from *T.angulosa* by its less angular form, more inflated and rounded chambers. I have not observed any specimens which attain the dimensions quoted by Loeblich and Tappan (1953) for hypotype material from Frobisher Bay and Northern Alaska at depths between 37-100 m., although the present values are typical of material illustrated by Feyling-Hanssen (1964) from Late Glacial deposits near Troms, North Norway and by Knudsen (1971) from Sandnes, southwest Norway and from the Older *Yoldia* Clay of Frederikshavn, Vendsyssel. This species appears to have an Arctic affinity and, as illustrated by Cushman (1948), many Arctic references to *T.angulosa* may belong here.

Genus                    CANCRIS                    Montfort, 1808

*Cancris oblongus* (Williamson)

Plate 16, figs.1,2,3

*Rotalina oblonga* Williamson, 1858, p.51, pl.4, figs.98-100.

*Cancris oblongus* (Williamson) Cushman & Todd, 1942, p.80, pl.20, figs.2-5; Le Calvez, 1958, p.184, pl.3, figs.42-43; Haynes, 1973, p.145, pl.20, fig.13, pl.23, figs.5-6, text-fig.27, nos.1-3.

*Pulvinulina auricula* Gøes, 1894, p.98, pl.16, fig.809 (not 810) (not Fichtel & Moll).

*Cancris auricula* Cushman, 1931, p.72, pl.15, fig.1; Murray, 1971, p.137, pl.57, figs.1-7 (not Fichtel & Moll).

#### Description (fig.1)

Test large, sub-ovate, compressed. Periphery acute, with slight keel developed over the last two chambers and tendency to become increasingly lobate. Chambers inflated, tapering towards the periphery, about twice as high as long, arranged in a low trochospire with 7 chambers visible in the final whorl. Sutures distinct, impressed and radial on the ventral side, becoming deeply incised as they meet the umbilicus. Dorsal sutures distinct, limbate and curved backwards at the periphery. Test smooth, densely perforate except in an oval over the basal area of the apertural face and onto the distinctive umbilical flaps. Aperture a narrow slit along the ventral basal suture, extending under the umbilical flap.

#### Dimensions

	fig.1	fig.2	fig.3	L/17
maximum length	1.06 mm.	1.01 mm.	466 $\mu$ m.	447 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

fig.3 VE 57/-09/60 <sup>a</sup>/4, 22-24 cm. 'outer'

fig.1 VE 57/-09/89 0.2-0.3 m.

fig.2 VE 57/-09/89 <sup>a</sup>/6, 80-90 cm.

L/17 Laugharne, Taf estuary, S. Wales (not illustrated).

#### Remarks

The present material agrees with the description and illustrations of *C.oblongus* by Haynes (1973) and are tentatively placed here. They also closely resemble Murray's (1971) figures of *C.auricula* (Fichtel & Moll) which he notes "has sometimes been recorded as *C.oblonga* (Williamson)". However, as Haynes (1973, p.147), following Cushman and Todd (1942) and Le Calvez (1958), has remarked "this species is distinguished from *C.auriculus* by

its more elongate and compressed test and narrower chambers as well as by the pronounced incision of the sutures in the umbilical area; *C.oblongus* also appears to be more flattened on the dorsal side and to possess a larger umbilical lobe".

Heron-Allen and Earland (1913) have also noted the difficulty of separating the two species and record both from, for example, shore 'gatherings' at Mulranny, Clew Bay, Ireland. Here *P.auricula* is recorded as frequent while *P.oblonga* is very rare. I have examined T.S.82, sq.67 at the British Museum (N.H.) and find the specimens difficult to separate; unfortunately Heron-Allen and Earland also failed to distinguish their specimens on this slide.

#### Occurrence

Numerous records from west and southwest Britain exist for both *C.oblongus* and *C.auriculus*, although only Le Calvez (1958) appears to have recorded both forms together from the Celtic Sea. Eastern Atlantic records include Cushman and Todd (1942) and Phleger and Parker (1951), while Mediterranean records include Todd (1958) and Parker (1958) as well as the Arctic (Goës, 1894). I can find no previous Quaternary records of this species.

Family	DISCORBIDAE	Ehrenberg, 1838
Genus	DISCORBIS	Lamarck, 1804

*Discorbis?* (*Rotaliella*) *chasteri* (Heron-Allen and Earland)

Plate 16, figs.4,6

*Discorbina minutissima* Chaster, 1892, p.65, pl.1, fig.15.

*Discorbina chasteri* Heron-Allen & Earland, 1913, p.128, pl.13, figs.1-3; Heron-Allen & Earland, 1916, p.272.

*Discorbis chasteri* (Heron-Allen & Earland) Harris, 1958, p.343, pl.30, fig.2a-c.

#### Description

Test minute/very small, trochospiral, sub-ovate. Periphery broadly rounded with  $3\frac{1}{2}$  inflated chambers visible in final whorl. Sutures distinct, deeply incised, radial with each chamber ornamented by 2 or 3 deep slits which extend from the deeply excavated umbilicus onto the periphery. Test wall finely perforate. Aperture obscured but appears to be a simple opening deep within the umbilicus.

#### Dimensions

maximum diameter 140  $\mu$ m.; thickness c.55  $\mu$ m.

#### Material

Never frequent but fairly ubiquitous.



Provenance

VE 57/-09/89 2.4-2.45 m.

Remarks & Occurrence

This minute species is rarely illustrated and this may partly be a function of the sieve size employed by most workers. The specimen illustrated here agrees well with the specimen figured by Harris (1958) which he records as widely distributed but rare from N. Scotland at depths shallower than 240 m.

This form might possibly belong in the genus *Rotaliella* Grell (1954) although I have not observed the denticulate umbilical margin reported in that genus. It certainly lacks the secondary chamberlets reported in *Discorbis*.

? *Discorbis* (*Discorbinella*) *bertheloti* (d'Orbigny)

Plate 16, figs.6,7

*Rosalina bertheloti* d'Orbigny, 1839, p.135, pl.1, figs.28-30.

*Discrobina berthelotianana* (d'Orbigny) Parker & Jones, 1865, pl.17, figs.26-27; Goës, 1894, p.93, pl.15, figs.790a,b.

*Discorbina bertheloti* (d'Orbigny) Brady, 1884 (pars), p.650, pl.89, figs.11,12.

*Discorbis bertheloti* (d'Orbigny) Cushman, 1915?, p.20, pl.7, fig.3; Harris, 1958, p.340, pl.29, fig.9 (with extensive synonymy).

Description

Test a low trochospire, flattened, concavo-convex. Periphery sub-acute, finely keeled and slightly lobate as later chambers are added. Chambers numbering 9 in the final whorl with strongly curved backwards limbate sutures and slight umbilical depression on the ventral side; slight flattened boss developed on dorsal side. Test wall thin and delicate, finely perforate. Aperture a low arch bordered by a distinctive lip and extending backwards from the periphery under flap-like projections of earlier chambers on the dorsal side.

Dimensions

	fig.6	fig.7
maximum diameter	450 $\mu$ m.	413 $\mu$ m.

Material

Two specimens only.

Provenance

VE 57/-09/89 0.65-0.70 m.

#### Remarks and Occurrence

There appears to be some confusion in the literature regarding the correct generic affinity of specimens previously assigned to the genus *Discorbis*. The present form is placed in *D.bertheloti*, although it may be that it is better referred to as *Discorbinella*.

Harris (1958) records this species as "well represented" in deeper water (300-350 m.) northeast of the Shetlands.

Family	ROSALINIDAE	Reiss, 1963
Genus	ROSALINA	d'Orbigny, 1826

*Rosalina anomala* Terquem

Plate 16, figs.8,9,10

*Rosalina anomala* Terquem, 1875, p.438, pl.5, fig.1; Haynes, 1973, p.150, pl.17, figs.1-3, pl.19, fig.2, pl.30, figs.1-2, text-fig.28, nos.1-7 (with extensive synonymy).

*Rosalina globularis* Voorthuysen, 1958, p.33, pl.24, fig.16; Haake, 1962, p.43, pl.3, figs.10-11 (not d'Orbigny).

*Discorbina globularis* Goës, 1894, p.94, pl.15, figs.793a,b (not d'Orbigny).

*Discorbis globularis* Cushman, 1931, p.22, pl.4, figs.9a-c; 1948, p.68, pl.7, fig.12 (not d'Orbigny).

#### Description

Test concavo-convex, with an evolute, convex dorsal side and involute, concave ventral side; periphery sub-angular to sub-rounded, lobate. Dorsal side with 13 chambers visible, increasing steadily in size, apart from the final two chambers which are much larger; very coarsely perforate. Ventral side imperforate, 5 chambers visible in the final whorl with distinctive, hooked umbilical beaks and a deep umbilicus. Sutures impressed, particularly on the ventral side where they open into the umbilicus, strongly curved backwards towards the periphery. Aperture interio-marginal, extending from the periphery beneath the umbilical beak (lobe) as far back as the sutural slit of the previous chamber; a thin, arched lip borders the aperture. Test wall smooth and imperforate on ventral side, coarsely perforate (> 5  $\mu$ m. diameter) on dorsal side.

#### Dimensions

	fig.8	fig.9	fig.10
maximum diameter	365 $\mu$ m.	400 $\mu$ m.	400 $\mu$ m.

Material

Limited numbers only.

Provenance

fig.8 VE 57/-09/89 2.25-2.35 m.  
fig.9 VE 57/-10/17 2.1-2.2 m.  
fig.10 VE 56/-09/142 1.22-1.25 m.

Remarks

This form is readily confused with *R.globularis* as the very brief outline synonymy (above) indicates; this is partly because of the broad species concept commonly applied to the latter. The present material agrees very closely with the descriptions and illustrations given by Haynes (1973), particularly the coarsely perforate appearance of the dorsal side and the red-brown colour of the early whorls. Haynes discusses the basis for assigning this form to Terquem's largely overlooked species *R.anomala*.

Occurrence

Confusion with *R.globularis* is a problem faced when attempting to work out the distribution of this species. It is known from around the British Isles and from its growth form can be assumed to live an attached mode of life, possibly associated with seaweeds. It was first described by Terquem (1875) from beach sands at Dunkirk. Cushman (1948) records it from the Arctic, while Parker and Jones (1865) record it from the Davis Strait; its occurrence within the present study indicates a preference for boreal climatic conditions.

*Rosalina* cf. *bradyi* (Cushman)

Plate 16, figs.11,12,13.

Description

Test a flattened concavo-convex, with evolute dorsal side and involute ventral side; periphery sub-angular and lobate. Dorsal side gently convex with 10 chambers visible, increasing rapidly in size in the last whorl, so that the final chamber is nearly equal in length to the test diameter. Ventral side flattened, 4<sup>1</sup>/<sub>2</sub> chambers visible with distinctive 'hammer-shaped' umbilical beaks. Dorsal sutures slightly impressed, gently curving backwards to the periphery; spiral suture distinct. Ventral sutures nearly straight, increasingly sigmoid between earlier chambers, tapering down from the open and excavated umbilicus. Test wall mostly smooth on the ventral side, perforate (<5 μm.) on dorsal side. Aperture interiomarginal, extending from the periphery, beneath the umbilical lobe, to the previous suture.

Dimensions

	fig.11	fig.12	fig.13
maximum diameter	400 μm.	680 μm.	440 μm.

Material

Limited numbers only.

#### Provenance

- fig.11 Laugharne, Taf estuary, S.Wales.  
fig.12 VE 48/-10/51, southern Celtic Sea.  
fig.13 VE 57/-10/17 2.1-2.2 m.

#### Remarks and Occurrence

This form is often difficult to distinguish from *R.anomala* of the present study, a species which it clearly resembles. However, it differs from the latter in being generally flatter, having finer dorsal perforation, and in the style of the umbilical beaks, which are generally more strongly developed and 'hammer-shaped'. These specimens bear an affinity to specimens described and illustrated by Haynes (1973, p.153, pl.17, figs.4-5; pl.19, figs. 1,3,6; text-fig.28, nos.8-11) as *R.cf.bradyi* and are tentatively placed here. Haynes' described specimen comes from the Dovey estuary, W.Wales. Murray's (1971) specimens of *R.globularis* probably belong here; these are described as an inner shelf species of southern affinity.

*Rosalina praegeri* (Heron-Allen & Earland)

Plate 16, fig.14

*Discorbina praegeri* Heron-Allen & Earland, 1913b, p.122, pl.10, figs.8-10.

*Discorbis* (?) *praegeri* (Heron-Allen & Earland) Cushman, 1931, p.30, pl.6, figs.4a-c (figures after Heron-Allen & Earland).

*Gavelinopsis praegeri* (Heron-Allen & Earland) Hofker, 1951a, p.486, text-figs.332-334; Loeblich & Tappan, 1964a, C578, text-fig.456, no.4; Murray, 1970, p.484(list), pl.2, figs.17-18; Murray, 1971, p.133, pl.55, figs.1-5.

#### Description

Test plano-convex with an acute, thickened, imperforate and sub-carinate periphery, tending to become lobate as later chambers are added. Dorsal, spiral side, convex; sutures distinct, almost flush. Ventral side flat with  $6\frac{1}{4}$  chambers visible in the final whorl. Ventral sutures distinct, impressed becoming open at umbilical end, curving backwards towards the periphery. The umbilicus is filled by a flat, imperforate plug and bordered by sub-trigonal lobes projecting from the end of each chamber. Test wall perforate only towards the outer, ventral surface of each chamber; no dorsal perforation visible. Aperture a narrow slit along the basal suture beneath a large flap with crenulate margin and distinct notches both proximally & distally.

Dimensions

	fig.14	12/21	12/8
Maximum diameter	243 $\mu$ m.	243 $\mu$ m.	262 $\mu$ m.

Material

Numerous specimens.

Provenance

fig.14 Laugharne, Taf Estuary, S. Wales.  
12/21 VE 57/-09/46<sup>a</sup>/6, 47-51 cm.(not illustrated).  
12/18 VE 57/-09/46<sup>a</sup>/6, 33-38 cm.(not illustrated).

Remarks

The development of the umbilical plug in this form is a highly variable feature which Haynes (1973, p.161) discusses at some length in view of the basis of distinction between this species and *R. williamsoni* as proposed by Heron-Allen & Earland (1913b). These two species are most readily distinguished by the restricted pore distribution of *R. praegeri* and its generally more conical and robust looking test. Haynes (1973) has demonstrated that forms of *R.praegeri* occur which lack umbilical plugs; a feature which has been the basis of generic distinction in the past.

The distinctive distal apertural notch recorded & illustrated here is partly visible in Haynes' pl.17, fig.9 and illustrated by Murray (1971); however, it is the proximal notch which has been noted upon in the past.

Occurrence

Murray (1971) records the species living in the shelf waters around the British Isles; accounting for up to 11% of faunas at depths between 84-95 m. in the English Channel south of the Lizard (Murray, 1970).

*Rosalina williamsoni* (Chapman & Parr)

Plate 16, fig.15

*Rotalina nitida* Williamson, 1858, p.54, pl.4, figs.106-108  
(homonym of *Rotalina nitida* Reuss).

*Discorbina nitida* (Williamson) Wright, 1889, p.449.

*Discorbis nitida* (Williamson) Cushman, 1931, p.26, pl.6,  
figs.1a-c.

*Discorbis williamsoni* Chapman & Parr, 1932, p.226, pl.21, fig.25.

*Rosalina williamsoni* (Chapman & Parr) Voorthuysen, 1958, p.34,  
pl.24, fig.1; Haake, 1962, p.43,  
pl.4, figs.1,2; Haynes, 1973, p.162,  
pl.17, figs.13-15, text-fig.31,  
nos.1-4.

Description

Test plano-convex, compressed. Dorsal side a low cone, evolute with full spiral of chambers visible in two whorls; sutures distinct, flush. Ventral side flat, five chambers visible in final whorl, sutures distinct, impressed, sinuous and backwards curving. Umbilicus a central depression with small central boss surrounded by numerous irregular lobes. Aperture a narrow slit along ventral basal suture extending into the umbilicus together with what appears to be a secondary tubular opening on the ventral surface final chamber.

Dimensions

maximum diameter = 330  $\mu$ m.

Material

Single specimen only.

Provenance

VE 57/-10/17 <sup>c</sup>/4, 10-20 cm.

Remarks

This form is highly compressed and closely resembles *R. williamsoni*; although what appears to be a secondary apertural opening is visible on the distal, ventral surface of the final chamber. The changes in generic assignment are discussed by Haynes (1973) and like him I have followed Voorthuysen (1958). It is distinguished from *R. praegeri* by its smaller umbilical plug much more compressed test and less localized perforation.

Occurrence

This form is common from around British Isles and as discussed by Haynes (*op. cit.*, p.164) many British records may have it confused with *R. praegeri*, largely as a result of Heron-Allen & Earland's (1916a) attempt to distinguish the latter from *R. williamsoni* on the basis of its umbilical plug; however both forms can be umbonate! In summary, it is widely distributed in the shallow waters of the Atlantic & Mediterranean.

Family PSEUDOPARRELLIDAE Voloshinova, 1952

Genus EPISTOMINELLA Husezima & Maruhasi, 1944

*Epistominella naraensis* (Kuwano)

Plate 17, figs.1,2

*Pseudoparrella naraensis* Kuwano, 1950, p.317, text-figs.6a-c.

*Epistominella naraensis* (Kuwano) Haynes, 1973, p.217, pl.20, fig.14, pl.23, figs.7-8, text-fig.47 nos.1-5.

? *Epistominella sandiegoensis* Uchio, 1960, p.68, pl.9, figs.6,7.

*Pulvinulinella exigua* Hofker, 1951a, p.322, text-figs.219-221 (not *Pulvinulina exigua* Brady).

#### Description

Test small, biconvex, somewhat inflated with rounded periphery, sub-circular in outline. Chambers arranged in a low trochospire, 5 visible in the final whorl. Slight umbilical depression, sutures distinct, impressed, nearly straight. Test wall smooth, finely perforate. Aperture a high-arched slit, sub-parallel to the periphery, extending upwards from the basal suture, bordered by a denticulate lip.

#### Dimensions

	fig.2	fig.1
maximum diameter	112 $\mu$ m.	128 $\mu$ m.

#### Material

Limited numbers.

#### Provenance

fig.1 VE 57/-10/17 <sup>b</sup>/4, 70-75 cm.  
fig.2 VE 56/-09/142 <sup>c</sup>/6, 83-85 cm.

#### Remarks

This form is very distinctive with  $4\frac{1}{2}$  to  $5\frac{1}{2}$  chambers in the final whorl, a broadly rounded periphery and inflated chambers. It bears some resemblance to *E.naraensis* as illustrated by Haynes (1973) and may belong here. It is readily distinguished from *E.vitrea* of the present study by its smaller, more inflated test. No specimens were observed with 6 chambers in the final whorl, as described in the type material (Kuwano, 1950), and the present specimens are therefore only tentatively assigned to this species.

#### Occurrence

The type level is the Pliocene Nara mudstone, Honshu Island, Japan. Other specimens, placed in synonymy by Haynes (1973), come from the Pacific region, often from considerable depth.

*Epistominella vitrea* Parker

Plate 17, figs.3,4,5

*Epistominella vitrea* Parker, 1953, p.9, pl.4, figs.34-36, 40-41;  
Murray, 1971, p.131, pl.54, figs.1-6

#### Description

Test small, biconvex, low trochospire. Periphery sub-acute, slightly lobate. Chambers sub-trigonal, numbering 7 in the final whorl. Dorsal side distinctly convex, ventral side only slightly convex with a slight umbilical depression. Sutures distinct, slightly depressed and gently curved. Surface 'leathery', finely

perforate. Aperture a long, narrow slit, oblique to the periphery, extending from the basal suture and bordered by a narrow lip.

#### Dimensions

	fig.4	fig.5	fig.6
maximum diameter	246 $\mu$ m.	257 $\mu$ m.	206 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

fig.4	VE 57/-10/17 <sup>b</sup> /4, 70-75 cm.
fig.5	10/35 BH 81/34, 135.9 m.
fig.3	VE 57/-09/46 <sup>f</sup> /6, 4-7 cm.

#### Remarks and Occurrence

The type specimens are from the north-central Gulf of Mexico, from a water depth of 17 m. offshore from the Mississippi Delta. The present specimens closely resemble the type specimens but are considerably larger than the 100  $\mu$ m. average greatest diameter quoted by Murray (1971), who records it as a shelf species from around the British Isles.

The 'leathery' surface ornament seen at high magnifications is a feature which I have not seen reported elsewhere for this species.

Family	PLANULINIDAE	Bermudez, 1952
Genus	HYALINEA	Hofker, 1951

*Hyalinea balthica* (Schroeter)

Plate 17, figs.6,7,8

*Nautilus balthicus* Schroeter, 1783, p.20, pl.1, fig.2.

*Anomalina balthica* (Schroeter) Cushman, 1931, p.108, pl.19, fig.3  
(with extensive synonymy)

*Hyalinea balthica* (Schroeter) Hofker, 1951, p.508, figs.345-348;  
Barker, 1960, p.230, pl.112,  
figs.1,2; Feyling-Hanssen, 1964,  
p.351, pl.21, figs.14-16; Knudsen,  
1971, p.259, pl.9, figs.7,8; Murray,  
1971, p.173, pl.72, figs.5-8.

#### Description

Test highly compressed low trochospire, very nearly plai-spiral, evolute. Periphery sub-rectangular, keeled, nearly circular in side view. Chambers deflated, numbering 8<sup>1</sup>/<sub>2</sub> in final whorl; sutures distinct, limbate and strongly curved backwards to join the robust & imperforate peripheral keel. Distinctive



umbilical flaps developed. Aperture a narrow interio-marginal slit bordered by a distinctive lip and extending backwards under umbilical flaps; test wall finely perforate.

Dimensions

	9/2	9/3	9/4	fig.6
Maximum diameters	566 $\mu\text{m}$ .	550 $\mu\text{m}$ .	523 $\mu\text{m}$ .	507 $\mu\text{m}$ .

Material

Numerous.

Provenance

fig.7 VE 57/-09/89 0.8-0.9 m.

fig.6 VE 57/-09/89 0.2-0.3 m.

Remarks

This distinctive species is typically present in the Holocene conversands of most of the vibrocores investigated from the Hebridean shelf. It differs from *Planulina ariminensis* d'Orbigny in its generally smaller size, more transparent test, finer perforation and distinctive umbilical flaps.

Occurrence

This species appears to be universally distributed in the eastern parts of the North Atlantic and according to Nørvang (1945) its "main distribution: the boreal and lusitanian parts of the Atlantic and the Pacific. Vertical range: from 40 m. down to 4500 m., but normally found in shallow water". It is restricted but often common, to west & south coasts of Iceland. It is equally common in Quaternary deposits eg. together with *Cassidulina laevigata carinata* it is an index fossil of oldest Quaternary deposits of the Mediterranean (Selli, 1967).

Genus                    PLANULINA                    d'Orbigny, 1826

*Planulina ariminensis* d'Orbigny

Plate 17, figs.9,10

*Planulina ariminensis* d'Orbigny, 1826, p.280, pl.14, figs.1-3;  
Voorthuysen, 1950b, p.66, pl.4,  
fig.1; Barker, 1960, p.192, pl.93,  
figs.10,11; Knudsen, 1971, p.258,  
pl.9, figs.4-6.

Description

Test compressed, discoid, low trochospire, evolute on both sides. Periphery rectangular, about 12 chambers visible in final whorl. Sutures limbate, curved backwards to join the imperforate thickened keel. Aperture a low, interio-marginal arch extending backwards beneath slightly developed, imperforate umbilical flaps. Test coarsely perforate on ventral side, scattered pores on dorsal side.

Dimensions	fig.9	fig.10	15/1
maximum diameter	690 $\mu\text{m}$ .	626 $\mu\text{m}$ .	660 $\mu\text{m}$ .

Material

Limited to 3 specimens only.

Provenance

fig.9 VE 57/-10/21<sup>d</sup>/5 52-55 cm.  
 fig.10 VE 48/-09/148, Celtic Sea  
 15/1 VE 57/-09/89<sup>b</sup>/6 80-90 cm.(not illustrated).

Remarks and Occurrence

This species, while resembling *Hyalinea balthica* in its general discoid form, is readily identified by its coarsely perforate and thickened test wall. The present form is in close agreement with specimens illustrated by Knudsen (1971) from Sandnes, Norway. Other Quaternary records include the Older *Yoldia* Clay at Hirtshals (Knudsen, 1971) and older Pleistocene deposits of the Netherlands (Voorthuysen, 1950b).

Family	CIBICIDIDAE	Cushman, 1927
Genus	CIBICIDES	de Montfort, 1808

*Cibicides lobatulus* (Walker & Jacob)

Plate 17, figs.11,12,13,14

*Nautilus lobatulus* Walker & Jacob, 1798, p.642, pl.14, fig.36

*Truncatulina lobatula* (Walker & Jacob) d'Orbigny, 1839b, p.134, pl.2, figs.22-24 (as '*lobata*').

*Cibicides lobatulus* (Walker & Jacob) Cushman, 1927a, p.93, pl.20, fig.4; Murray, 1971, p.175, pl.73, figs.1-7; Haynes, 1973, p.173, pl.20, figs.1,2, pl.21, figs.3,5,6, pl.33, figs.1-7, text-fig.35, nos.4-10 (with extensive synonymy).

Description (figs.11,13)

Test a low trochospire, plano-convex with flattened dorsal side and convex ventral side. Periphery sub-angular, slightly carinate and lobate with about 7 chambers visible in the final whorl. Chambers increasing slowly, tending to become longer than high. Ventral sutures distinct, impressed and curved backwards at the periphery. Dorsal sutures distinct, thickened, particularly the spiral suture. Test coarsely perforate, but with fewer pores on dorsal side. Aperture a low arch beneath a distinctive lip extending from the ventral side onto the dorsal side and backwards along the spiral suture.

#### Dimensions

	8/fig.11	fig.12	fig.13	8/33
maximum diameter	640 $\mu\text{m}$ .	620 $\mu\text{m}$ .	493 $\mu\text{m}$ .	533 $\mu\text{m}$ .
	8/34	8/35	fig.14	
maximum diameter	950 $\mu\text{m}$ .	1.0 mm.	1.03 $\mu\text{m}$ .	

#### Material

Very numerous.

#### Provenance

figs.11,12,13	VE 57/-09/46 <sup>a</sup> /6	38-43 cm.
8/33	VE 57/-10/17 <sup>a</sup> /4	0-5 cm.
8/34,35	VE 57/-10/17 <sup>b</sup> /4	70-75 cm.
fig.14	VE 56/-09/142 <sup>b</sup> /6	22-25 cm.

#### Remarks

This species exhibits a considerable degree of variation in form, although the specific features which distinguish it from other species of *Cibicides* are readily identifiable. Nyholm (1961) has discussed this morphological variation in detail and the reader is directed to Haynes (1973, p.174) for a general overview of the somewhat unusual specific and generic affinities of this and related species.

In counting many of the samples of this study I have adopted a broad taxonomic view of this species. However, I have described and illustrated two other distinct forms which occur and which can be distinguished quite readily when placed together on a grid slide; these are *C.pseudoungerianus* and *C.refulgens*.

#### Occurrence

Due to the problems of taxonomic lumping, many of the records of *C.lobatulus* from around the world's oceans may not belong there. For example, Barker (1960) reproduces figures of *C.lobatulus* from Brady (1884 = *Truncatulina lobatula*) and as mentioned by Haynes (1973) it would appear that only the material illustrated from Vigo Harbour, Spain belongs here (ie. Brady, 1884, pl.93, figs.1a-c). However, this species does appear to be very widely distributed in the North Atlantic area and is generally most abundant on the inner-shelf, particularly in areas of high current velocities or of seaweed growth where its attached mode of life is well suited.

Quaternary records are numerous, particularly in sandy and coarser sediments, see Knudsen (1971) or Feyling-Hanssen (1964), for examples.

#### *Cibicides pseudoungerianus* (Cushman)

Plate 17, fig.15; Plate 18, figs.1,2

*Truncatulina ungeriana* (d'Orbigny) Parker & Jones, 1865, pl.16, figs.23-25; Brady, 1884, pl.94, figs.9a-c.

*Truncatulina pseudoungerianus* Cushman, 1922, p.97, pl.20, fig.9

*Cibicides pseudoungerianus* (Cushman) Cushman, 1931, p.123, pl.22, figs.3-7; Barker, 1960, p.194, pl.94, fig.9 (after Brady, 1884); Feyling-Hanssen, 1964, p.340, pl.19, figs.4-6; Murray, 1971, p.177, pl.74, figs.1-6.

#### Description

Test a low trochospire with flattened, slightly convex dorsal side and distinctly convex ventral side. Periphery sub-angular, regular, sub-circular in outline. Chambers increasing slowly, numbering about 9 in the final whorl. Sutures distinct, impressed and curving gently backwards to the periphery. Ventral side with an umbilical depression filled with an imperforate area, test otherwise coarsely perforate, except the apertural face which is also imperforate. Aperture a low arch with distinctive lip extending along the basal suture of the final chamber from the ventral side onto the dorsal side and then backwards along the spiral suture.

#### Dimensions

	8/18	8/19	8/20	8/22	8/23
maximum diameter	450 $\mu\text{m}$ .	550 $\mu\text{m}$ .	636 $\mu\text{m}$ .	622 $\mu\text{m}$ .	720 $\mu\text{m}$

#### Material

Numerous specimens.

#### Provenance

VE 57/-10/17<sup>d</sup>/4 55-65 cm. (all specimens)

#### Remarks

This form, like all the species of *Cibicides* in this study, exhibits considerable variation. However, it is distinguished from *C.lobatulus* by its more regular, sub-circular outline, its imperforate umbilical area and imperforate apertural face. The strongly biconvex specimens illustrated by Brady (1884) and again by Barker (1960) are placed in synonymy although most specimens observed here had flattened dorsal sides.

#### Occurrence

Murray (1971) describes this species as an inner shelf form, distributed around the British Isles. Brady's (1884) specimens, however, do come from a water depth of over 1,500 m. from S.W. Ireland. Feyling-Hanssen (1964) describes specimens only from the Holocene of the Oslofjord area; Knudsen (1971) reports a single specimen from Older *Yoldia* Clay at Løkken, Vendsyssel; Voorthuysen (1950a, 1958) records it in Plio-Pleistocene and Eemian deposits from the Netherlands.

*Cibicides refulgens* Montfort

Plate 18, figs.3,4,5

*Cibicides refulgens* Montfort, 1808, p.122; Cushman, 1947, p.23, pl.4, figs.7a,b; Knudsen, 1971, p.261; Loeblich & Tappan, 1988, p.582, pl.634, figs.1-3.

*Truncatulina refulgens* (Montfort) Brady, 1884, p.659, pl.92, figs.7-9.

Description

Test a low trochospire, flattened, slightly concave dorsal side, strongly convex ventral side. Periphery angular, slight keel developed, regular outline. Chambers numbering 8 in final whorl, ventral sutures distinct, impressed, gently curving backwards; dorsal sutures distinct, slightly impressed, more strongly curved; spiral suture thickened. Chambers increasing slowly, becoming increasingly involute as height increases. Test moderately to finely perforate, except along the sutures and a broad band over the ventral apertural opening, which extends as a narrow slit over the periphery and backwards along the spiral suture.

Dimensions

	8/28?	fig.3	fig.4	8/31
maximum diameter	1.23 mm.	680 $\mu$ m.	715 $\mu$ m.	680 $\mu$ m.
height	----	----	----	320 $\mu$ m.
	8/32	fig.5		
maximum diameter	1.17 mm.	760 $\mu$ m.		
height	500 $\mu$ m.	480 $\mu$ m.		

Material

Moderate numbers.

Provenance

figs.3,4 & 8/28,31,32 VE 57/-10/17<sup>a</sup>/4 0-5 cm.  
fig.5 VE 57/-09/89<sup>c</sup>/6 35-45 cm.

Remarks

This form is readily distinguished from *C.lobatulus* by its highly convex ventral side, imperforate apertural face, lack of an obvious apertural lip and generally finer pores. However, less obviously convex specimens are difficult to distinguish from the latter, particularly when the periphery becomes slightly lobate.

Occurrence

This would appear to be a deeper water taxon than the other species of *Cibicides* encountered in this study. Harris (1958) reports it as a common taxon on the Scottish and Faeroe Shelves where it accounts for up to 22% of the fauna.

Family           PLANORBULINIDAE   Schwager, 1877  
 Genus           PLANORBULINA       d'Orbigny, 1826

*Planorbulina distoma* Terquem

Plate 18, figs.6,7

*Planorbulina distoma* Terquem, 1876, p.73; 1877, p.164, pl.8, fig. 11; Haynes, 1973, p.177, pl.20, figs.10-12, pl.21, figs.4,7,8, text-fig.36, nos.1,2.

*Planorbulina vulgaris* Williamson, 1858, p.57, pl.5, figs.119,120 (not d'Orbigny).

*Planorbulina mediterranensis* Brady, 1884, p.656, pl.92, figs.2,3; Goës, 1894, p.91, pl.15, fig.786; Mills, 1900, p.149, pl.11, fig.37; Cushman, 1931, p.129, pl.24, fig.5 only; 1949, p.52, pl.10, fig.9; Murray, 1971, p.179, pl.75, figs.1-6 (not d'Orbigny).

Description. (fig.6)

Test plano-convex, flattened dorsal side, raised ventral side. Periphery sub-angular, lobate, lobate and nearly hexagonal (sub-quadrate) in outline. Consists of an initial spiral (low trochospire) followed by irregular chambers arranged in rings. Finally giving way to a more regular addition of chambers-allowing outline form to develop. Sutures are distinct, particularly distinct on the ventral side. Test wall coarsely perforate, each pore being centred within a countersunk depression. Apertures are multiple and small, each chamber with two main peripheral openings, two along the dorsal suture and two very small openings on the ventral side.

Dimensions

	fig.7	9/7	fig.6	L/16	L/15
max. diam.	508µm	600µm	485µm	538µm	514µm

Material

Numerous specimens.

Provenance

fig.6 VE 57/-09/46 <sup>a</sup>/6, 30-33 cm.  
 fig.7 VE 56/-09/142 <sup>b</sup>/6, 63-67 cm.

Remarks

The present form is very close to material described and illustrated as *P.distoma Terquem* by Haynes (1973) and I have followed his interpretation here. It would appear that many N.W. European references to *P.mediterranensis* belong here. This form is well known from around the British coast; it appears to be rare in Quaternary sediments.

Family	ACERVULINIDAE	Schultze, 1854
Genus	ACERVULINA	Schultze, 1854

*Acervulina inhaerens* Schultze

Plate 18, figs.8,9

*Acervulina inhaerens* Schultze, 1854, p.68, pl.6, fig.12; Barker, 1960, p.210, pl.102, figs.1-6 (referred to *Gypsina* by Brady); Murray, 1971, p.181, pl.76, figs.1-2; Loeblich & Tappan, 1988, p.597, pl.659, figs.1-6.

#### Description

Test attached, irregular and encrusting. Early growth spiral, later chambers random. Coarsely perforate (5-10  $\mu\text{m}$ .) and lacking any distinctive apertural openings. Attached surface uneven, free side a series of convex "mounds". Test wall apparently a double layer ( inner & outer) separated by radially arranged crystals.

#### Dimensions

maximum diameter 566  $\mu\text{m}$ .

#### Material

Single specimen only.

#### Provenance

VE 56/-09/142<sup>b</sup>/6, 22-25 cm.

#### Remarks

This form, is very clearly illustrated by Loeblich & Tappan (1988) from the Holocene, Adriatic Sea and the present form bears a close affinity to their material. The generic description states: "aperture consists only of the coarser perforations" Loeblich & Tappan (p.597). However, Murray illustrates a specimen showing clearly lipped apertures on the umbilical side as in *Planorbulina distoma* (= *P. mediteranensis*) - a species with which it it shares some common features, particularly the coarse perforation. The two species are readily distinguished in the present study.

#### Occurrence

I can find no previous record of this species in Quaternary sediments. It appears to be widespread in the world's oceans- often in shallow, current swept waters. Brady's deepest record appears to be c. 70m from Bass Strait, Pacific.

Family            ASTERIGERINIDAE    d'Orbigny, 1839  
Genus            ASTERIGERINATA    Bermudez, 1949

*Asterigerinata mamilla* (Williamson)

Plate 18, fig.10

*Rotalina mamilla* Williamson, 1858, p.54, pl.4, figs.109-111.

*Discorbina mamilla* (Williamson) Heron-Allen & Earland, 1913b,  
p.123, pl.11, figs.4-6.

*Discorbis mamilla* (Williamson) Cushman, 1931, p.23, pl.5,  
figs.1a-c.

*Asterigerinata mamilla* (Williamson) Hofker, 1951<sup>a</sup>, p.472,  
test-figs.322-326; Haynes, 1973,  
p.164, pl.15, figs.1-4, pl.19,  
figs.7,9, text-fig.32, nos.1-5 (with  
extensive synonymy).

#### Description

Test small, plano-convex. Dorsal side high, rounded with full evolute spiral visible. Periphery sub-acute, thickened and slightly lobate. Ventral side flattened with 6 1/2 chambers visible in final whorl, sutures distinct and impressed; chambers alternating between extra-umbilical supplementary thumb-shaped chamberlets. Test finely perforate with larger pores bordering the dorsal sutures and the proximal edge of supplementary chamberlets. Aperture (damaged) a high, open arch at the basal suture of final chamber, opening into umbilicus and bordered by a narrow lip.

#### Dimensions

fig.10            maximum diameter = 206  $\mu$ m.

Laugharne/23    maximum diameter = 325  $\mu$ m. (not illustrated)

#### Material

Moderate numbers.

#### Provenance

fig.10 VE 57/-09/46 <sup>b</sup>/6, 68-71 cm.

#### Remarks & Occurrence

This form is close to the description and illustration given by Haynes (1973), and although his specimens exhibit an acute, sub-carinate periphery, he does note sub-rounded specimens. The reader is referred to the latter (*op. cit.*, p.166) for further remarks and a comprehensive treatment on its modern distribution which suggests a concentration from Mediterranean-Lusitanian provinces.



Family	NONIONIDAE	Schultze, 1854
Genus	NONION	de Montfort, 1808

*Nonion barleeanum* (Williamson)

Plate 18, figs.11,12

*Nonionina barleeanum* Williamson, 1858, p.32, pl.3, figs.68,69.

*Nonion zaandamae* (Voorthuysen) Loeblich & Tappan, 1953, p.87, pl.16, figs.11,12.

*Melonis zandamae* (Voorthuysen) Leslie, 1965, p.164, pl.7, fig.10.

*Nonion pompilioides* (Fichtel & Moll) Feyling-Hanssen, 1954, p.137, pl.2, fig.7.

*Melonis pompilioides* (Fichtel & Moll) Murray, 1971, p.199, pl.84, figs.1-7.

*Nonion barleeanum* (Williamson) Feyling-Hanssen, 1958b, p.9, pl.1, figs.16,17; Feyling-Hanssen, 1964, p.329, pl.17, figs.7-12; Knudsen, 1971, p.261, pl.9, figs.15-18; Hald & Vorren, 1987, p.156, pl.2, fig.4.

#### Description

Test an involute planispire with broadly rounded periphery and excavated umbilicus. Periphery even, becoming slightly lobate in later stages, 10 chambers visible in final whorl. Sutures are distinct but not at all depressed, they are highlighted by a band of imperforate test material which extends all the way over the periphery and into the umbilical area which is also imperforate. The sutures gently curve backwards towards the periphery. The apertural face is imperforate, while chamber walls are perforate elsewhere (c. 5 $\mu$ m); the aperture consists of a low interiomarginal arch which tapers into the umbilical depression where it is covered by a thin flap. Test typically translucent.

#### Dimensions

maximum diameters (11/33) 480  $\mu$ m. (11/34) 490  $\mu$ m. (11/30) 620  $\mu$ m. (11/32) 435  $\mu$ m. (11/31) 363  $\mu$ m.

#### Material

Numerous

#### Provenance

(11/30)	VE 57/-09/60	<sup>b</sup> /4, 27-30 cm.
(11/31)	VE 57/-10/21	<sup>e</sup> /5, 17-20 cm.
(11/32)	VE 57/-09/60	<sup>d</sup> /4, 30-33 cm.
(11/33 & 34)	VE 57/-10/17	<sup>d</sup> /4, 55-65 cm.
figs.11,12	VE 57/-10/17	1.70-1.75 m.

#### Remarks

The present species is typical of material described and illustrated in the literature (see synonymy) and it is apparent that *M.barleeanum* and *N.pompilioides* (Fichtel & Moll) have been confused in the literature. Nørvang (1959) and later Feyling-Hanssen (1964) recognize this problem and reach different conclusions based upon the presence/absence of perforation on the apertural face; the latter notes that in his specimens the apertural face is always perforate.

However, the apertural face in these specimens is imperforate and this begs the question as to the importance of this feature in Fichtel & Moll's species concept of *Nonion pompilioides*, described from recent Mediterranean faunas and from the Pliocene of Italy. I have not seen the original illustrations but reading through the literature suggests that the true *N.pompilioides* (Fichtel & Moll) should have a much thicker test than the present form, which I am tentatively assigning to *N.barleeanum*, particularly in view of current and past usage which would appear to include forms similar to the present.

#### Occurrence

This appears to be a wide-ranging species, known from the Arctic as well as Lusitanian environments, over a considerable depth range; recorded by Murray (1971) as a shelf species and more recently (Murray, 1991) as the *Melonis barleeanum* association:

Salinity	34.93 - 35.60 ppt.
Temperature	-0.4° to 9°C
Substrate	silty mud
Depth	280-2710 m.

It has also been recorded as an additional common species in the following shelf associations of Atlantic Seaboard Europe/Africa (Murray, 1991):-

<i>B.marginata</i>	(900m. MacKensen <i>et al.</i> , 1985)
<i>C.laevigata</i>	Sejrup <i>et al.</i> , 1981; MacKensen <i>et al.</i> , 1985; Lutze, 1980 (NW Africa); Lutze, 1980 (NW Africa).
<i>C.lobatulus</i>	MacKensen <i>et al.</i> , 1985.
<i>T.angulosa</i>	Sejrup <i>et al.</i> , 1981; MacKensen <i>et al.</i> , 1985; Qvale (1986a); Belanger & Streeter, 1980.

See Knudsen (1971) for a brief review of its distribution within Quaternary sediments.

*Nonion labradoricum* (Dawson)

Plate 18, figs.13,14,15,16

*Nonionina labradorica* Dawson, 1860, p.101, fig.4.

*Nonion labradoricum* (Dawson) Cushman. 1939, p.23, pl.6,  
figs.13-16; Loeblich & Tappan, 1953,  
p.86, pl.17, figd.1,2;  
Feyling-Hanssen, 1964, p.331, pl.17,  
figs.15-18; Knudsen, 1971, p.262,  
pl.10, figs.1,2.

Description

Test medium, sub-ovate, planispiral. Periphery rounded, only slightly lobate in side view with 9 chambers in final whorl, increasing gradually until final chamber which is nearly twice as high and strongly overlapping at the periphery. Sutures distinct, depressed particularly in umbilical area and backwards curving. Umbilicus deeply excavated. Aperture a narrow, arched slit at the base of the sub-triangular face. Test smooth finely perforate.

Dimensions

	25	26	24	10
maximum diameter	812 $\mu$ m.	802 $\mu$ m.	480 $\mu$ m.	444 $\mu$ m.

Material

Very numerous.

Provenance

fig.13 VE 57/-10/17 1.70-1.75 m.  
figs.14,15,16 VE 57/-10/17 3.55-3.65 m.

Remarks

This is a distinctive and readily identified species in the adult form. The adult specimens typically have a maximum test diameter of c.800  $\mu$ m. although smaller specimens occur (eg. pl.18, figs.14,15,16); these are illustrated here in an attempt to demonstrate the similarities with *Nonionella*.

I have been fascinated by the variation in chamber size so clearly exhibited by this species, not only the near doubling in height of the final chamber, but also the reduced size of the third or fourth from last chamber. I interpret this step-wise reduction and then increase in chamber dimension, often at this same position, as possibly a function of the test having overwintered and not feeding which would result in discontinuous growth? It was with much interest that I listened to a seminar by Tomas Cedhagen (Arhus, 1989) on the relationship of this species and symbiotic chloroplasts in the Skagerrak; further work on the seasonal growth patterns of foraminifera in cold water is required.

Occurrence

This is a boreo-arctic species typically occurring at depths greater than 20 m. It's occurrence in Quaternary sediments appears to be limited largely to the late Pleistocene (Knudsen, 1971) and it is particularly frequent and characteristic of subzones Am and

B1 of the Oslofjord region (Feyling-Hanssen, 1964) ie. Late Pleistocene/Early Holocene. It is equally well developed in zone 4 at Solberga (Knudsen, 1971) which was interpreted as representing deposition during the Younger Dryas. Equally, in the present study this species is particularly well developed within zones 1 and 5/6 of vibrocores 57/-09/46 and 57/-09/89 respectively; both of which are correlated to the Younger Dryas chronozone. It's significance is discussed at greater length in the text, but it appears to indicate cold, relatively deep (>30m) and normal marine salinities.

*Nonion orbiculare* (Brady)

Plate 19, figs.1,2

*Nonionina orbicularis* Brady, 1881, p.415, pl.21, fig.5.

*Nonion orbiculare* (Brady) Cushman, 1930, p.12, pl.5, figs.1-3;  
Cushman, 1948, p.53, pl.6, fig.3;  
Knudsen, 1982, p.174 (list), fig.  
14:11.21, fig.14:13.8,9.

*Elphidium orbiculare* (Brady) Loeblich & Tappan, 1953, p.102,  
pl.19, figs.1-4.

*Protelphidium orbiculare* (Brady) Todd & Low, 1961, p.20, pl.2,  
fig.11; Feyling-Hanssen, 1964,  
p.349, pl.21, fig.3; Knudsen, 1971,  
p.289, pl.14, figs.8-11, pl.24,  
figs.6-8; Knudsen, 1978, p.34(list),  
pl.3, figs.9-10.

#### Description

Test an inflated, involute planispire with very broadly rounded periphery, slightly lobate in side view; 9 chambers visible in final whorl. Umbilical area flattened and covered in large papillae which extend up the deeply incised and tapering sutures and around the basal suture of the final chamber as a broad band. The suture and umbilical area are broken by deep, irregular slits. The aperture is obscured by papillae and appears as a discontinuous series of openings along the basal sutures of the final chamber. Test wall otherwise smooth, finely perforate and determined to be optically radial.

#### Dimensions

	fig.2	fig.1	11/27
maximum diameter	565 $\mu\text{m}$ .	564 $\mu\text{m}$ .	670 $\mu\text{m}$ .
Thickness	c.350 $\mu\text{m}$ .	---	---

#### Material

Numerous specimens.

Provenance

VE 57/-10/17<sup>b</sup>/4, 70-75 cm.

Remarks

This tumid form is readily distinguished from the other species of *Nonion* and *Elphidium* in this study by its broadly rounded periphery and dense umbilical and sutural ornament of rather coarse papillae. I have crushed specimens and found the wall structure to be radial which, together with the apparently perforate basal aperture, was sufficient to lead Cushman (1939) to suggest an affinity with *Elphidium* and convinced Leoblich & Tappan (1953) that it belonged there. It was subsequently transferred to *Protelphidium* Haynes (1956) which describes its specific characteristics well, however the latter appears to only apply to species ranging from the Lower Paleocene to Oligocene (Leoblich & Tappan, 1988) and it is placed back within *Nonion* in recent literature; although Murray (1991), and others, appears to have adopted Banner & Culver's (1978) genus *Haynesina* which may eventually prove most suitable/acceptable. For an interesting discussion on the relationship of these genera the reader is directed to Haynes (p.241-242, op. cit.) as a starting point.

Occurrence

The species is well known from Arctic waters; Murray (1991, p.64) describes the *H.orbiculare* association from estuaries and lagoons from the Atlantic seaboard of N. America and summarizes the ecological data as salinity: 22-26 ppt; temperature: 0-20°C; substrate: sand, muddy sand; depth <10 m.. From the Arctic Ocean in areas of seasonally ice-free waters it occurs as an additional common species within *Eggerella advena* and *E.clavatum* associations; summarized as <10°C and generally shallow.

It is well known from Quaternary deposits (see Knudsen, 1971 for summary).

*Nonion pauperatum* (Balkwill & Wright)

Plate 19, figs.3,4

*Nonion pauperata* Balkwill & Wright, 1885, p.353, pl.13, figs.25,26.

*Nonion pauperatum* (Balkwill & Wright) Cushman, 1930, p.13, pl.5, figs.4,5,7 (after Balkwill & Wright; Halkyard, 1889; and Heron-Allen & Earland, 1911); Haake, 1962, p.42, pl.3, figs.6-7.

*Nonion (Florilus) pauperatum* (Balkwill & Wright) Haynes, 1973, p.210, pl.22, figs.13,14, pl.23, fig.4, test-fig.44, nos.4-7.

Description (figs.3,4)

Test an involute planispiral, compressed with sub-angular periphery, lobate in side view, and greatest thickness over umbilici. Chambers numbering 8 in final whorl, gradually increasing in size with distinct, backward-curving sutures, final chamber strongly overlapping and extending into umbilical area. Test wall perforate, umbilical area thickened. Aperture a narrow arch at the base of the final chamber, extending into umbilical area as a narrow slit.

Dimensions

fig.3 maximum diameter 150  $\mu$ m.

fig.4 maximum diameter 170  $\mu$ m., thickness c. 70  $\mu$ m.

Material

Two(?) specimens only

Provenance

fig.3 Aberdaron A1, 600m silt lens

fig.4 VE 56/-09/142<sup>d</sup>/6, 10-12 cm.

Remarks & Occurrence

The present forms, although showing some variation in the acuteness of the periphery agree well with the specimens illustrated by Haake (1962) and Haynes (1973). A number of records exist from western coast of the British Isles & Ireland (see Haynes, 1973, p.211).

*Florilus* de Montfort (1808) is, according to the generic classification of Leoblich & Tappan (1988), unavailable pending a petition to the ICZN that it be suppressed. However, the oblong arch of the aperture extending up into the apertural face is not observed in the present material.

Genus                   NONIONELLA                   Cushman, 1926

*Nonionella auricula* Heron-Allen & Earland

Plate 19, figs.5,6

*Nonionella auricula* Heron-Allen & Earland, 1930, p.192, pl.5, figs.68-70; Cushman, 1939, p.33, pl.9, figs.7-9 (after Heron-Allen & Earland); (not fig.9); Feyling-Hanssen, 1954, p.327, pl.16, figs. 21-23; Haynes, 1973, p.211, text-fig.45, nos.1-3.

Description

Test small, sub-ovate, compressed. Chambers inflated, periphery rounded, lobate. Sutures distinct impressed, gently curving backwards. Eight chambers visible in final whorl, inflated become about two and a half times as high as long. Surface smooth,

very glassy finely perforate. Dorsal side gently convex-full spiral visible, distinct ventral umbilicus. Aperture a low arch along the ventral basal suture of final chamber.

Dimensions

	fig.6	fig.5
maximum length	160 $\mu$ m.	168 $\mu$ m.

Material

Moderate numbers.

Provenance

fig.6 VE 56/-09/142<sup>b</sup>/6, 8-10 cm.  
fig.5 VE 57/-09/89 3.02-3.04 m.

Remarks

This small species is difficult to identify, particularly in view of the similarity of juvenile specimens belonging to this genus. I am in general agreement with Haynes' (1973) view that larger specimens, for example those of Loeblich & Tappan (1953) and possibly those of Feyling-Hanssen *et al.* (1971), do not belong here. The present specimens are very close to those of Feyling-Hanssen (1964) from the Post glacial of the Oslofjord area. It is possible that this tiny species may be missed in many investigations where a larger than 63 $\mu$ m sieve size is employed.

Occurrence

First described from near Plymouth by Heron-Allen & Earland (1930), it has also been recorded from the Arctic (Loeblich & Tappan, 1953) although in view of the considerably larger size and very high chambers, it is doubtful whether these are the same species. Quaternary records include the Holocene of the Oslofjord (Feyling-Hanssen, 1964), the Postglacial deposits of Spitsbergen (Feyling-Hanssen, 1964b), the Older *Yoldia* Clay and Lateglacial *Yoldia* Clay of Vendsyssel (Feyling-Hanssen *et al.*, 1971).

*Nonionella turgida* (Williamson)

Plate 19, fig.7,8

*Rotalina turgida* Williamson, 1858, p.50, pl.4, figs.95-97.

*Nonionina turgida* (Williamson) Brady, 1884, p.731, pl.109, figs.17-19?

*Nonionella turgida* (Williamson) Cushman, 1930, p.15, pl.6, figs.1-4; Feyling-Hanssen, 1964, p.328, pl.17, figs.2-6.; Haynes, 1973, p.213, pl.22, fig.12; text-fig.45, no.4 (with extensive synonymy).

#### Description (fig.7)

Test sub-ovate, compressed with broadly rounded periphery. Chambers arranged in an evolute low trochospire, increasing rapidly in height as added, inflated. Sutures distinct, impressed. Final chamber equal to 90% of the test length in height, distinctly assymetrical with a large umbilical lobe. Test thin, finely perforate. Aperture extends from periphery under ventral lobe as an elongate slit (partly obscured).

#### Dimensons

	fig.7	fig.8
length	325 $\mu$ m.	355 $\mu$ m.

#### Material

Moderate numbers.

#### Provenance

fig.7	VE 57/-09/89 2,25-2.35 m.
fig.8	VE 56/-09/142 <sup>b</sup> /6 22-25 cm.

#### Remarks

This species is readily identified by its large ventral umbilical lobe. The rare digitate variety of Nørvang is easily distinguished. However, as discussed by Haynes (1973, p.213) there is some confusion as to the validity of including aequilateral forms as illustrated by Brady (1884, pl.109, fig.17) and in the present study I have restricted the concept of this species to inaequilateral specimens only. The symetrical forms are therefore distinguished and placed in affinity with this species, unlike many recent authors (eg.Cushman, 1930) who have included both forms under *N.turgida*.

#### Occurrence

The distribution of this species has been summarized by Haynes (1973) who notes a particular concentration around western coasts of the British Isles. Quaternary records include the Postglacial zone F of the Oslofjord area (Feyling-Hanssen, 1964), a single specimen from the Older *Yoldia* Clay at Løkken (Knudsen, 1971) and the Eemian of Fjøsanger, western Norway (Mangerud *et al.* 1981).

*Nonionella* aff. *turgida* (Williamson)

Plate 19, figs.9,10,11

#### Description

Test compressed, sub-ovate with broadly rounded periphery. Chambers inflated, considerably higher than long and increasing rapidly in height as added; 11 chambers visible in the final whorl. Chambers nearly planispirally arranged, involute, biumbilicate. Sutures distinct, impressed, curving backwards gently. Test wall smooth, finely perforate. Aperture a narrow slit along the basal suture of the final chamber; the latter is nearly equal in length to the test itself.



Dimensions

	fig.9	fig.10
length	387 $\mu$ m.	364 $\mu$ m.

Material

Numerous specimens.

Provenance

fig.9 VE 57/-09/46 <sup>a</sup>/6 43-47 cm.  
fig.10 VE 57/-09/46 <sup>a</sup>/6 38-43 cm.  
fig.11 VE 57/-09/46 <sup>a</sup>/6 75-82 cm.

Remarks

This form, as discussed above, is readily distinguished from *N.turgida* by its nearly symmetrical chamber arrangement throughout its growth. Such forms, illustrated by Brady (1884, pl.109, fig.17) and later by Cushman (1930) for example, have been included in Williamson's species but are recognised as distinct in the present study as suggested by Haynes (1973). This species is distinguished from *Nonion scaphum* (Fichtel & Moll) and *Nonion grateloupi* (d'Orbigny) by its very high and enveloping final chambers; although juvenile specimens might possibly be confused with the latter.

*Nonionella turgida* (Williamson) var. *digitata* Nørvang

Plate 19, fig.12

*Nonionella turgida* (Williamson) var. *digitata* Nørvang, 1945, p.29, text-fig.4; Cushman, 1948, p.55, pl.6, fig.5 (after Nørvang); Parker, 1952a, p.413, pl.5, figs.15-16; Haynes, 1973, p.214, text-fig.45, nos.5,6.

Description

Test sub-ovate, compressed. Periphery rounded with 10 chambers in the final whorl, arranged in a low trochospire. Sutures distinct, impressed, curving gently backwards. Final chamber with inflated umbilical flap on the ventral side with digit-like processes radiating from it, some of which bifurcate, giving the appearance of an embryonic hand. Test wall smooth, finely perforate.

Dimensions

maximum diameter 218  $\mu$ m.

Material

Single specimen only.

Provenance

VE 57/09/46 <sup>a</sup>/6 33-38 cm.

#### Remarks and Occurrence

This specimen, like that of Haynes (1973, text-fig.45, nos.5, 6), exhibits what is assumed to be "the incipient development of the remarkable 'tubulose appendices' which in the type partially cover the earlier chambers". However, this specimen more closely resembles Nørvang's Islandic material in possessing 10 chambers in the final whorl, rather than the 7 of Haynes' juvenile specimen from Cardigan Bay. It has also been recorded from the north east seaboard of North America (Parker, 1952a).

Genus                    ASTRONONION                    Cushman and Edwards, 1937

*Astronoion (Laminononion) gallowayi* Loeblich and Tappan

Plate 19, figs.13,14,15

*Nonionina stelligera* d'Orbigny, Brady, 1884, p.?? (not *Nonionina stellata* d'Orbigny, 1839).

*Astrononion stellatum*    Cushman & Edwards, 1937, p.32, pl.3, figs.9-11 (not *Nonionina stellata* Terquem, 1882).

*Astrononion stelligerum* (d'Orbigny) Cushman, 1948, p.55, pl.6, fig.6.

*Astronion gallowayi* Loeblich & Tappan, 1953, p.90, pl.17, figs.4-7; Feyling-Hanssen, 1964, p.332, pl.18, fig.4; Knudsen, 1971, p.266, pl.10, figs.10-12.

#### Description (13/4)

Test an involute planispire, periphery rounded, lobate in side view with 8 chambers in final whorl. Sutures distinct, depressed, strongly backwards curving. Chambers with sub-trigonal plates extending backwards to cover nearly 1/2 preceding suture and into umbilical area where they are fused and form a flattened plate. Test wall fairly coarsely perforate, hyaline. Aperture a low slit extending from periphery into umbilical area.

#### Dimensions

	fig.13	fig.14	fig.15	16/3,2
maximum diameter	493 $\mu$ m.	475 $\mu$ m.	317 $\mu$ m.	261 $\mu$ m.

#### Material

Numerous specimens.

#### Provenance

16/2,3	Aberdaron, A4 (not illustrated).
fig.13	VE 57/-10/17 <sup>d</sup> /4, 55-65 cm.
figs.14,15	VE 57/-09/60 <sup>a</sup> /4, 26-28 cm.'outer'.

#### Remarks & Occurrence

This form is readily distinguished from *A.(L.)tumidum* of this study by its generally larger more compressed and less lobate test; often with 8 or more chambers in the final whorl.

Typically an arctic to boreal species, although problems in separating this species from other closely related and warmer water taxa exist. Arctic records include Loeblich & Tappan (1953) off Point Barrow at 3-223 m. and elsewhere Leslie (1965); near a glacier front, West Spitsbergen at 4-50 m. (Nagy, 1965); Oslofjord at 25-330 m. (Risdal, 1964). Its occurrence in Quaternary deposits is well known - see Knudsen (1971, p.266).

#### *Astrononion (Laminononion) tumidum* Cushman and Edwards

Plate 19, fig.16

*Nonionina stelligera* d'Orbigny, 1839.

*Astrononion tumidum* Cushman & Edwards, 1937, p.33, pl.3, fig.17;  
Boltovskoy, 1954a, p.166, pl.7,  
fig.7; Barker, 1960, p.224, pl.109,  
fig.5; Feyling-Hanssen, 1964, p.333,  
pl.18, fig.3.

#### Description

Test an involute planispire, compressed. Periphery rounded, highly lobate in side view with 6 chambers visible in the final whorl. Sutures distinct, deeply impressed and backwards curving. Umbilical area slightly depressed and covered by rhomb-shaped plates which extend from the base of each chamber. Aperture a low slit at the base of the final chamber extending from periphery to umbilical area.

#### Dimensions

maximum diameter 250  $\mu$ m.

#### Material

Three damaged specimens.

#### Provenance

VE 57/-10/17 <sup>a</sup>/4, 20-25 cm.

#### Remarks

This species is distinguished from the morphologically similar *A.(L.)gallowayi* of this study by its more lobate periphery and fewer, more inflated chambers, per whorl. It appears that Brady (1884) considered both these forms as *N.stelligera* and many records of *A.(L.)tumidum* may be recorded here? as well as under *A.gallowayi*.

#### Occurrence

Described originally from the E. Atlantic, records are few. A few specimens are recorded by Feyling-Hanssen (1964) in Postglacial deposits of the Oslofjord.

Genus                    PULLENIA                    Parker and Jones, 1862

*Pullenia bulloides* (d'Orbigny)

Plate 20, fig.1

*Nonionina bulloides* d'Orbigny, 1826, p.293, no.2; d'Orbigny, 1846, p.107, pl.5, figs.9,10.

*Nonionina sphaeroides* d'Orbigny, 1826, p.293, no.1, modèles no.43.

*Pullenia sphaeroides* (d'Orbigny) Brady, 1884, pl.84, figs.12, 13; Cushman, 1924, p.40, pl.8, figs.3,4.

*Pullenia bulloides* (d'Orbigny) Cushman & Todd, 1943, p.13, pl.2, figs.15-18; Barker, 1960, p.174, pl.84, figs.12,13; Feyling-Hanssen, 1964, p.333, pl.18, figs.1,2; Sejrup *et al.*, 1981, p.293, pl.2, fig.8.

#### Description

Test small, sub-spherical, slightly compressed. Periphery very broadly rounded, circular in out-line, sutures indistinct with 4 chambers just visible in final whorl. Aperture a low arch along the basal suture.

#### Dimensions

maximum diameter 250  $\mu$ m.

#### Material

Limited numbers only.

#### Provenance

VE 57/-09/46 <sup>d</sup>/6, 69-72 cm.

#### Remarks & Occurrence

These specimens are distinguished by their sub-sphaerical, non-lobate test form. However, specimens do occur which are transitional between this and a 4 lobed form which I have figured here as *Pullenia* sp.A.

Quaternary records include the Postglacial of the Oslofjord area (Feyling-Hanssen, 1964), as rare in late Quaternary of Vendsyssel (Knudsen, 1971) and in oldest Quaternary deposits of the Netherlands (Voorthuysen, 1950b). Recent records include the Norwegian Continental Margin (Sejrup *et al.*, 1981) 211-1690 m., the Oslofjord (Risdal, 1964) 30-330 m. and N. Pacific (3,388 m.) & S. Atlantic (4029 m.) Brady (1884).

*Pullenia subcarinata* (d'Orbigny)

Plate 20, figs.2,3

*Nonionina subcarinata* d'Orbigny, 1839b, p.28, pl.5, figs.23,24.

*Pullenia subcarinata* (d'Orbigny) Heron-Allen & Earland, 1932, p.403, pl.13, figs.14-18; Barker, 1960, p.174, pl.84, figs.14,15; Feyling-Hanssen, 1964, p.334, pl.18, figs.7,8.

*Nonionina quinqueloba* Reuss, 1851, p.71, pl.5, fig.31.

*Pullenia quinqueloba* (Reuss) Brady, 1884, pl.84, figs.14,15; Batjes, 1958, p.139, pl.6, fig.8.

#### Description

Test medium, an involute planispire compressed with rounded to sub-rounded periphery, slightly lobate in side view. Chambers inflated, five visible in final whorl; sutures distinct, radial, impressed; biumbilicate. Aperture a narrow slit along the basal suture, bordered by a thin lip.

#### Dimensions

maximum diameter 350  $\mu$ m., width 170  $\mu$ m.

#### Material

Limited numbers.

#### Provenance

VE 57/-10/17<sup>d</sup>/4, 55-65 cm.

#### Remarks & Occurrence

This species is distinguished from other forms of *Pullenia* by its larger size, more angular periphery and 5 chambers in the final whorl; all other forms encountered exhibit 4 chambers in the final whorl. As noted by Barker (1960), Heron-Allen & Earland (1932) "have stated that the Falkland Islands form is *P. subcarinata* (d'Orbigny), that d'Orbigny's came from that region and also show five and six chambered tests. They reached the conclusion that *P. quinqueloba* (Reuss) is a synonym of *P. subcarinata* (d'Orbigny)".

Risdal (1964) has recorded it from the Oslofjord at depths between 30 m. and 330 m.; while Brady (1884) illustrates specimens from the Pacific. Quaternary records include the Postglacial of the Oslofjord area (Feyling-Hanssen, 1964) as well as zone 1 of Sandnes Clay, the Older *Yoldia* Clay and the Lateglacial *Yoldia* Clay of Vendsyssel (Knudsen, 1971).

*Pullenia* sp.A

Plate 20, fig.4

Description

Test small and inflated, planispirally coiled, involute, slightly compressed. Periphery rounded, lobate with 4 inflated chambers visible in the final whorl. Sutures distinct, impressed, radial nearly straight. Aperture a narrow slit along the basal suture, bordered by a thin lip.

Dimensions

maximum diameter 200  $\mu$ m.

Material

Limited numbers.

Provenance

VE 57/-09/60 <sup>a</sup>/4, 35-39 cm.

Remarks

This form differs from *P.bulloides* in having a lobate periphery, but is otherwise very similar in size, number of chambers and its degree of inflation. *P.subcarinata* is larger, with 5 chambers in the final whorl and a sub-acute, rounded periphery.

Family CHILOSTOMELLIDAE Brady, 1881

Genus CHILOSTOMELLA Reuss, 1849

*Chilostomella oolina* Schwager

Plate 20, figs.5,6

*Chilostomella oolina* Schwager, 1878, p.257, pl.1, fig.16; Barker, 1960, p.112, pl.55, figs.12-14,17-18; Thomas *et al.*, 1990, p.227, pl.7, fig.9.

*Chilostomella ovoidea* Reuss, Brady, 1884, pl.55, figs.12-14,17-18.

#### Description

Test elongate, ovoid, circular in sectional view. Two chambers visible externally, as an enveloping, involute planispire with two chambers per whorl. Test smooth, finely perforate, slit-like pores; broadly rounded and bullet shaped apex. Aperture a circular slit with slightly raised outer margin.

#### Dimensions

length 690  $\mu$ m., maximum breadth 364  $\mu$ m.

#### Material

Single specimen only.

#### Provenance

VE 57/-09/32 <sup>a</sup>/6 0-10 cm.

#### Remarks

Brady's (1884) specimens come from the central and northern Pacific at depths between 174 m. and 1,062 m.. Thomas *et al.* (1990) record this species from the upper part of an 11 m. piston core from a water depth of 4,046 m. on the Scotian Rise, as well as in surface grabs from the Scotian Slope.

Family HETEROLEPIDAE Gonzáles-Donoso, 1969

Genus ANOMALINOIDES Brotzen, 1942

*Anomalina (Anomalinoides) globulosa* Chapman and Parr

Plate 20, figs.7,8,9

*Anomalina grosserugosa* (Gumbel) Brady, 1884, pl.94, figs.4,5.

*Anomalina globulosa* Chapman & Parr, Barker, 1960, p.194, pl.94, figs.4,5; Knudsen, 1971, p.258, pl.9, figs.1-3.

### Description

Test small, trochospiral but tending towards planispiral; involute umbilical side, evolute spiral side. Chambers inflated, periphery evenly rounded, lobate with 7 chambers in the final whorl. Sutures distinct, depressed, curving gently backwards. Test wall smooth, finely perforate, hyaline. Aperture a low arch extending from the small umbilicus over the periphery and backwards as a narrow slit along the spiral suture where it is covered by a thin flap.

### Dimensions

	figs.7,9	13/6	fig.8	13/8
maximum diameter	156 $\mu\text{m}$ .	160 $\mu\text{m}$ .	195 $\mu\text{m}$ .	129 $\mu\text{m}$ .

### Material

Moderate numbers.

### Provenance

figs.7,9	VE 57/-09/60	<sup>a</sup> /4	32-35 cm.
13/6	VE 56/-09/142	<sup>a</sup> /6	67-69 cm.
fig.8	VE 56/-09/142	<sup>b</sup> /6	89-91 cm.
13/8	VE 57/-10/17	<sup>a</sup> /4	50-55 cm.

### Remarks

The present form appears very close to material illustrated by Knudsen from the Postglacial at Løkken, and like this material from Vendsyssel, lacks the coarse perforation of the test illustrated by Brady (1884) as *A.grosserugosa* (Gumbel) and subsequently referred to *A.globulosa* by Chapman and Parr (1937). The present material is very close in its general form to Brady's specimen (pl.94, fig.4) from a depth of 770 m. off Ascension Island.

Although I have left the present form in *Anomalina* d'Orbigny, it appears that as a result of the very wide concept applied to this genus that taxonomic revision was required. A petition to ICZN to suppress *Anomalina* in favour of retaining *Epistomaroides* (Loeblich & Tappan, 1988) has been turned down (pers. comm. J.R. Haynes). The nearest and most probable genus suitable for this form would therefore appear to be *Anomalinoides* Brotzen (1942), although the latter is reported to be coarsely perforate with early whorls on the evolute spiral side covered by a central boss?

### Occurrence

This form is known from the Postglacial deposits and occasionally in the Older *Yoldia* Clay of Vendsyssel (Feyling-Hanssen *et al.*, 1971).



Family            GAVELINELLIDAE       Hofker, 1956  
 Genus            DISCANOMALINA       Asano, 1951

*Paromalina (Discanomalina) crassa* (Cushman)

Plate 20, figs.10,11,12

*Anomalina coronate* Parker & Jones, Brady, 1884, pl.97, figs.1,2.

*Anomalina coronata* Parker & Jones var. *crassa* Cushman, 1931,  
 p.105, pl.19, figs.1,2.

*Paromalina crassa* (Cushman) Murray, 1971, p.201, pl.85, figs.1-6.

#### Description

Test robust, essentially planispiral with flattened sides and gently curved, broad periphery producing a quadrate outline. Chambers numbering 7 in final whorl, sutures distinct, slightly depressed. Test wall thick, coarsely perforate around periphery, sides essentially imperforate. Aperture a low interiomarginal arch, bordered by a thick lip; secondary apertures visible as irregular slits beneath fused umbilical flaps.

#### Dimensions

	fig.11	fig.12	fig.10
maximum diameter	970 $\mu\text{m}$ .	970 $\mu\text{m}$ .	708 $\mu\text{m}$ .
thickness	663 $\mu\text{m}$ .	647 $\mu\text{m}$ .	-

#### Material

3 specimens only

#### Provenance

figs.11,12 VE 57/-10/17 <sup>a</sup>/4, 75-80cm  
 fig.10 VE 48/-09/137, S. Celtic Sea

#### Remarks

First assigned to the genus *Anomalina* and later to *Paromalina* by Loeblich & Tappan (1957); the latest classification would have *Paromalina* included in Asano's (1951) genus *Discanomalina*. The specimens I have inspected show considerable variation in form, a feature which Mediolo and Scott (1978) have demonstrated from a large population of the type species *Discanomalina japonica* Asano, 1951.

#### Occurrence

Murray (1971) fails to record any live specimens from around the British Isles but records dead specimens from the shelf edge by the Western Approaches to the English Channel (Murray, 1970). Brady (1884) records *P. coronata* from the S. Pacific and off the Canaries, E. Atlantic at 1,136 m. water depth.

Genus                   GYROIDINA                   d'Orbigny, 1826

*Gyroidina neosoldanii* Brotzen

Plate 20, fig.13

*Rotalina soldanii* (d'Orbigny) Brady, 1884, pl.107, figs.6,7.

*Gyroidina neosoldanii* Brotzen, 1963, p.158; Barker, 1960, p.220,  
pl.107, figs.6,7; Murray, 1971,  
p.197, pl.83, figs.1-5.

#### Description

Test medium low trochospire, biconvex. Periphery sub-rounded, nearly circular in plan view with c. 10 chambers visible in final whorl. Sutures distinct but only very slightly depressed in later part, radial, gently curving backwards. Umbilical side much more strongly convex with small, but deep umbilicus and distinctive apertural face along the base of which is a narrow slit which extends to the periphery and has a narrow flap above it. Surface smooth, very finely perforate.

#### Dimensions

maximum diameter 460  $\mu$ m.

#### Material

Single specimen only

#### Provenance

VE 57/-10/84

#### Remarks

This specimen appears to be misnamed as *G. soldanii* d'Orbigny according to Murray (1971). Unfortunately, I have not seen d'Orbigny's (1826?) illustrations of the latter or Brotzen's (1936) illustrations and description of *G. neosoldanii*; I have used Murray (1971) and Barker (1960) in assigning this form. Specimens illustrated as *G. soldani* (author's spelling) d'Orbigny from a grab sample at 3,985 m. on the lower Scottian Slope (Thomas *et al.*, 1990) appear to belong here. Loeblich & Tappan (1988), following work by Hansen (1967, 1970), have separated d'Orbigny's species *soldanii* from others of the genus *Gyroidina* and assigned it as the type species of their new genus *Hansenisca*, which differs from *Gyroidina* in possessing "an open umbilicus surrounded by umbilical chamber flaps over the supplementary umbilical apertures". The present form does not exhibit these features and utilizing *G. soldanii* to define the present form is therefore considered invalid.

#### Occurrence

The single specimen described here was recovered from vibrocore 57/-10/84 at a water depth of c. 1340 m. from the Hebridean Slope. Murray has found it on the shelf edge by the Western Approaches to the English Channel and Brady (1884) records it from water depths of 2650 m. from the South Pacific and from 3750 m. in the North Pacific. Its distribution is therefore widespread but typically confined to "sub-shelf" water depths.



to juveniles of *B.tenerrima* than the present species. I have included illustrations of juvenile *B. tenerrima* (pl.21, fig.1) in an attempt to clarify this problem.

#### Occurrence

This would appear to be a cold water taxon and is widespread in Arctic waters. For example Leslie (1965) recorded *B. frigida* living at depths of 37-212 m. in Hudson Bay where bottom temperatures varied from 2.98°C to -1.78°C and salinity was 3.3 ppt.. Loeblich & Tappan (1953) recorded it at depths of 18-136 m. from Point Barrow, Greenland and Cushman's lectotype came from a depth of 18.3 m. on the Arctic east Canadian coast. Murray (1965b, 1968) has recorded it living from southern Britain and notes "this appears to be a northern species whose southerly limit of distribution is the English Channel".

Quaternary records are given by Knudsen (1971) who notes that "in Vendsyssel it is more common in the *Yoldia* Clays than in the Postglacial deposits".

*Buccella tenerrima* (Bandy)

Plate 20, figs.15,16; Plate 21, fig.1

*Eponides frigidus* (Cushman) Cushman, 1948, p.71, pl.8, fig.7 (with extensive synonymy).

*Rotalina tenerrima* Bandy, 1950, p.278, pl.42, fig.3.

*Buccella inusitata* Anderson, 1952, p.148, figs.10,11; Loeblich & Tappan, 1953, p.116, pl.22, fig.1.

*Buccella tenerrima* (Bandy) Feyling-Hanssen, 1964b, p.47, pl.3, figs.3-5; Knudsen, 1971, p.254, pl.8, figs.15-17; Sejrup *et al.*, 1981, p.290, pl.1, figs.2,3.

#### Description

Test medium bi-convex, trochospiral with sub-acute, slightly lobate, keeled periphery. Spiral, dorsal side cone-shaped and highly convex; ventral side slightly/gently raised with 7 chambers visible in final whorl. Dorsal sutures distinct, strongly curved backwards towards the periphery; ventral sutures nearly straight, impressed and bordered by a band of dense papillae which extend over raised umbilical area. Apertures multiple as a series of irregular slits along the ventral sutures, particularly well developed over umbilicus and near periphery.

#### Dimensions (maximum diameters)

fig.16	fig.1	fig.15	10/29	10/30	10/31
242 μm.	242 μm.	655 μm.	687 μm.	633 μm.	608 μm.

#### Material

Numerous specimens.

Provenance

fig.16,1 VE 56/-09/142 <sup>e</sup>/<sub>d</sub>/6, 23-25cm  
fig.15 VE 57/-09/32 <sup>e</sup>/<sub>d</sub>/6, 12-20cm  
10/29 VE 57/-09/32 <sup>c</sup>/<sub>b</sub>/6, 10-20cm  
10/30,31 VE 57/-09/60 <sup>b</sup>/<sub>a</sub>/4, 27-30cm.

Remarks

To quote Loeblich & Tappan (1953) "this species differs from the associated *B.frigida* in being larger, more sharply keeled and more strongly convex". I have, however, illustrated specimens which I consider to be juveniles and which bear a strong resemblance to some author's concept of *B.frigida*. However, the ventral side remains distinctly convex, the periphery is moderately acute and distinctly lobate.

Occurrence

The modern distribution of this species appears to be confined to the Arctic with records by Loeblich & Tappan (1953), Leslie (1965) Wagner (1968) and Nagy (1968) and from Spitsbergen by Nagy (1965). It is interesting to note that Nørvang (1945) records *Eponides frigida* (Cushman) from Iceland and includes *Rotalina karsteni* as recorded by Terquem & Terquem (1886) in the list of Icelandic records. Brady (1884, pl.105, figs.8,9) illustrates *Pulvinulina karsteni* (Reuss) from the Magellan strait, Antarctica and from Cape Frazier which I consider to belong here and not in

*Buccella frigida* (Cushman) as Barker (1960) notes. Thus, as Haynes (1973) notes, "most references to *Eponides karsteni* probably indicate *B.inusitata* Anderson" although according to Nørvang (1945) *Eponides frigida* (Cushman) "is probably recorded by several authors under the name *Pulvinulina karsteri* Reuss". Both forms, as recognized in the present study, are quite distinct even as juveniles and hopefully their distribution patterns will be resolved in the future.

Family ROTALIIDAE Ehrenberg, 1839

Genus AMMONIA Brunnich, 1772

*Ammonia batavus* (Hofker)

Plate 21, figs.2,3,4

*Streblus batavus* Hofker, 1951, pp.498, 340, 341; Haake, 1962, p.52, pl.6, figs.6-12.

*Ammonia batavus* (Hofker) Feyling-Hanssen, 1964, p.349, pl.21, figs.4-13; Haynes, 1973, p.187, pl.18, figs.5,6,14,16, text-fig.39, nos.1-4.

*Roblina beccarii* Williamson, 1858, p.48, pl.14, figs.90-92 (not *Nautilus beccarii* Linné).

*Rotalina beccarii* part Parker, 1952<sup>b</sup>, p.457, pl.5, figs.5a,b (not Linné).

?*Streblus beccarii* Todd & Low, 1961, p.18, pl.2, figs.18,19.

*Ammonia beccarii* (Linné) var. *batavus* (Hofker) Murray, 1965a, p.502(list), pl.1, figs.1 & 2 (stereopairs).

*Ammonia beccarii* (Linné) Murray, 1971, p.151, pl.62, figs.1-7.

#### Description

Test a low trochospire, biconvex. Periphery sub-rounded, slightly lobate. The evolute spiral, dorsal side is gently convex, the involute ventral side more strongly so with a deep umbilical excavation and central umbilical plug. Chambers somewhat inflated, numbering 9 in the final whorl, tapering towards the umbilicus where they are irregular, bossed and tend to become digitate. Sutures distinct, deeply incised on the ventral side, radial, nearly straight; dorsal spiral suture distinct, deeply incised but tending to become thickened and nearly flush over earlier whorls; pits mark the location of the junction between radial & spiral sutures. Test wall translucent, highly perforate, fine. Aperture an interio-marginal slit which extends into umbilical area and backwards along spiral suture.

#### Dimensions

	11/2	11/3	11/4	11/5	11/8
maximum diameter	560 $\mu$ m.	636 $\mu$ m.	580 $\mu$ m.	450 $\mu$ m.	620 $\mu$ m.
	16/20	L/18	L/19	15/35	
maximum diameter	376 $\mu$ m.	466 $\mu$ m.	400 $\mu$ m.	210 $\mu$ m.	

#### Material

Numerous.

#### Provenance

figs.2-3 VE 57/-09/89 2.15-2.25 m.  
11/8 VE 57/-09/89 2.35-2.40 m.†  
15/35 Aberdaron, A4.†  
16/20 Aberdaron, A12.†  
L/18,19 Laugharne, Taf estuary.†

† = not illustrated

#### Remarks

The present form, considered here as a single species, exhibits considerable variation in test morphology. The dorsal side may be deeply incised as illustrated or may be nearly flat and smooth with flush sutures as described by Haynes (1973). The ventral side also exhibits a considerable degree of variation, specimens may have a strong, central plug or no plug at all but instead a series of well developed bosses at the end of each chamber which suggests that transitional forms exist between Hofker's species and *A.beccarii* (Linné). Haynes (1973, p.188) discusses the variation in this species and illustrates other species of the genus *Ammonia*; the reader is directed to the latter for a fuller treatment of this form.

I have illustrated both coiling directions here (cf. pl.21,

figs.2&3), however, the sinistral form typically dominates.

The present form differs from the typical *A.beccarii* in its generally less well developed ventral ornament, less angular periphery and smaller size range.

#### Occurrence

As discussed by Haynes (1973) there are problems in working-out the distribution of this species which relate to confusion with *A.beccarii* in the literature. Many of the specimens encountered in the present study might equally be placed in *A.baccarii*. However, it would appear to be "a southern species which is close to its northern limit of distribution" (Murray, 1971). Quaternary records include Knudsen (1971) where it is reported to be the dominant taxon in the Postglacial deposits of Vendsyssel (up to 93%), it is also common in Interglacial deposits (Knudsen, 1971).

Family	ELPHIDIIDAE	Galloway, 1933
Genus	ELPHIDIELLA	Cushman, 1936

*Elphidiella arctica* (Parker & Jones)

Plate 21, figs.5,6

*Polystomella arctica* Parker & Jones, in Brady, 1864, p.471, pl.48, fig.18.

*Elphidium arcticum* (Parker & Jones) Cushman, 1930, p.27, pl.11, figs.1-6.

*Elphidiella arctica* (Parker & Jones) Cushman, 1939, p.65, pl.18, figs.11-14; Loeblich & Tappan, 1953, p.106, pl.20, figs.1-3; Feyling-Hanssen, 1964b, p.48, pl.3, fig.13; Knudsen, 1971, p.284, pl.14, fig.1.

#### Description

Large, planispiral test, broadly rounded, even periphery, flattened sides. Chambers increasing gradually, about 10 in the final whorl. Sutures slightly depressed, particularly later ones, producing a gently lobate periphery. A distinctive double row of pores, numbering approximately 11 pairs, consisting of elongate slits which produce an open 'v' pointing towards the flattened umbilicus. Wall covered in very fine tubercles which are not normally visible under the light microscope. Apertural face strongly curved with a few randomly arranged pores.

#### Dimensions

	fig.5	fig.6
maximum diameter	1.07 mm.	778 $\mu$ m.
width	----	350 $\mu$ m.

Material

Limited numbers (14 specimens).

Provenance

VE 57/-09/60 <sup>b</sup>/4 7-10 cm.

Remarks

This form is assigned to *E.arctica*, although the original and later descriptions mention a smooth, rather than finely pustulose test as seen in the present material under high magnification. It is readily distinguished by its double row of slit-like openings along the sutures and by the thickened and flat sided umbilical areas. Feyling-Hanssen's (1971) species *Cryptoelphidiella itriaensis* differs in that the papillate surface is coarser and concentrated about the central area, the apertural face and the peripheral border.

Occurrence

Numerous records exist for this taxon and it is well known, although apparently never in large numbers, from Quaternary deposits; it is an index species for Early Pleistocene deposits in the Netherlands (Ten Dam & Reinhold, 1941; Voorthuysen, 1953). It occurs in Recent Arctic faunas (Loeblich & Tappan, 1953; Leslie, 1965; Nagy, 1965) and is also known from the Late Quaternary of the Oslofjord area (Feyling-Hanssen, 1964).

Genus                   ELPHIDIUM                   de Montfort, 1808

*Elphidium albiumbilicatum* (Weiss)

Plate 21, figs.7,8

*Nonion pauciloculum* Cushman, subsp. *albiumbilicatum* Weiss, 1954, p.157, pl.32, figs.1,2; Lafrenz, 1963, p.22, pl.1, figs.19-22.

*Nonion depressulus* (Walker & Jacob) forma *asterotuberculatus* Voorthuysen, 1957, p.28, pl.23, fig.3.

*Nonion depressulus* (Walker & Jacob) forma *asterotuberculata* Voorthuysen, 1960, p.254, pl.11, fig.21.

*Nonion depressulum* (Walker & Jacob) forma *asterotuberculatum* Voorthuysen, Haake, 1962, p.41, pl. 3, fig.5.

*Cribrononion asklundi* (Brotzen) Lutze, 1965, p.104, pl.15, fig.42.

*Protelphidium asterotuberculatus* (Voorthuysen) Gudina, 1969, p.35, pl.12, fig.6.



*Elphidium albiumbilicatum* (Weiss) Knudsen, 1971, p.268, pl.10,  
figs.15-19, pl.19, figs.4-8;  
Knudsen, 1978, p.33, pl.2, figs.3-7,  
pl.4, figs.1-5.

#### Description

Test somewhat compressed with rounded periphery and slightly depressed umbilical area. Chambers numbering 7 in final whorl, increasing slowly. Sutures indistinct, backwards curving and marked by distinctive bands of papillae which taper towards the periphery giving a star-like appearance. Sutural pores are irregularly developed and visible as pits within the papillose bands. This papillate ornament also extends over  $\frac{2}{3}$  of the apertural face and onto the periphery beneath it for approximately  $1\frac{1}{2}$  chambers. Aperture as a multiple series of pores, largely obscured by papillae, at the base of the final chamber.

#### Dimensions

	15/15	fig.8	fig.7	1/30
maximum diameter	330 $\mu\text{m}$ .	400 $\mu\text{m}$ .	277 $\mu\text{m}$ .	389 $\mu\text{m}$ .

#### Material

Numerous specimens.

#### Provenance

15/15 VE 57/-09/46 <sup>b</sup>/<sub>6</sub> 75-79 cm.  
fig.8 Upper Saxicava Sand, Nørre Lyngby, Denmark.  
fig.7 VE 57/-09/46 <sup>b</sup>/<sub>6</sub> 33-37 cm.  
1/30 VE 57/-10/21 <sup>b</sup>/<sub>5</sub> 30-33 cm.

#### Remarks

The present species, while variable in form, is very close to the material described and figured from the Quaternary deposits of Vendsyssel (Knudsen, 1971, 1978). For comparative purposes I have included an illustration of a specimen from the Upper Saxicava Sand, Nørre Lyngby; collected in the field with Dr.K.L. Knudsen, September, 1989 (pl.21, fig.8).

It is sometimes difficult to distinguish this species from *E.hallandense* of this study, particularly juvenile specimens, except that the latter exhibits more extensive sutural pores, papillae which extend as a sub-parallel band all the way to the periphery and are less extensive over the apertural face. The possibility that these two species are ecophenotypes of one species group is discussed by Knudsen (1978, p.25). The species *E.asklundi* is distinguished from this species on the basis of its generally lobate periphery, better defined sutures with clear septal bars and generally less papillate surface ornament; again juvenile specimens can be difficult to separate. The reader is referred to Knudsen (1971, p.268) for a more detailed account of this species.

#### Occurrence

The modern distribution of this taxon is partly confused by a failure to recognise it as distinct from closely related morphological forms. It appears to be most common in shallow waters, often where salinity is lowered, with a boreo-arctic and boreal affinity. In borings from Nørre Lyngby, for example,

Knudsen (1978) interprets the *E.albumbilicatum* zone as indicative of rising temperature and possibly lowered salinities. In this study it appears to be a good proxy indicator of climatic amelioration.

*Elphidium asklundi* Brotzen

Plate 21, figs.9,10,11

*Elphidium asklundi* Brotzen, in Hessland, 1943, p.267, fig.109-1; Knudsen, 1971, p.270, pl.10, figs. 20-21, pl.11, figs.1-5; Knudsen, 1978, p.34, pl.2, figs.8-9, pl.3, fig.1, pl.4, figs.6-8.

Description

Test large, periphery rounded, lobate in side view. Involute planispire with 11 chambers visible in the final whorl. Sutures well defined, curving backwards gently with few septal bars and deep, irregular pores. Umbilical area with irregular, flattened bosses and papillate ornament which extends into the open-ended sutures. Apertural face smooth except for basal papillae which surround the series of apertural pores along the basal suture.

Dimensions

	2A/23	2A/24	1/21
maximum diameter	976 $\mu$ m.	----	830 $\mu$ m.
maximum width	---	380 $\mu$ m.	---

Material

Numerous specimens.

Provenance

VE 57/-09/89 <sup>e</sup>/6, 10-20 cm.

Remarks

Large adult specimens with highly lobate peripheries, deeply incised, elongate sutural pores and a tendency to form an umbilical plug are readily distinguished from the other species of *Elphidium*, although juveniles can prove problematic. Knudsen (1971, p.270) discusses the similarity of this form to *E.incertum* (Williamson), as noted by Madsen (1895), particularly specimens with irregular double rows of elongate slits in the sutures and more flattened than usual tests. However, the present specimens appear to be closer to the typical form.

While Knudsen (1971) notes the similarities with *E.incertum*, no attempt to relate earlier records of this species to *E.asklundi* is made either in synonymy or in the discussion on its occurrence. As Loeblich and Tappan (1953, p.101) state with reference to *E.incertum* : "This species has apparently been misidentified with abandon throughout the American literature. An examination of all Arctic specimens in the Cushman and U.S. National Museum collections shows not a single specimen like that figured by Williamson. Probably no other species has been so thoroughly

confused". Arctic records of *E. asklundi* certainly exist and it is highly likely that earlier arctic records, for example *E. incertum* (Williamson) var. *clavatum* Cushman of Phleger belong here. Unfortunately, I have been unable to view some of these collections and the illustrations are often poor.

As far as confusion of this species in the literature is concerned, it was with considerable interest that I noted specimens of *E. asklundi* and *E. hallandense* included with very well preserved specimens of *Nonionina depressula* (Walker & Jacob) in the Heron-Allen & Earland collection, Clare Island Survey at the British Museum (N.H.). These specimens are presumable derived and I understand from Dr. P. Coxon, Trinity College, Dublin (pers. comm.) that proposed glacial marine deposits occur nearby.

#### Occurrence

This is a common taxon in Quaternary deposits of Denmark and surrounding areas; see Knudsen (1971) for a review of its distribution in this general area.

#### *Elphidium bartletti* Cushman

Plate 21, fig.12

*Elphidium bartletti* Cushman, 1933, p.4, pl.1, fig.9; Loeblich & Tappan, 1953, p.96, pl.18, figs.10-14 [with expanded synonymy]; Feyling-Hanssen, 1964, p.343, pl.21, figs.1,2; Knudsen, 1971, p.271, pl.11, figs.6-9, pl.20, figs.1-4 [with expanded Russian synonymy]; Knudsen, 1978, p.34, pl.3, fig.2.

*Elphidium goesi* Stschedrina, 1946, p.144, pl.4, fig.20.

*Criboelphidium goesi* (Stschedrina) Saidova, 1961, p.80, pl.24, fig.166; Gudina, 1966, p.58, pl.3, figs.1-6, pl.10, fig.4, pl.11, fig.5, text-fig.8.

*Criboelphidium vulgare* Voloshinova, 1958, p.174, pl.7, figs.2-10.

#### Description

Medium test with broadly rounded, even periphery, slightly evolute. Nine chambers in final whorl, increasing slowly. Sutures slightly backward curving, narrower towards periphery, broader & finely pustulate towards the flat umbilicus. Apertural face high, about 1/2 test diameter, with small pores along its basal margin and larger, scattered pores centrally.

#### Dimensions

maximum diameter 516  $\mu$ m.

#### Material

Single specimen only.

Provenance

VE 56/-09/142 b/6, 89-91cm.

Remarks

I have recognized a single abraded specimen as belonging to this species and am therefore not readily able to remark upon the variation which it is reported to exhibit (see Loeblich & Tappan, 1953, p.97 and Knudsen, 1971, p.272 for further comments). It closely resembles specimens illustrated by Feyling-Hannsen, 1964 from a depth of 8m in Wijdefjord, Spitsbergen; although there is a possibility of confusion with *E. asklund*.

Occurrence

In a broad summary, this is an Arctic, shallow water species. However, Stschedrina (1958) records it (= *Criboelphidium goesi*) from 99-1,140 m. in the Greenland Sea, although Knudsen (1971) notes that it normally occurs above 100 m. water depth. Its occurrence in Quaternary sediments is variable, it accounts for up to 20% in a sample from zone 3 in the Sandnes Clay, Norway; it is rarer from the late Quaternary of Vendsyssel; it was also recorded in Bridlington Crag at Dimlington, Holderness by Catt & Penny (1966).

*Elphidium crispum* (Linné)

Plate 21, figs.13,14,15

*Nautilus crispus* Linné, 1758, p.709; Linné, 1767, p.1162, 275.

*Polystomella crispa* (Linné) Lamarck, 1816 and 1822, p.625, no.1.

*Elphidium crispum* (Linné) Cushman, 1939, p.550, pl.13, figs.19-21 (not 17, 18); Murray, 1971, p.155, pl.64, figs.1-6(?).

Description

Test large, circular, planispiral involute, lenticular in peripheral view. Periphery bluntly produced and keeled. Chambers high and narrow increasing in size slowly, numbering 19 in final whorl. Sutures distinct, depressed and strongly curved backwards at periphery. Septal pits narrow, numbering up to 13 in one suture. Separated by distinctive bar-like septal bridges (ponticuli) which are equal in length to chamber width at their maximum. Raised and extensive umbilical area of clear shell material with up to 10 large (20  $\mu$ m. diam.) pits present; chamber ends merge into umbilicus undisturbed. Complete apertural face not observed.

Dimensions

maximum diameters	870 $\mu$ m.	860 $\mu$ m.	860 $\mu$ m.	710 $\mu$ m.	1030 $\mu$ m.
thickness	460 $\mu$ m.	420 $\mu$ m.	390 $\mu$ m.	360 $\mu$ m.	440 $\mu$ m.

Material

Moderate numbers.

Provenance

VE 57/-09/89 <sup>e</sup>/6, 10-20cm.

Remarks

This form has proven particularly difficult to identify and I am grateful to Dr. Hans Petter Sejrup for drawing my attention to similarities between it and material from zone F5 of the Eemian of Fjøsangerian, western Norway and the specimen which he subsequently sent me. I must also acknowledge the help given by Karen Luise Knudsen at Aarhus who pointed out the differences between *E. groenlandicum* and the present form; both of us wondering whether this was a new species.

The difficulty in placing this form in *E. crispum* arises partly as a result of there being few reliable modern illustrations of the species and of possible confusion in the literature with *E. macellum*. For example, Murray's (1971, pl.64) illustration of *E. crispum* is typical of most author's *E. macellum*; although he does state that "in the British material there is continuous variation between smaller forms of *macellum* type and larger forms of *crispum* type". Equally, Heron-Allen and Earland (1913) in their report on the Clare Island fauna, while distinguishing these two species as distinct, do note "besides typical specimens of *P. macella*, there are abundant intermediate examples which could with equal reason be assigned to the present form, particularly in the inflated form of the test and the punctured umbilical area (boss)". It is also of interest to note that Brady (1884) considered *E. macellum* (*P. macella*) as "a compressed variety of *P. crispa* with acute or sub-acute periphery and somewhat depressed umbilici".

Additional problems arise in identifying the often broken and abraded specimens of this form- often acting to make the chambers broader. Haynes (cf. McCabe *et al.*, 1990) has noted that reworked specimens are often worn-down to the extent that only the 'central pillar' remains.

Occurrence

This is a common British taxon and Murray (1971) suggests that it is an inner shelf, stenohaline marine species of southern affinity close to its northern limit of distribution around the British Isles. However, more northerly occurrences are known at Fjøsanger, western Norway in Eemian Sediments (Mangerud *et al.*, 1981) for example.

*Elphidium earlandi* Cushman

Plate 22, figs.1,2

*Elphidium earlandi* Cushman, 1936, p.85, pl.15, figs.5a,b; Murray, 1971, p.157, pl.65, figs.1-7.

Description

Test a compressed, involute planispire. Margin rounded, lobate in side view with 8 chambers visible in final whorl. Sutures distinct, depressed with septal pits separated by strong,

slightly inflated septal-bars, numbering between 5 & 6 on either side. Distinctive tuberculate ornament around septal pits, umbilical area, and extending along basal margin of apertural face, amongst small apertural pores.

Dimensions

maximum diameter 380  $\mu$ m. (fig.1), 180  $\mu$ m. (fig.2)

Material

Two specimens only.

Provenance

fig.1 VE 57/-09/46 <sup>a</sup>/6, 5-10cm

fig.2 VE 56/-09/142 <sup>a</sup>/6, 17-19cm.

Remarks & Occurrence

The present form is very close to Murray's figured specimens from south-west Britain. He notes that "this species has not previously been recorded from Britain" and the present record, in Holocene sands from the Hebridean Shelf, is possibly the most northerly yet. Cushman's types come from South-west Spain. I can find no Quaternary record for this species.

*Elphidium excavatum* (Terquem) forma *clavata* Cushman

Plate 22, figs.3,4,5,6,7,8,9,10,11

*Elphidium incertum* (Williamson) var. *clavatum* Cushman, 1930, p.20, pl.7, fig.10; Cushman & Cole, 1930, p.96, pl.13, figs.8-9; Cushman, 1948, p.57, pl.6, fig.8; Voorthuysen, 1949, p.65, pl.1, fig.4

*Elphidium clavatum* Cushman, Loeblich & Tappan, 1953, p.98, pl.19, figs.8-10; Todd & Low, 1961, p.18, pl.2, fig.1; Buzas, 1965, p.23, pl.3, figs.3-4; Knudsen, 1971 (part) p.273, pl.11, figs.12-13, pl.20, figs.7-8.

*Elphidium incertum clavatum* Cushman, Feyling-Hanssen, 1954, p.141, pl.2, fig.11; Boltovskoy, 1954, p.275, pl.24, fig.7; Feyling-Hanssen, 1964, p.345, pl.20, figs. 11-15.

*Elphidium subclavatum* Gudina, 1964, p.69, pl.1, figs.4-10 Q, text-fig.1; 1966, p.45, pl.4, figs.4-10, pl.9, fig.3, pl.10, fig.3

*Elphidium excavatum* (Terquem) forma *clavata* Cushman, Feyling-Hanssen, 1972, p.339, pl.1, figs.1-9 pl.2, figs.1-9; Miller *et al.*, 1972,

p.124, pl.1, figs.5-8, pl.2,  
figs.3-8, pl.3, figs.3-8, pl.4,  
figs.1-6, pl.5, figs.4-8, pl.6,  
figs.1-5 (with extended synonymy).

#### Description

Test medium, planispiral, involute. Periphery rounded to sub-rounded, slightly lobate; 12 chambers visible in the final whorl. Sides flattened, biumbonate, with clear, imperforate umbilical plugs. Chambers increasing steadily in size, with distinct, backwards curving and impressed sutures. Sutural pits and distinct sutural bridges present, varying in number from a single pit to 3 or 4 pits and bridges. Sutures become closed by the imperforate, clavate umbilical chamber ends to form an almost entire fused band around the umbilicus. Umbilicus and test area bordering apertural face ornamented by fine papillae. Aperture consists of a single row of pores at the base of the apertural face. Test wall generally thin, yellow-orange-brown in colour, with distinctive small perforations limited in number around the umbilicus and bordering sutures.

#### Dimensions

Aberdaron test diameter range = 72  $\mu$ m. - 336  $\mu$ m.  
VE 56/-09/142 = 84  $\mu$ m. - 548  $\mu$ m.  
VE 57/-09/89 = 84  $\mu$ m. - 660  $\mu$ m.

#### Material

The most ubiquitous and abundant species of the present study

#### Provenance

figs.3-9,11 VE 57/-09/89  
fig.10 Aberdaron, A1

#### Remarks

The confusion surrounding *Elphidium excavatum* (Terquem) is quite astounding; it was Feyling-Hanssen (1972) who first realized the nature of the problem by grouping several common species as ecophenotypes of this species. This is the approach that I have followed in the present study, simplifying Feyling-Hanssen's and then Miller *et al.*'s (1982) subdivision, and recognising only two forms: the present forma *clavata* and forma *selseyensis*. In view of the continuous variation exhibited within this species and the tendency of forma *clavata* to characterize boreo-arctic assemblages and forma *selseyensis* to characterize temperate assemblages, I am inclined to regard these formae as ecophenotypic rather than subspecific as proposed by Wilkinson (1979). However, while these morphotypes may derive from nongenetic modification of the phenotype in response to specific ecological conditions, the separation of genetic and nongenetic factors have yet to be resolved for this species.

It is distinguished from *E. excavatum* forma *selseyensis* of this study by its distinctly clavate chambers which tend to form an imperforate collar around the umbilicus, which may or may not contain an imperforate plug, as well as its orange-brown, glassy test. I have attempted to illustrate some of the variation exhibited by this form with a number of figures. Although it appears that Cushman (1930, p.21, pl.8, figs.4-7) may have

mistaken *E.williamsoni* Haynes for *E.excavatum*, the former is readily identified by its numerous sutural bridges.

#### Occurrence

This form is reported from Recent and Holocene sediments from estuarine, nearshore zones, bays and continental margins in general, from the high Arctic to the tropics (Miller *et al.*, 1982). It is best known for its often dominant occurrence within Weichselian deposits and the reader is directed to Feyling-Hanssen (1972) or Miller *et al.* (1982) for comprehensive reviews on its distribution.

Murray (1991) summarizes the ecological requirements of the *Elphidium clavatum* association (= *E.excavatum* forma *clavata*) from the Atlantic seaboard of Europe and Africa, based upon published data by Rouvillois (1966), Nagy (1965), Jarke (1960), Sejrup *et al.* (1981), Hansen (1965), and van Weering and Qvale (1983), as:

salinity : 10-35 ‰.  
temperature : 0°-7°C  
substrate : muddy gravel, sand  
depth : 0-285 m.

*Elphidium excavatum* (Terquem) forma *selseyensis* (Heron-Allen & Earland)

Plate 22, figs.12,13,14

*Polystomella excavata* Terquem, 1876, p.429, pl.2, figs.2a-d.

*Polystomella striatopunctata* (Fichtel & Moll) var., Heron-Allen & Earland, 1909, p.695, pl.21, fig.2.

*Polystomella striatopunctata* (Fichtel & Moll) var. *selseyensis* Heron-Allen & Earland, 1911, p.448.  
Type description and figure 1909, p.695, pl.21, figs.2a-c.

*Elphidium* (*Polystomella*) *excavatum* (Terquem) Heron-Allen & Earland, 1932, p.439, pl.16, figs.22-23.

*Elphidium excavatum* (Terquem) Parker, 1952, p.412, pl.5, fig.8;  
Murray, 1971, p.159, pl.66, figs.1-7

*Elphidium incertum selseyensis* (Heron-Allen & Earland) Brand, 1941, pp.65-66.

*Elphidium incertum* (Williamson) Cushman, 1949, p.28, pl.5, fig.9.

*Elphidium selseyensis* (Heron-Allen & Earland) Voorthuysen, 1957, p.31, pl.23, fig.9.

*Elphidium selseyense* (Heron-Allen & Earland) Haake, 1962, p.49, pl.5, fig.15, pl.6, figs.1-5;  
Richter, 1964, pp.343-351, text-figs.5-6; Haynes, 1973, p.204, pl.22,



figs.3,4, pl.24, fig.11, pl.26,  
figs.4,5,7,9,10, pl.29, figs.1-3.

*Elphidium clavatum* Cushman, Brondniewicz, 1965 (part), p.210,  
pl.10, fig.32; Knudsen, 1971 (part),  
p.273, pl.20, figs.5-6.

*Elphidium excavatum* (Terquem) forma *selseyensis* (Heron-Allen &  
Earland) Feyling-Hanssen, 1972,  
p.341, pl.4, figs.1-7, pl.5,  
figs.1-7.

*Elphidium clavatum nudum* Wilkinson, 1979, p.638, pl.1, fig.6,  
pl.2, fig.8.

*Elphidium excavatum* (Terquem) forma *excavata* (Terquem) Miller,  
Scott & Medioli, 1982, p.128, pl.1,  
figs.9-12, pl.2, figs.1-2, pl.3,  
figs.1-2, pl.4, figs.13-16, pl.5,  
figs.15-16, pl.6, figs.6-8,14.

#### Description

Test medium, planispiral, involute and moderately compressed. Periphery rounded, slightly lobate, with 8 chambers visible in the final whorl. Chambers increasing in size steadily; sutures distinct, gently curving backwards towards the periphery, incised. Numerous papillae fill the generally open sutures, particularly where they connect with the excavated umbilicus. Septal bridges vary in number as do the deeply excavated septal pits. Aperture comprises a single row of pores along the base of the apertural face. Test wall translucent and densely perforate, giving a distinctly hazy appearance to this form.

#### Dimensions

	1/12	1/13	1/10
maximum diameter	412 $\mu$ m.	500 $\mu$ m.	378 $\mu$ m.

#### Material

Limited numbers only.

#### Provenance

VE 57/-09/89

#### Remarks

As with *E.excavatum* forma *clavata*, the density of pores varies within this form, but is generally more densely perforate than forma *clavata*. These forms are also readily distinguished by the open, more densely papillate sutures and umbilicus of this form. My specimens agree fairly well with those illustrated by Feyling-Hanssen (1972) from the Lim Fjord, Denmark, and with the specimen from the Postglacial of boring no.1, Løkken, Denmark (Knudsen, 1971). Again, as with forma *clavata*, Feyling-Hanssen (1972) and Miller *et al.* (1982) provide useful comments on this form.

Haynes (1973) discusses the redescription by Lévy *et al.* (1969) of topotype material of *E.excavatum* and states "this diagnosis excludes *E.selseyense*"; a view which Miller *et al.*

(1982) have followed, but at the forma rather than specific level. Miller *et al.* (1982) do recognize a distinct form from the present which they assign to *E.excavatum* forma *selseyensis*, however this does not fall within the concept of *E.excavatum* forma *selseyensis* of the present study.

#### Occurrence

*Polystomella excavata* was originally described from the beach sands of the Dunkirk area (Terquem, 1876); while *Polystomella striatopunctata* var. *selseyensis* was described from the beach sands of Selsey Bill (Heron-Allen & Earland, 1909,1911). According to Feyling-Hanssen (1972) "it seems to be mainly distributed in the southern part of the Boreal and northern part of the Lusitanian region of the European coasts". For detailed accounts of its distribution the reader is directed to the references cited in the text.

#### *Elphidium gerthi* Voorthuysen

Plate 22, fig.15

*Elphidium* sp.1 Voorthuysen, 1951, p.25, pl.2, fig.19; Haake, 1962, p.48, pl.5, fig.10.

*Elphidium gerthi* Voorthuysen, 1957, p.32, pl.23, fig.12; Knudsen, 1971, p.274, pl.11, fig.14; Murray, 1971, p.161, pl.67, figs.1-7; Knudsen, 1982, p.170 (list), fig.14:12,13,14.

*Elphidium exoticum* Haynes, 1973, p.198, pl.24, figs.8,9, pl.26, figs.2,3,6,8, pl.28, figs.1-4.

#### Description

Test an involute planispire, highly compressed. Periphery evenly rounded, slightly lobate with 11 chambers visible in the final whorl. Sutures distinct, backwards curving at the periphery, depressed with septal pits between moderately fine bars which number approximately 7 per side. Chambers 4 times the length of the septal bars at periphery, clavate and flattened at umbilical end to produce a 'collar' surrounding a central boss; whole umbilical area and much of test flattened. Aperture consists of a series of basal arches (interiomarginal). Fine tubercles line septal pits, umbilical area and basal sutures of fine chamber. Finely perforate, hyaline.

#### Dimensions

maximum diameter 447  $\mu$ m.

#### Material

Moderate numbers

#### Provenance

Specimen illustrated from Laugharne, Taf estuary, S. Wales.

#### Remarks

My material is very close to the specimens figured by Murray (1971) although the specimen illustrated here exceeds the average greatest diameter of 0.3 mm. quoted by nearly 50%. Hayne's species *E.exoticum* described from the Dovey Marshes of Cardigan Bay, West Wales probably belongs here and it is interesting to note that he records a max. diameter of 0.38 mm.. I have examined paratypes of *E.exoticum* at the British Museum [1970.11.26.398-406] and find them nearly identical to the present form, except that they are slightly more inflated and with a smaller umbilical boss; I have subsequently compared material with Haynes at Aberystwyth and confirmed these slight differences. Knudsen (1971), following observations by Haake (1962), discusses the variation in this species and appears to have followed Lafrenz (1963) in referring both "plugged" and "unplugged" specimens to *E.gerthi*. All of the present forms assigned to this species exhibit a distinctive plug. Haynes (1973) does not, rather surprisingly in view of the similarities, include *E.gerthi* in his discussion of similar species and may therefore have overlooked Voorthuysen's original description and subsequent records.

#### Occurrence

Murray (1971) records this as an inner shelf species; this appears to be confirmed by other records. It is known from Eemian deposits of Schleswig-Holstein (Lafrenz, 1963), the Netherlands (Voorthuysen, 1957) as well as a number of late Quaternary deposits, particularly the Postglacial of Vendsyssel (Feyling-Hanssen *et al.*, 1971) and zone 1 of Solberga (Knudsen, 1982)

#### *Elphidium groenlandicum* Cushman

Plate 23, fig.1

*Elphidium groenlandicum* Cushman, 1933, p.4, pl.1, fig.10; Knudsen, 1971, p.275. pl.12, figs.1-8, pl.21, figs.1-3.

*Elphidiella groenlandica* (Cushman) Cushman, 1939, p.66, pl.19, fig.3; Cushman, 1948, p.60, pl.6, fig.14; Loeblich & Tappan, 1953, p.106, pl.19, figs.13,14; Todd & Low, 1967, p.34, pl.4, fig.21; Gudina, p.40, pl.13, fig.3.

*Elphidiella tumida* Gudina, 1969, p.40, pl.13, fig.4.

#### Description

Test large, planispiral, involute. Periphery sub-acute, rounded and lobate with 13 inflated chambers visible in final whorl. Sutures distinct, varying in degree of curvature with

sutural pores in a single or off-set double row, may be fused and irregular. Maximum thickness occurs over convex umbilical area where test is thickened and 'glassy' with distinctive pits. Surface finely perforate except bordering sutures and over umbilical area. Aperture comprising a series of pores along the basal suture of final chamber.

#### Dimensions

	2A/22	fig.1	15/17	15/18
maximum diameter	1.24 mm.	740 $\mu$ m.	1.13 mm.	1.0 mm.

#### Material

Infrequent

#### Provenance

15/17	VE 57/-09/60	<sup>b</sup> /4,	7-10 cm.
15/18	VE 57/-10/21	<sup>b</sup> /5,	88-91 cm.
fig.1	VE 57/-09/89	<sup>e</sup> / <sub>d</sub> 6,	10-20 cm.
2A/22	VE 57/-10/17	<sup>d</sup> /4,	5-10cm.

#### Remarks

This is a variable form, both in the number of chambers per whorl and in the arrangement of sutural pits. I have observed both specimens with single rows of sutural pits, typically juveniles, and specimens with both single and various forms of double rows, normally larger adults. I have not recorded any specimens with only double rows of sutural pores.

I have not had the opportunity to undertake detailed examination of the internal structure of this species and am uncertain as to its correct generic affinity. I have placed it here in *Elphidium* so that it remains consistent with current taxonomic usage following Knudsen (1971). However, the transfer of this species back from *Elphidiella* to *Elphidium* on the basis of "its irregular or inconsistent double rows of sutural pores" (Knudsen, 1971, p.276) hardly seems sufficiently justified (and will only be resolved after internal details have been studied ie. affinity of sutural opening resolved).

#### Occurrence

See Knudsen (1971) for details : generally cold, deep water.

*Elphidium hallandense* Brotzen, 1943

Plate 23, figs.2,3

*Elphidium hallandense* Brotzen, 1943; Knudsen, 1982, p.170 (list), fig.14:12.15.

*Elphidium subarcticum* Cushman, 1944, p.27, pl.3, figs.34-35; Loeblich & Tappan, 1953, p.105, pl.19, figs.5-7; Knudsen, 1971, p.280, pl.13, figs.3-7, pl.22, fig.9; Knudsen, 1978, p.34(list), pl.3, figs.6-8, pl.5, figs.5-8.

*Criboelphidium subarcticum* (Cushman) Gudina, 1969, p.38, pl.12, figs.11, 12.

#### Description (fig.2)

Test large, an involute planispire, with flattened sides and a broadly rounded, slightly lobate periphery. Chambers slightly inflated increasing slowly and numbering 7 in final whorl. Sutures distinct, slightly depressed with a single line of pores, bordered by a broad, parallel sided band of fine papillae which extend over the periphery and merge in the umbilical area. The apertural face has papillae over lower  $\frac{1}{2}$  and a row of marginal pores. Surface finely perforate, hyaline, sutural papillae white & opaque.

#### Dimensions

	fig.2	fig.3
maximum diameter	660 $\mu$ m	655 $\mu$ m.

#### Material

Numerous specimens.

#### Provenance

- fig.2 VE 57/-10/17<sup>c</sup>/4, 30-40 cm.  
fig.3 VE 57/-09/89<sup>a</sup>/6, 80-90 cm.

#### Remarks

This species, although showing some variation in the number of chambers per whorl (7-9), is readily distinguished from other forms of *Elphidium* in this study. Occasionally, if the broad band of sutural papillae taper slightly towards the periphery, it can be difficult to distinguish from *E. albiumbilicatum*; except that the apertural face of the latter is more extensively covered in papillae.

While Knudsen (1971) notes "*E.hallandense* Brotzen, 1943 is most probably synonymous with *E.subarcticum*" it became obvious that *hallandense* is infact the senior synonym and therefore takes priority over *subarcticum*. Thus, many records of this species exist as *E.subarcticum* and infact Cushman's species name is still employed by some for this form.

No pores were observed above the basal suture on the apertural face as first described for this species by Loeblich & Tappan (1953).

#### Occurrence

Originally described (Brotzen, 1943) from late Quaternary of S.W. Sweden, Cushman (1944) described it from Eastport on the coast of Main and subsequently (Cushman, 1948) from N.E. Greenland at 50-57 fms. (=c.91-104 m.). Loeblich & Tappan (1953) record it from a number of Arctic stations, quoting it at depths from 37-223 m.. Risdal (1964) reports it from the Oslofjord between 10-310 m.

Its occurrence in Quaternary sediments is well documented (see Knudsen, 1971 for examples). Jensen & Knudsen (1988) include it in calculating the percentage of shallow water species in BH 81/29 from central North Sea.

*Elphidium macellum* (Fichtel & Moll)

Plate 23, fig.4

*Nautilus macellus* Fichtel & Moll, 1798, p.66, var.b, pl.10, figs.L-K.

*Elphidium macellum* (Fichtel & Moll) Montfort, 1808, p.15; Feyling-Hanssen, 1964, p.347, pl.20, fig.16; Knudsen, 1971, p.278, pl.12, figs.13,14, pl.22, figs.1-4; Haynes, 1973, p.201, pl.24, figs.1-3, pl.25, figs.1-5,7,8, pl.27, figs.4,5.

*Polystomella macella* (Fichtel & Moll) var. *aculeata* Silvestri, 1901, p.45.

*Elphidium macellum* (Fichtel & Moll) var. *aculeatum* (Silvestri) Cushman, 1949, p.27, pl.5, fig.10.

*Elphidium crispum* (Linné) subsp. *spinosum* Atkinson, 1969, p.537, pl.6, figs.4a,b.

#### Description

Test planispiral, circular with sub-angular periphery and fine keel. Strongly compressed and flattened over most of test. Chambers narrow and high, numbering 14 in the final whorl. Sutures distinct, curving backwards strongly at the periphery with distinctive septal pits (10) interspaced by bar-like septal bridges which appear to extend forwards and appear to be more clearly fused to preceding chamber each time. Apertural face broken.

#### Dimensions

	fig.4	15/19
maximum diameter	500 $\mu$ m.	360 $\mu$ m.

#### Material

Two specimens only.

#### Provenance

fig.4 VE 57/-10/17 <sup>a</sup>/<sub>4</sub> 90-95 cm.  
15/19 VE 57/-09/46 <sup>b</sup>/<sub>6</sub> 33-37 cm.

#### Remarks

The specimens assigned here to *E.macellum* are atypical of many illustrated specimens in the literature. The typical form, often with spinose juveniles does not occur in the present material, although I have seen it in Recent sediments from N.W. Spain. Such specimens appear to be intermediate between the present *E.crispum* with its inflated test and pitted umbilical area and *E.macellum* which is strongly compressed and has a more papillate surface. Haynes (1973, pl.24, figs.1-3), for example, illustrates specimens which he assigns to *E.macellum*, but which might be assigned here to both *E.crispum* (his fig.1) and *E.macellum* (his figs.2,3). Clearly then, the present author has either failed to grasp the correct taxonomic concept of these two

species, or that specimens of *E.crispum* have persistently been confused with and assigned to *E.macellum*. Specimens catalogued as *E.macellum* from the Clare Island Survey (Heron-Allen & Earland, 1913) have been inspected and appear to be closer to *E.margaritaceum* (Cushman); in this respect it is interesting to note that Haynes (1973) places *Polystomella macella* Heron-Allen and Earland (1909) in synonymy with *E.margaritaceum*. The latter, although not a member of the present faunas, is illustrated here (pl.23, fig.5) to allow comparison with *E.macellum*.

#### Occurrence.

Originally described from the Mediterranean, it appears to be a warm water taxon and according to Brady (1884): "it is not common in the northern temperate zone, the Mediterranean being apparently its boreal limit". However, if one accepts the records as belonging to *E.macellum*, then it is also known from Postglacial deposits of the Oslofjord area (Feyling-Hanssen, 1964) and Vendsyssel, with a few specimens in the Lateglacial and Older *Yoldia* Clay deposits (Knudsen, 1971).

*Elphidium* cf. *ustulatum* Todd fide Knudsen

Plate 23, fig.6

*Elphidium ustulatum* Todd, 1957, p.230, pl.28, fig.16; Knudsen, 1971, p.283, pl.13, figs.12,13, pl. 23, figs.5-7.

*Protoelphidium lenticulare* Gudina, 1966, p.55, pl.3, figs.7-9, pl.9, fig.1; Gudina, 1969, p.35, pl.12, figs.7,8.

#### Description

Test compressed, an involute planispire with  $8\frac{1}{2}$  chambers visible in the final whorl. Periphery sub-acute, rounded (not keeled) and slightly lobate in side view. Sutures distinct, consisting of a single elongate slit, tapering towards the periphery which it nearly reaches in later stages, lately it is divided into two. These slits are lined with a few papillae which are also present around the base of the apertural face. The umbilical area is flattened, extensive and imperforate, while the remainder of the test is very finely perforate. A flattened, digitate extension at the base of the final chamber extends into the umbilical area and has numerous papillae around it.

#### Dimensions

maximum diameter 154  $\mu$ m.

#### Material

Single specimen only.

#### Provenance

VE 57/-09/89 2.35-2.40 m.

#### Remarks

I have not seen Todd's original description and illustration of this species and have based my identification upon specimens illustrated by Knudsen (1971) from the Older *Yoldia* Clay of Vendsyssel and a single specimen collected in the field in September, 1989 from the Upper Saxicava Sand, Nørre Lyngby and subsequently identified as *E.ustulatum* by K.L. Knudsen. The present form differs from the above in its smaller size and tendency for the sutural slits to be bridged during the later stages of growth.

#### Occurrence.

Originally described from Miocene or Pliocene faunas from Carter Creek, northern Alaska and subsequently as *Elphidium* sp.2 (Voorthuysen, 1958) from the Pliocene of Belgium (Knudsen, 1971). The latter records it from zone 1 Sandness and from Elgane, Jæren. Feyling-Hanssen (1967) reports it from Clyde Foreland, N.E. Baffin Island in sediments older than 50,000 years BP.

#### *Elphidium williamsoni* Haynes

Plate 23, figs.7,8,9

*Polystomella umbilicatula* Williamson, 1858, p.42, pl.3, figs.81,82  
(not *Nautilus umbilicatus* Wlaker & Jacob )

*Elphidium umbilicatum* (Williamson) Lévy *et al.*, 1969, p.96, pl.1, figs.6a, 6b, pl.2, figs.1,2; Knudsen, 1971, p.281, pl.13, figs.8-11, pl.23, figs.1-4.

*Elphidium excavatum* Cushman, 1930 (part), p.21, pl.8, figs.4-7 (only); Feyling-Hanssen, 1964, p.344, pl.20, figs.7-8; Murray, 1965a, p.503 (list), pl.1, fig.6/6 (stereopair). (not *E. excavatum* (Terquem)).

*Elphidium articulatum* (d'Orbigny) Murray, 1971, p.153, pl.63, figs.1-7.

*Elphidium williamsoni* Haynes, 1973, p.207, pl.24, fig.7, pl.25, figs.6,9, pl.27, figs.1-3; Knudsen, 1982, p.170 (list), fig.14:12,19, fig.14:14,10-11.

#### Description

Involute, planispirally coiled test, moderately compressed. Periphery broadly rounded (not keeled), very slightly lobate in side view with 13 chambers visible in final whorl, gradually increasing in size as added. Sutures distinct, curving gently backwards with deep septal pits, numbering about 8 and extending



onto the peripheral margin, separated by slender septal bars which appear continuous from one chamber to the next. Numerous small tubercles line the sutures and are extensive in the umbilical area. Chamber ends are digitate around a single, small umbilical plug. Aperture consists of a series of small arches at the peripheral margin of the final chamber (interiomarginal).

#### Dimensions

	fig.7	fig.8	fig.9
maximum diameter	422 $\mu$ m.	555 $\mu$ m.	380 $\mu$ m.

#### Material

Three specimens only.

#### Provenance

fig.7	VE 57/-09/46 <sup>b</sup> /6, 68-71 cm.
fig.8	Laugharne, Taf estuary, S.Wales
fig.9	BH CH1, Cork Harbour, Ireland

#### Remarks & Occurrence

The reader is referred to Haynes's discussion of this species for further information. There is some variation in the form and I have included illustrations of an additional two specimens here. This is a typical component in assemblages from hyposaline lagoons and estuaries and I have recorded it as the dominant live taxon from saltmarshes at Laugharne on the Taf estuary, South Wales. It is probably derived from Holocene sediments in present study as it occurs only rarely in fully marine, deeper water assemblages.

It is readily distinguished from other species of *Elphidium*; *E.earlandi* of this study is distinguished by having fewer chambers in the final whorl, a more lobate periphery, more depressed sutures with fewer, stronger septal bars and a less inflated

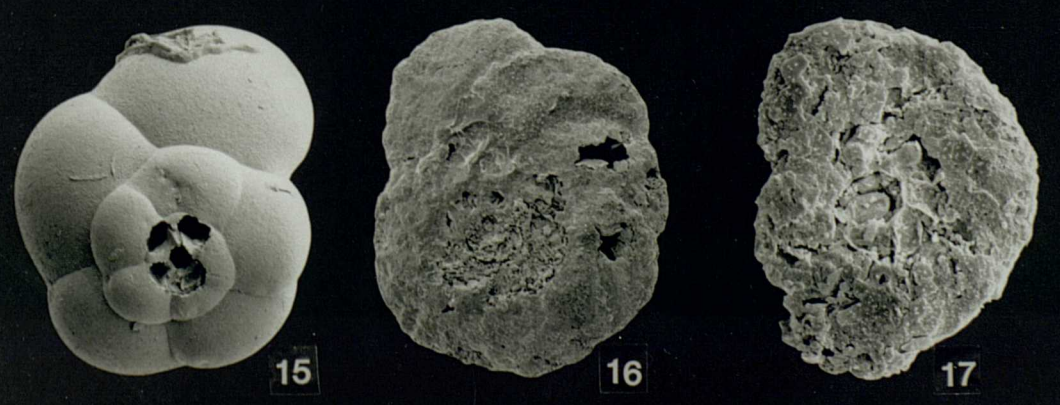
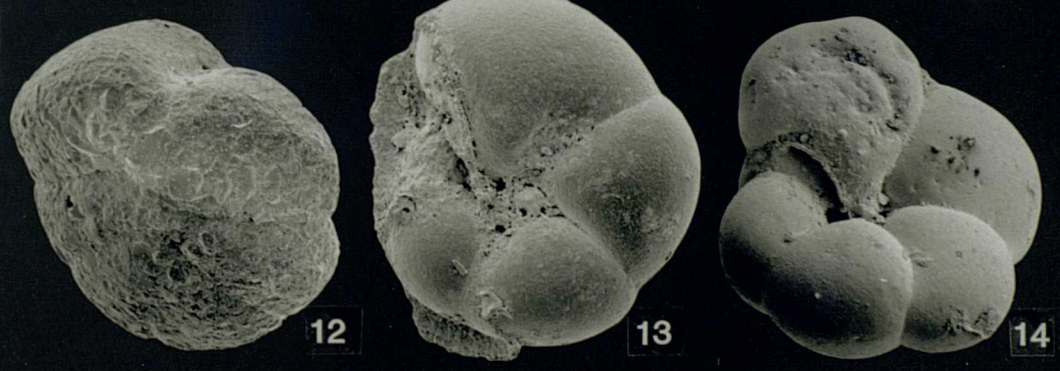
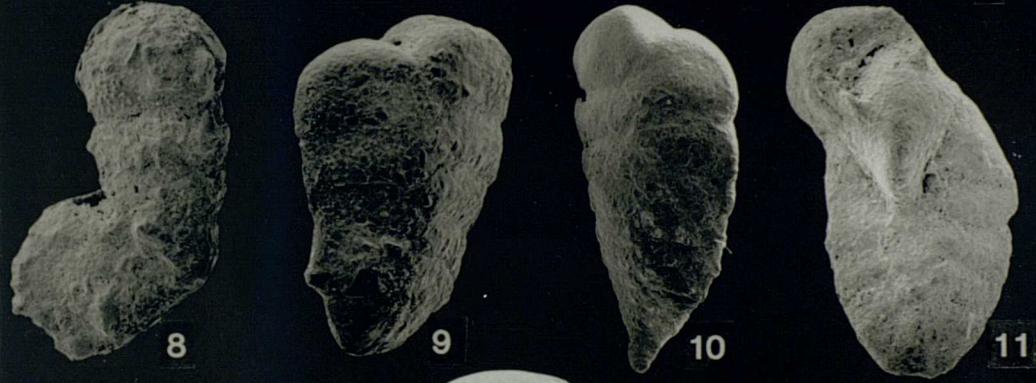
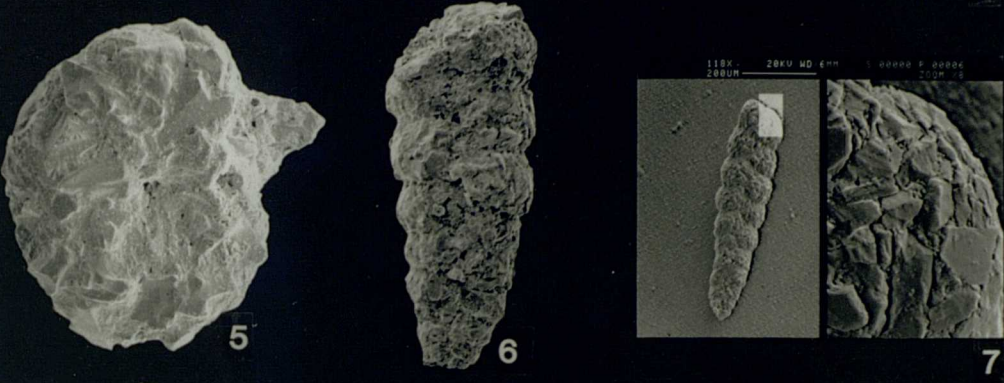
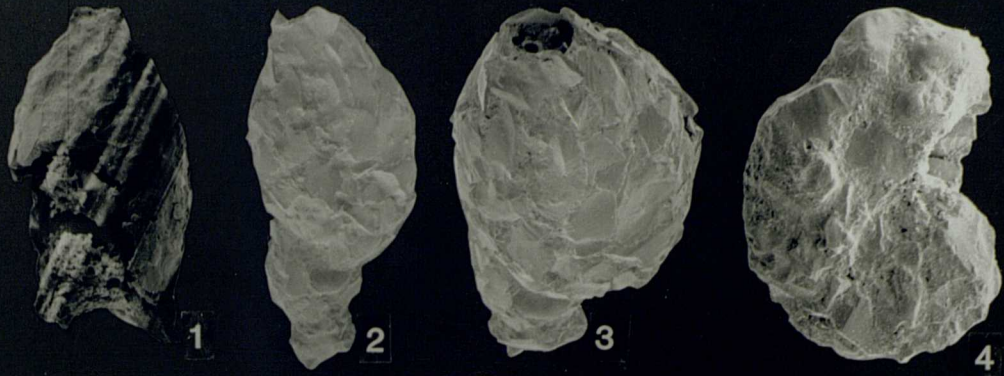


Plate 1

figs.1,2,3. *Reophax* cf. *fusiformis* (Williamson). 1, final chamber of damaged specimen from VE 57/-09/89 2.40-2.45 m. X85; 2, side view of specimen from western Irish Sea X53; 3, oblique apertural view of specimen from western Irish Sea X72.5.

figs.4,5. *Ammoscalaria runiana* (Heron-Allen and Earland). 4,5 side views X60 and X72.5 respectively (different specimens from VE 57/-09/89 0.1-0.2 m.).

figs.6,7. *Spiroplectammina earlandi* (Parker). 6, side view of damaged specimen from VE 57/-09/89 2.45-2.50 m. X130; 7, side view and wall detail (X8) of specimen from central Celtic Sea X50.

fig.8. *Ammobaculites* aff. *balkwilli* Haynes, side view X67.5.

figs.9,10,11,12. *Spiroplectammina wrightii* (Silvestri). 9, oblique side view X85; 10, oblique side view of microspheric form from VE 57/-09/89 2.10-2.15 m. X48; 11, side and apertural view of deformed specimen X85; 12, side view of juvenile megalospheric form X165 (all from VE 57/-09/60 0.16-0.18 m. 'outer').

figs.13,14,15. *Trochammina inflata* (Montagu). 13, ventral view of damaged specimen from VE 57/-09/89 0.75-0.80 m. X137.5; 14, ventral view X85; 15, dorsal view X80 (14,15 from marsh surface, Taf estuary, South Wales).

figs.16,17. *Trochammina* aff. *ochracea* (Williamson). 16, ventral view of specimen from VE 57/-09/89 2.25-2.35 m. X160; 17, dorsal view of specimen from VE 57/-09/89 2.40-2.45 m. X350.

Plate 2

figs.1,2. *Gaudryina rudis* Wright. 1, oblique side view of specimen from VE 57/-09/89 4.6-4.7 m. X34; 2, apertural view of specimen from VE 57/-09/60 0.16-0.18 m. 'outer' X72.5.

figs.3,4,5,6. *Eggerelloides scabrum* (Williamson). 3, side view of specimen from VE 56/-09/142 0.67-0.69 m. X150; 4, side view of specimen from Vigo Bay, N.W.Spain X79; 5 & 6, side views of specimens from VE 51/-07/17, central Celtic Sea X52 and X75 respectively.

figs.7,8,9. *Bigenerina nodosaria* d'Orbigny, side views of specimens from VE 57/-09/89 0.1-0.2 m. X30, X34, and X38 respectively.

figs.10,11. *Textularia bocki* Höglund. 10, oblique side view of microspheric ? generation from VE 57/-09/89 0.8-0.9 m. X50; 11, side view of megalospheric generation from VE 57/-09/46 0.00-0.05 m. X65.

figs.12,13. *Siphotextularia flintii* (Cushman). 12, side view of megalospheric generation X115; 13, side view of microspheric generation X67.5 (both specimens from VE 57/-09/89 0.0-0.1 m.).

fig.14. *Cornuspira foliacea* (Phillippi), side view of specimen from VE 56/-09/142 1.22-1.25 m. X72.5.

figs.15,16,17. *Cornuspira involvens* (Reuss). 15, side view of microspheric ? generation from VE 57/-10/21 1.30-1.33 m. X67.5; 16, side view of megalospheric generation from VE 56/-09/142 0/67-0/69 m. X290; 17, side view of megalospheric generation from VE 57/-09/46 1.00-1.05 m. X147.5.

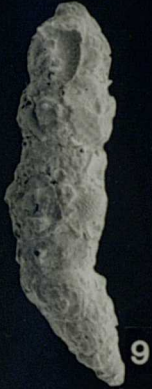


Plate 3

fig.1. *Cornuspira* cf. *foliacea* (Phillippi), side view of specimen from VE 57/-09/89 0.2-0.3 m. X32.

fig.2. *Cornuspira diffusa* (Heron-Allen and Earland), side view of 'branch' fragment from VE 57/-09/46 0.05-0.10 m. X44.

fig.3. *Spirophthalmidium acutimargo* var. *emaciatum* Haynes, side view of specimen from VE 56/-09/142 0.67-0.69 m. X215.

figs.4,5,6. *Spirophthalmidium* sp.A, side views of different specimens from VE 56/-09/142 0.67-0.69 m. X240, X220,& X230 respectively.

fig.7. *Spiroloculina canaliculata* d'Orbigny, side view of specimen from VE 57/-09/89 0.8-0.9 m. X52.5 .

fig.8. *Spiroloculina depressa* d'Orbigny, side view of damaged specimen from the Taf estuary, S. Wales. X112.5 .

figs.9,10. *Spiroloculina* cf. *rotunda* d'Orbigny. 9, side view of specimen from VE 57/-09/32 0.0-0.1 m. X71; 10, apertural view of specimen from VE 57/-10/17 0.00-0.05 m. X62.5 .

figs.11,12,13. *Massilina* cf. *secans* (d'Orbigny). 11 & 12, side views X57 and X57.5 respectively; 13, apertural/peripheral view X69 (all specimens from VE 57/-09/32 0.0-0.1 m.).

figs.14,15. *Quinqueloculina agglutinata* Cushman. 14, side view of specimens from VE 56/-09/142 1.22-1.25 m. X45; 15, side view of specimens from VE 57/-10/17 3.55-3.65. X50.

figs.16,17. *Quinqueloculina bicornis* (Walker & Jacob), side views of specimens from VE 57/-10/17 0.50-0.55 m. X80 and X46 respectively.

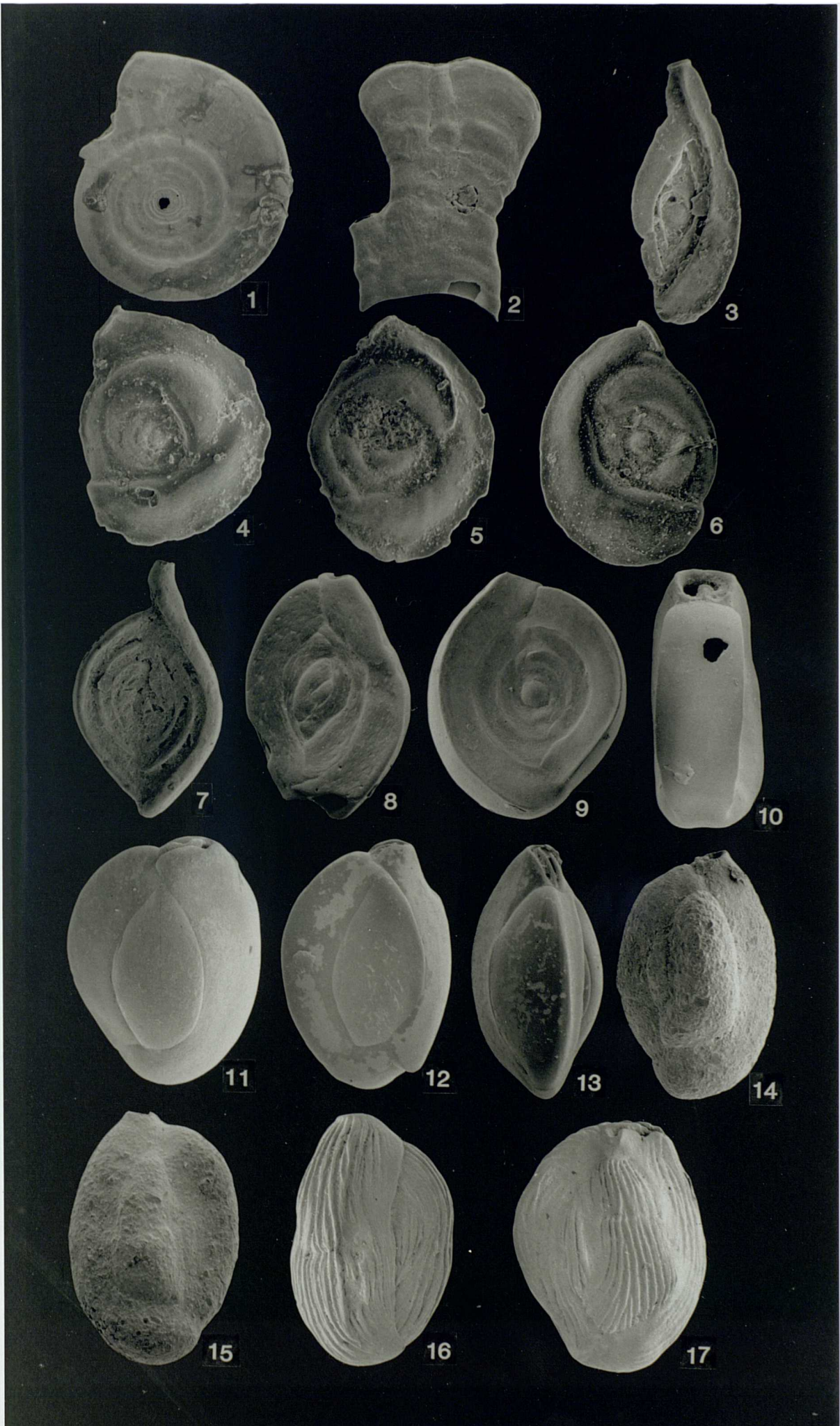


Plate 4

figs.1,2,3,4. *Quinqueloculina* cf. *cliarensis* Heron-Allen and Earland. 1, side view of specimen from VE 56/-09/142 0.67-0.69 m. X95; 2,3,4, various side views of different specimens from VE 51/-07/228 0.5-0.6 m. X55, X100, and X72.5 respectively.

figs. 5,6. *Quinqueloculina intricata* Terquem. 5 & 6, side view and apertural detail of specimens from VE 51/-07/199 3.45 m. X31.

figs.7,8. *Quinqueloculina seminulum* (Linné), side views of specimens from VE 57/-09/89 2.1-2.2 m. X51 and X42.5 respectively.

figs.9,10,11. *Quinqueloculina stalker* Loeblich & Tappan. 9 & 10, side views of specimens from VE 57/-10/21 3.52-3.55 m. X165 and X165 respectively; 11, side view of specimens from Aberdaron, sample no. A10 X165.

figs.12,13. *Quinqueloculina* cf. *pygmaea* Reuss, side views of specimens from VE 56/-09/142 1.89-1.91 m. X130 and 0.67-0.69 m. X130 respectively.

fig.14. *Quinqueloculina* sp.A, oblique side view of specimens from VE 57/-09/89 3.0-3.05 m. X210.

figs. 15,16. *Miliolinella subrotunda* (Montagu), side views of specimens from VE 57/-10/17 3.55-3.65 m. X42 and X37 respectively.

figs.17,18. *Miliolinella subrotunda* (Montagu) forma *hauerinoides* Rhumbler, side views of specimens from VE 57/-10/17 3.55-3.65 m. X80 and X117.5 respectively.





Plate 5

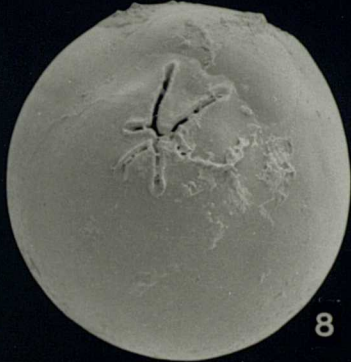
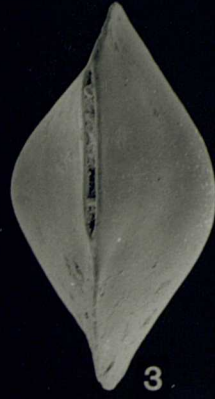
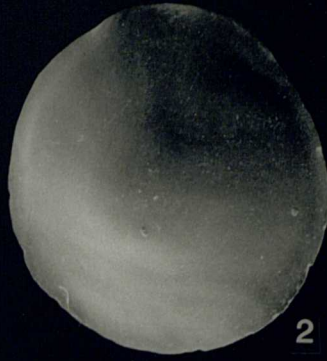
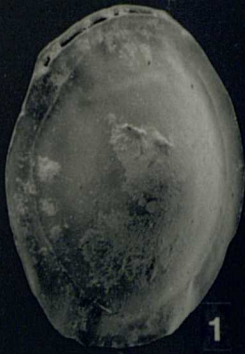
figs.1,2,3. *Pyrgo depressa* (d'Orbigny). 1, oblique front view X48; 2, back view X53; apertural view X75 (different specimens from VE 57/-09/89 0.1-0.2 m.).

figs.4,5,6,7. *Pyrgo williamsoni* (Silvestri). 4, front view X67.5; 5, apertural view (same specimen); 6, posterior view X58; 7, side view X52 (different specimens, all from VE 57/-09/89 0.1-0.2 m.).

figs.8,9,10. *Pyrgoella sphaera* (d'Orbigny). 8, apertural view of specimen from VE 57/-09/89 0.1-0.2 m. X65; 9 & 10, apertural view and apertural detail of specimen from VE 57/-09/32 0.0-0.1 m. X67.

fig.11. *Triloculina trigonula* (Lamarck), front view of specimen from VE 57/-09/89 0.1-0.2 m. X62.5.

figs.12,13,14,15. *Triloculina trihedra* Loeblich & Tappan. 12 & 15, front view and apertural detail of specimen from VE 57/-09/89 2.1-2.2 m. X60; 13, front view of specimen from VE 57/-10/17 1.70-1.75 m. X107.5; 14, side view of specimen from VE 57/-09/60 0.24-0.26 m. 'inner' X160.



487X 15KV WD 21MM S 00000 P 00049

312X 15KV WD 21MM S 00000 P 00040

496X 15KV WD 22MM S 00000 P 00019

Plate 6

figs.1,2,3. *Triloculinella* sp.A. 1 & 2, side view and apertural detail of specimen from VE 57/-10/17 0.75-0.80 m. X80; 3, side view of specimen from VE 57/-09/46 0.75-0.82 m. X87.5.

figs.4,5. *Triloculinella* sp.B. 4, oblique apertural view X190; 5, oblique side view X35 (both specimens from VE 57/-09/46 0.30-0.33 m.).

fig.6. *Sejunctella earlandi* Loeblich & Tappan, side view of specimen from VE 56/-09/142 1.08-1.10 m. X150.

fig.7. *Spirillina vivipara* Ehrenberg, side view of specimen from VE 57/-09/46 0.38-0.43 m. X141.

figs.8,9. *Patellina corrugata* Williamson. 8, dorsal view of specimen from Aberdaron, sample no.A7 X350; 9, ventral view of specimen from VE 57/-09/89 1.8-1.9 m. X240.

fig.10. *Dentalina frobisherensis* Loeblich & Tappan, side view of specimen from VE 57/-09/60 0.24-0.26 m. 'inner' X41.

fig.11. *Dentalina inornata bradyensis* (Dervieux), side view of specimen from VE 56/-09/142 1.22-1.25 m. X21.5.

fig.12. *Dentalina ittai* Loeblich and Tappan, side view of specimen from VE 56/-09/142 1.08-1.10 m. X135

figs.13,14. *Dentalina pauperata* d'Orbigny, side and apertural views of specimen from VE 56/-09/142 5.10-5.12 m. X33.

fig.15. *Dentalina subarcuata* (Montagu), side view of specimen from VE 57/-09/89 0.60-0.65 m. X57.5.

fig.16. *Dentalina* cf. *trondheimensis* Feyling-Hanssen, side view of specimen from VE 56/-09/142 1.89-1.91 m. X122.5.

figs.17,18,19. *Dentalina* sp.A. 17, side view of specimen from VE 57/-10/17 0.50-0.55 m. X25; 18 & 19, side and apertural detail of specimens from VE 57/-09/32 0.0-0.1 m. X74.

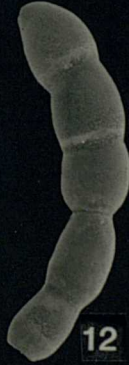
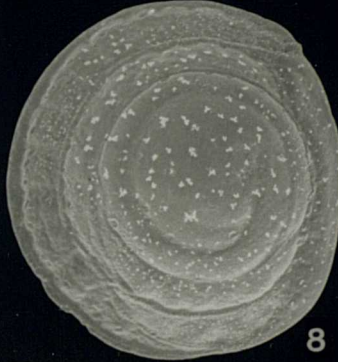
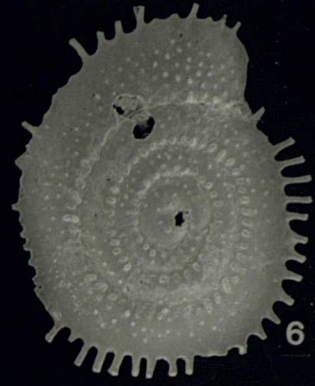
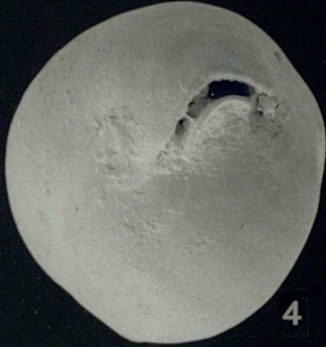
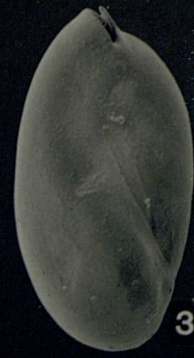


Plate 7

figs.1,2,3,4. *Amphicoryna scalaris* (Batsch). 1,2, & 3, side views of megalospheric specimens from VE 56/-09/142 1.63-1.67 m. X97.5, X97.5, and X135 respectively; 4, side view of possible (?) microspheric specimen from VE 57/-09/60 0.22-0.24 m. 'inner' X90.

fig.5. *Lagena clavata* (d'Orbigny), side view of specimen from VE 57/-09/46 0.47-0.51 m. X77.5.

fig.6. *Lagena distoma* Parker and Jones, side view of damaged specimen from VE 56/-09/142 1.22-1.25 m. X70.

fig.7. *Lagena* cf. *elongata* (Ehrenberg), side view of specimen from VE 56/-09/142 0.67-0.69 m. X190.

fig.8. *Lagena flatulenta* Loeblich and Tappan, side view of specimen from VE 56/-09/142 0.67-0.69 m. X190.

fig.9. *Lagena* cf. *gracilis* Williamson, side view of damaged specimen from VE 57/-10/17 X150.

figs.10,11. *Lagena gracillima* (Seguenza), side views of specimens from VE 56/-09/142 4.23-4.25 m. X112.5 and X77.5 respectively.

fig.12. *Lagena hispida* Reuss, side view of specimen from VE 57/-09/46 0.05-0.10 m. X70.

fig.13. *Lagena hispidula* Cushman, side view of specimen from VE 56/-09/142 0.67-0.69 m. X100.

figs.14,15,16. *Lagena laevis* (Montagu), side views of variously damaged specimens from VE 57/-09/46 0.72-0.75 m. X110, X95, and X87.5 respectively.

figs.17,18,19. *Lagena mollis* (Cushman), side views of damaged and complete (19) specimens from VE 57/-09/89 2.25-2.35 m. X91, X120, and X72.5 respectively.

fig.20. *Lagena parri* Loeblich and Tappan, side view of specimen from VE 57/-09/46 3.36-3.66 m. X109.

figs.21,22. *Lagena perlucida* (Montagu), side views of specimens from VE 57/-09/60 0.22-0.24 m. 'inner' X150 and X160 respectively.

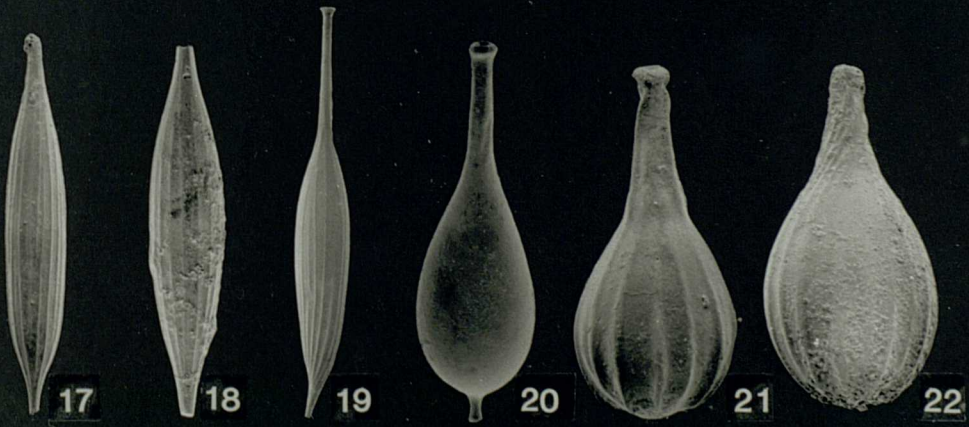
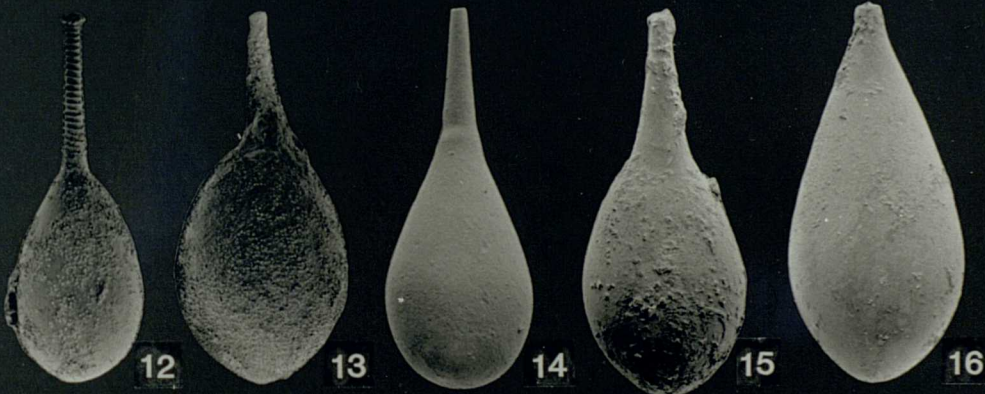
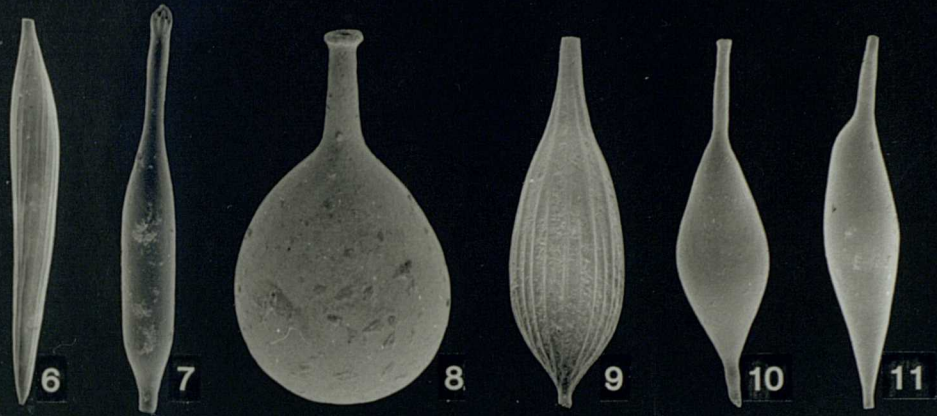
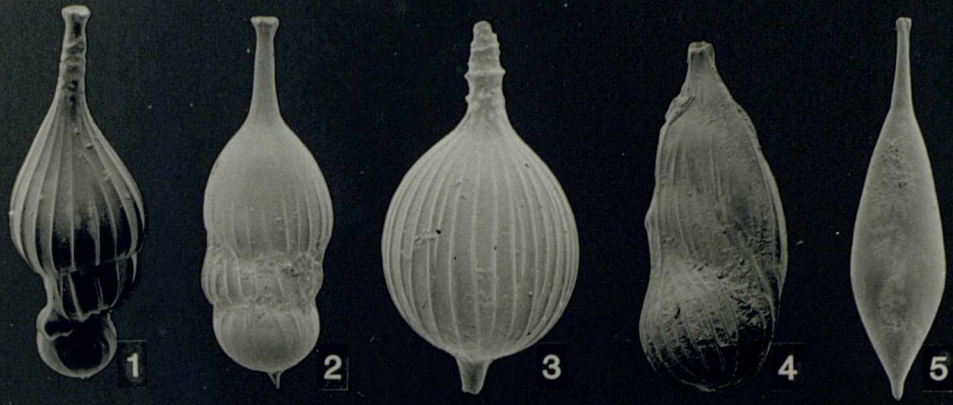


Plate 8

figs.1,2. *Lagena semilineata* Wright, side views of specimens from VE 56/-09/142 1.89-1.91 m. X87.5 and X130 respectively.

fig.3. *Lagena semistriata* (Williamson), side view of specimen from VE 57/-09/46 0.47-0.51 m. X82.5.

figs.4,5,6. *Lagena setigera* Millett, side views of specimens from: VE 57/-10/17 2.1-2.2 m. X80; VE 57/-10/21 3.52-3.55 m. X60; and VE 57/-09/46 1.79-1.82 m. X67.5 respectively.

figs. 7,8. *Lagena striata* (d'Orbigny), side views of specimens from VE 56/-09/142 1.89-1.91 m. X92.5 and X82.5 respectively (note different neck ornament).

figs.9,10. *Lagena* cf. *striata* (d'Orbigny), side views of specimens from VE 57/-09/46 1.79-1.82 m. X115 and X140 respectively.

fig.11. *Lagena sulcata* (Walker & Jacob) var. *torquiformis* Haynes, side view of specimen from Laugharne, Taf estuary, S. Wales X95.

fig.12. *Lagena* sp.A, side view of specimen from VE 57/-10/17 X185.

fig.13. *Lagena* sp.B, side view of specimen from VE 56/-09/142 0.67-0.69 m. X270.

fig.14. *Lagena* sp.C, oblique apertural view of specimen from VE 57/-09/89 0.65-0.7 m. X150.

fig.15. *Globulina gibba* d'Orbigny, oblique apertural view of specimen from VE 57/-09/60 0.16-0.18 m. 'outer' X122.5.

figs.16,17,18. *Globulina myristiformis* (Williamson). 16, side view of sub-rounded specimen X97.5; 17, apertural view of spherical specimen X112.5 (both specimens from VE 57/-09/60 0.16-0.18 m. 'outer'); 18, side view of elongate specimen from VE 57/-09/60 0.22-0.24 m. 'inner' X100.

fig.19. *Guttulina* (?*Laryngosigma*) *harrisi* Haynes, side view of specimen from VE 57/-09/60 0.16-0.18 m. 'outer' X65.

fig.20. Indeterminate Polymorphinid sp., side view of specimen exhibiting fistulose growth, from VE 57/-09/89 0.4-0.5 m. X34.

fig.21,22. *Oolina acuticosta* (Reuss). 21, side and apertural views of specimens from VE 57/-09/60 0.35-0.39 m. X129 and X170 respectively.



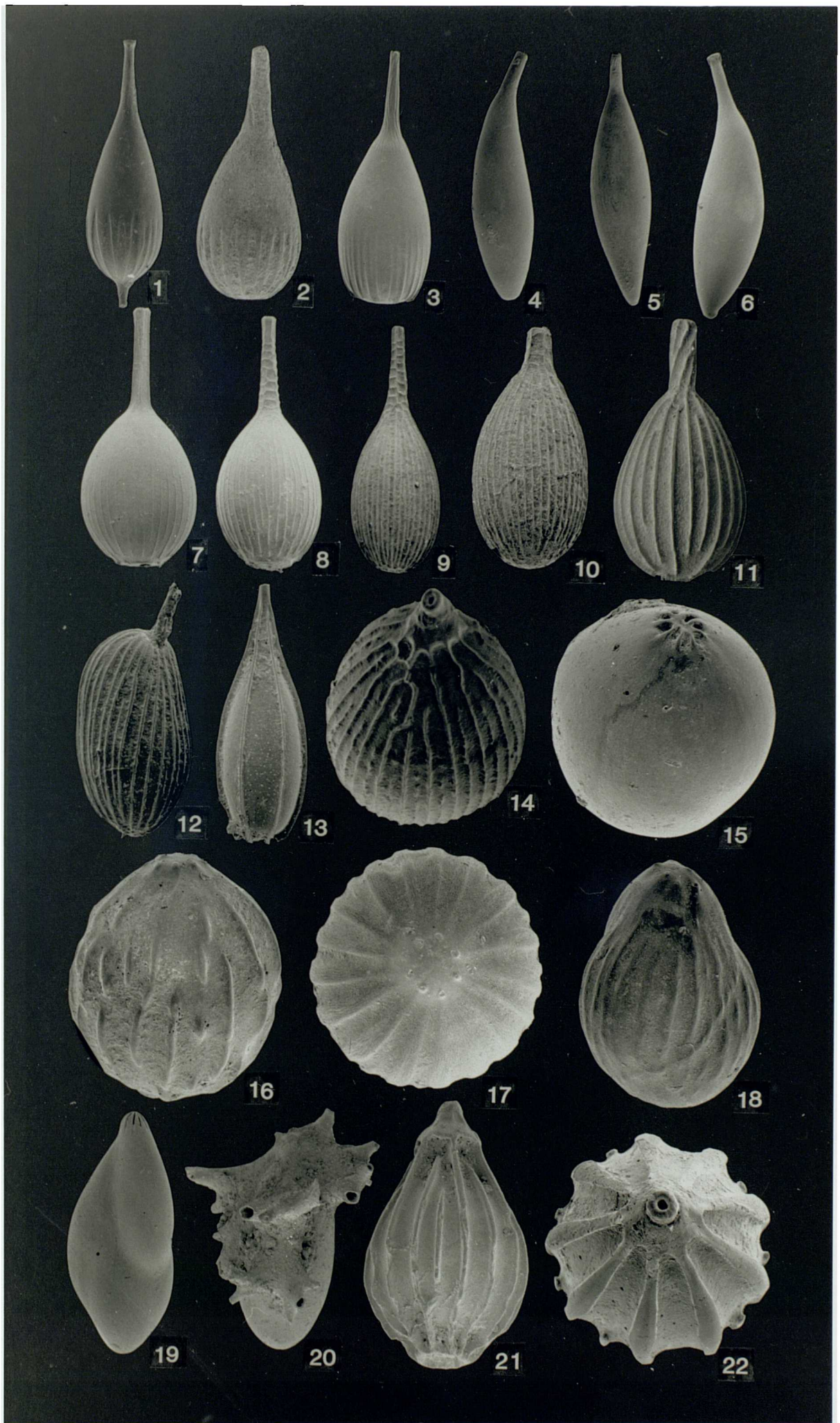


Plate 9

fig.1 *Oolina borealis* Loeblich and Tappan, oblique side view of specimen from VE 57/-09/60 0.24-0.26 m. 'outer' X135.

figs.2,3. *Oolina caudigera* (Wiesner). 2, side view X132.5; 3, oblique apertural view X137.5 (different specimens from VE 57/-09/60 3.30-3.33 m.).

fig.4. *Oolina* cf. *globosa* (Montagu), side view of specimen from VE 57/-10/17 X130.

figs.5,6. *Oolina heronalleni* Haynes, side view of specimens from VE 57/-10/17 1.3-1.35 m. X215 and X200 respectively.

figs.7,8. *Oolina hexagona* (Williamson). 7, side view of specimen from VE 57/-10/17 0.20-0.25 m. X270; 8, oblique side view of specimen from VE 57/-09/60 3.03-3.06 m. X235.

figs.9,10. *Oolina laevigata* d'Orbigny. 9, side view X155; 10, side view of fused pair X137.5 (from VE 57/-09/46 0.47-0.51 m.).

fig.11. *Oolina lineata* (Williamson), side view of specimen from VE 57/-10/17 X150.

figs.12,13. *Oolina melo* d'Orbigny. 12, side view of specimen from VE 57/-10/17 X137.5; 13, side view of specimen from VE 57/-09/46 2.82-2.87 m. X125.

fig.14. *Oolina* cf. *scalariforme-sulcata* (Wiesner), side view of specimen from VE 57/-09/89 1.6-1.7 m. X122.5.

fig.15. *Oolina squamosa* (Montagu), side view of specimen from VE 57/-09/60 2.15-2.18 m. X135.

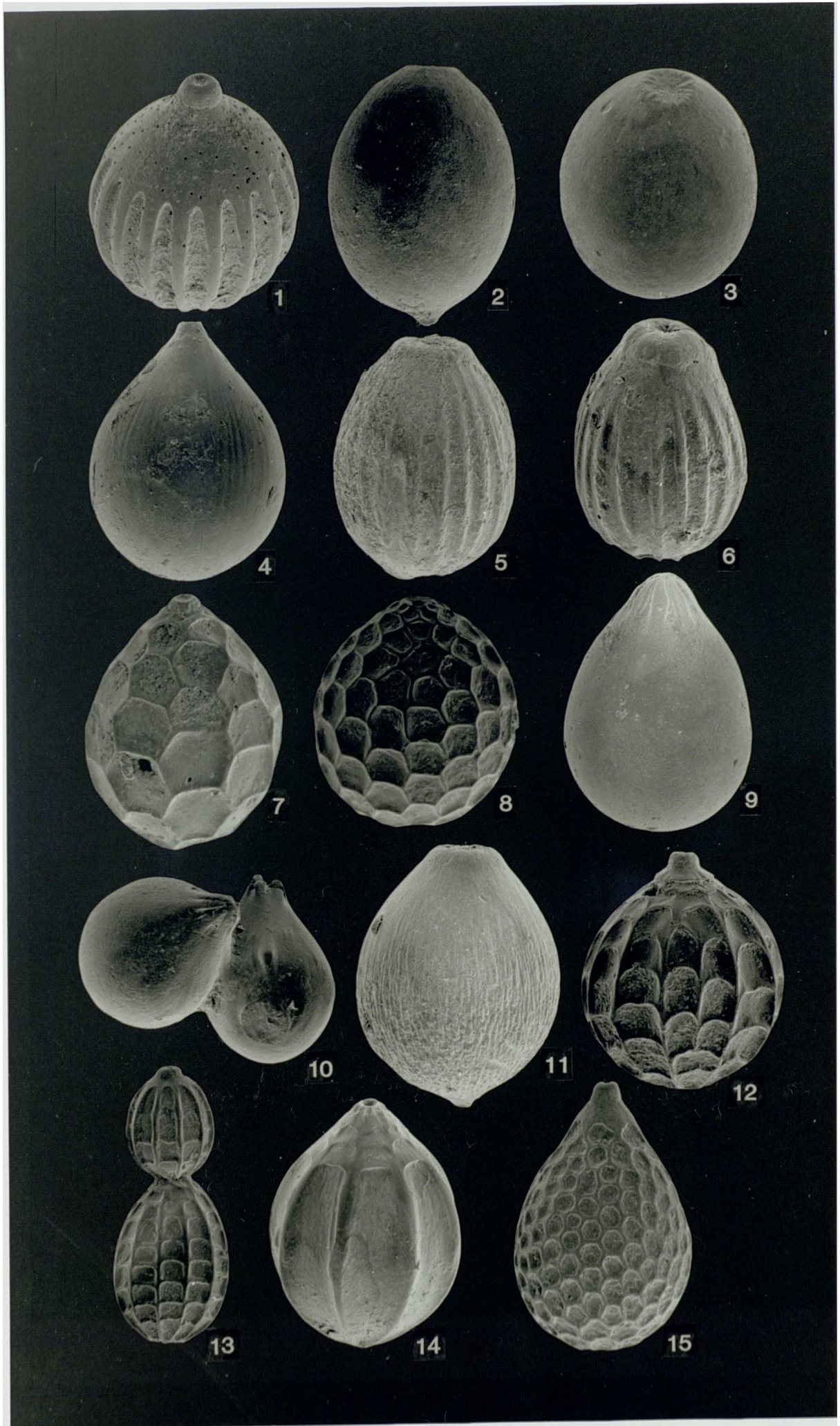


Plate 10

figs.1,2. *Oolina squamosa* (Montagu). 1, side view of specimen from VE 57/-10/21 3.52-3.55 m. X135; 2, side view of specimen from VE 57/-09/46 0.47-0.51 m. X165.

figs.3,4. *Oolina williamsoni* (Alcock). 3, side view of specimen from VE 57/-09/89 1.6-1.7 m. X131; 4, side view of specimen from Laugharne, Taf estuary, S. Wales X129.

fig.5. *Oolina* sp.A, oblique side view of specimen from VE 57/-09/60 0.22-0.24 m. 'inner' X150.

figs.6,7. *Fissurina danica* (Madsen). 6, oblique side view of specimen from VE 57/-09/46 0.72-0.75 m. X249; 7, oblique side view of damaged specimen from Aberdaron, sample no. A12 X350.

figs.8,9,10. *Fissurina elliptica* (Cushman). 8, side view of specimen from VE 51/-07/199 X236; 9 & 10, side view of specimens from VE 57/-09/46 0.00-0.05 m. X180 and X180 respectively.

fig.11. *Fissurina lagenoides* (Williamson), side view of specimen from VE 57/-10/17 1.05-1.10 m. X215.

figs.12,13. *Fissurina lucida* (Williamson). 12, peripheral view of specimen from VE 57/-10/17 X180; 13, side view of specimen from VE 57/-09/46 0.33-0.38 m. X142.5.

fig.14. *Fissurina marginata* (Walker & Boys), oblique side view of specimen from VE 57/-10/17 X185.

fig.15. *Fissurina* cf. *quadrata* (Williamson), side view of specimen from VE 56/-09/142 1.63-1.67 m. X175.

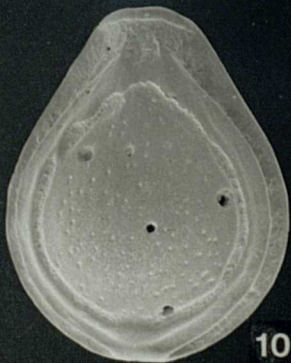
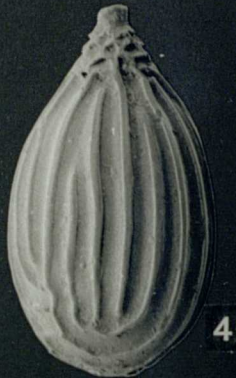
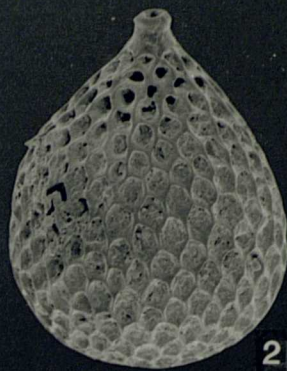
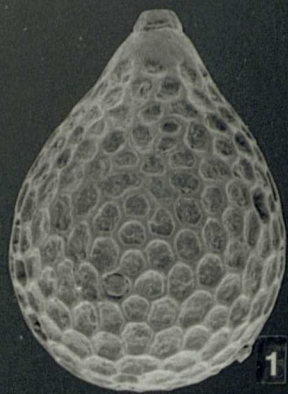


Plate 11

figs.1,2. *Fissurina serrata* (Schlumberger). 1, side view of specimen from VE 57/-10/17 X180; 2, side view of specimen from VE 57/-09/46 1.68-1.71 m. X145 (both damaged). -

fig.3. *Fissurina* sp.A, side view of specimen from VE 57/-10/17 X210.

fig.4. *Fissurina* sp.B, side view of specimen from VE 56/-09/142 1.89-1.91 m. X175.

fig.5. *Fissurina* sp.C, side view of specimen from VE 57/-10/17 X240.

fig.6. *Parafissurina fusuliformis* Loeblich and Tappan, side view of specimen from VE 57/-09/44 3.40-3.56 m. X205.

fig.7. *Parafissurina* aff. *fusuliformis* Loeblich and Tappan, side view of specimen from VE 57/-10/17 0.20-0.25 m. X210.

fig.8. *Parafissurina tectulostoma* Loeblich and Tappan, oblique side view of specimen from VE 57/-09/60 0.26-0.28 m. X165.

figs.9,10,11,12. *Lamarckina haliotidea* (Heron-Allen and Earland) 9,10 & 11, ventral views of specimens from VE 57/-09/44 2.4-2.6 m. X250; VE 57/-09/46 5.66-5.69 m. X165; Aberdaron, sample no.A10 X215 respectively. 12, dorsal view of specimen from VE 57/-09/46 5.66-5.69 m. X170.

fig.13. *Hoeglundina elegans* (d'Orbigny), ventral view of specimen from VE 56/-09/142 1.08-1.10 m. X75.

fig.14. *Robertinoides pumilum* Höglund, apertural view of specimen from VE 56/-09/142 1.08-1.10 m. X235.

fig.15. *Robertinoides suecicum* Höglund, apertural view of specimen from VE 57/-10/17 0.00-0.05 m. X92.5.

figs.16,17. *Bolivina alata* Seguenza, side views of broken specimens from VE 57/-10/17 3.55-3.65 m. X67.5 and X77.5 respectively.

fig.18. *Bolivina difformis* (Williamson), side view of specimen from VE 57/-10/17 2.1-2.2 m. X135.



Plate 12

fig.1. *Bolivina difformis* (Williamson), side view of specimen from VE 57/-10/17 2.1-2.2 m. X225.

figs.2,3. *Bolivina pseudoplicata* Heron-Allen and Earland, side views of specimens from VE 57/-10/17 3.55-3.65 m. X160 and Aberdaron, sample no.A1 X280 respectively.

figs.4,5,6. *Bolivina pseudopunctata* Höglund. 4 & 5, side views of specimens from VE 57/-10/17 2.1-2.2 m. X150 and X130 respectively. 6, side view of specimen from Aberdaron, sample no.A10 X200.

figs.7,8,9. *Bolivina skagerrakensis* Qvale and Nigam. 7, side view of megalospheric specimen X92.5; 9, side view of microspheric specimen X130 (both from VE 57/-10/17 3.55-3.65 m.); 8, side view of smaller megalospheric specimen from Aberdaron, sample no.A12 X245.

figs.10,11. *Bolivina spathulata* (Williamson), side views of specimens from VE 57/-10/17 0.20-0.25 m. X95 and VE 57/-09/46 0.43-0.47 m. X100 respectively.

figs.12,13,14. *Bolivina subaenariensis* Cushman, side views of specimens from VE 57/-10/17 1.05-1.10 m. X50; VE 57/-09/60 0.35-0.39 m. X59; VE 57/-09/89 3.20-3.25 m. X200 respectively.

figs.15,16. *Bolivina variabilis* (Williamson), side views of broken specimens from VE 57/-09/89 0.60-0.65 m. X100 and VE 57/-09/89 3.1-3.2 m. X130 respectively.

fig.17. *Cassidulina laevigata* d'Orbigny, side view of specimen from VE 57/-10/17 3.55-3.65 m. X160.

figs.18,19,20. *Cassidulina obtusa* Williamson. 18 & 19, side and apertural views of the same specimen X220; 20, side view X200 (both specimens from VE 57/-10/17 0.20-0.25 m.).



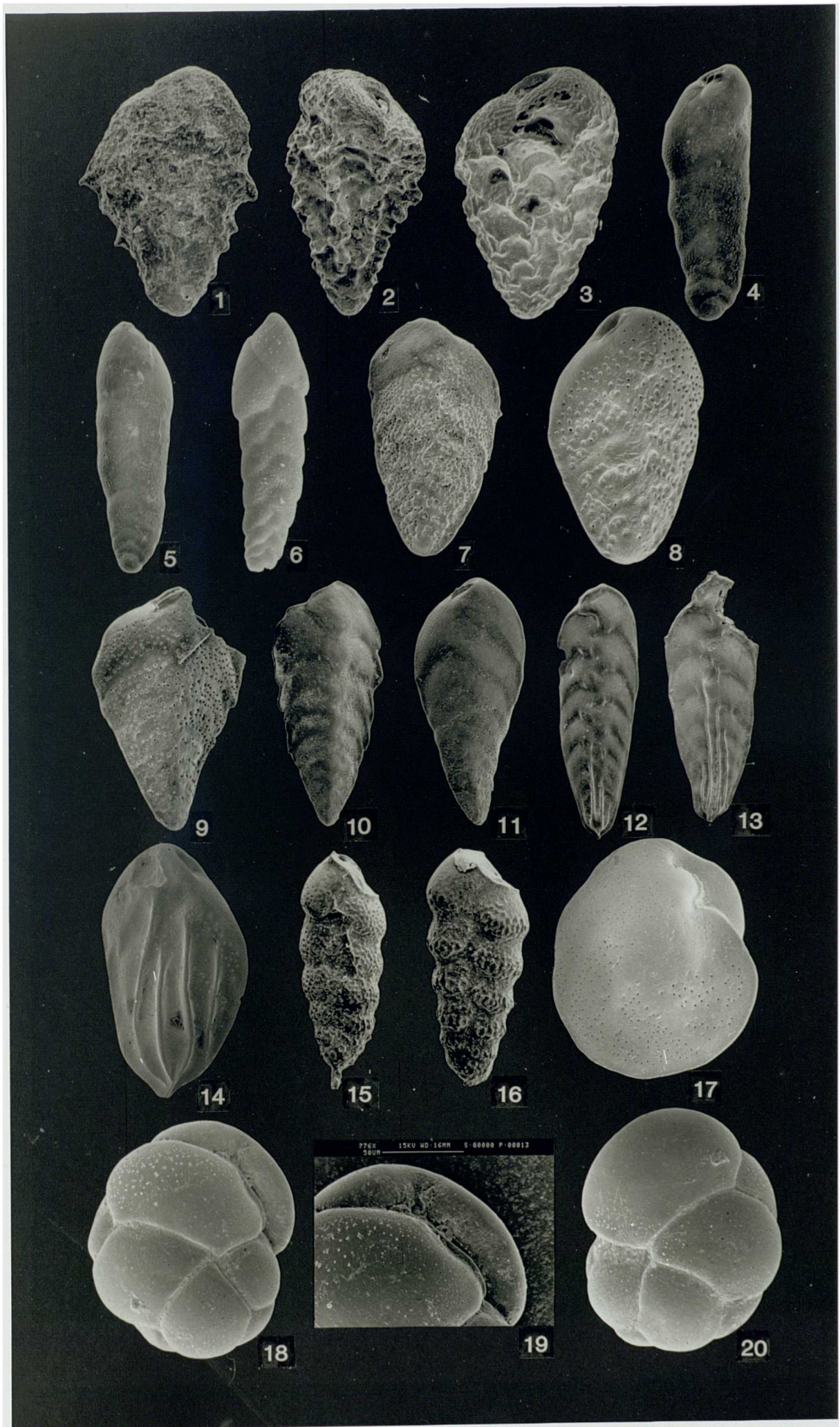


Plate 13

figs.1,2,3,4. *Cassidulina reniforme* Nørvang. 1 & 2, side views of specimens from VE 57/-10/17 3.55-3.65 m. X160 and X160 respectively; 3, apertural detail of specimen from VE 57/-09/89 4.8-4.9 m. X260; 4, side view of specimen from southern Celtic Sea X190.

figs.5,6,7. *Cassidulinoides bradyi* (Norman), side views of specimens from VE 57/-09/46 0.43-0.47 m. X165; VE 57/-10/17 0.00-0.05 m. X165; VE 56/-09/142 1.89-1.91 m. X125 respectively.

figs.8,9,10. *Globocassidulina subglobosa* (Brady). 8, oblique apertural view X290; 9, peripheral view X287.5; 10, apertural detail X600 (different specimens from VE 57/-09/46 0.00-0.05 m.).

figs.11,12. *Islandiella helenae* Feyling-Hanssen and Buzas. 11, side view X90; 12, apertural detail X260 (different specimens from VE 48/-09/148).

figs.13,14,15,16. *Islandiella islandica* Nørvang. 13 & 14, side view and apertural detail X120; 15, oblique peripheral view X116; 16, side view X119 (different specimens from VE 48/-09/148).

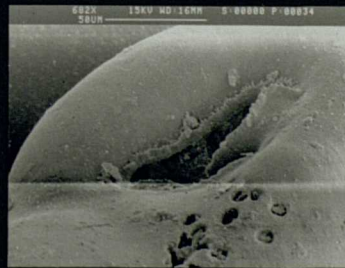
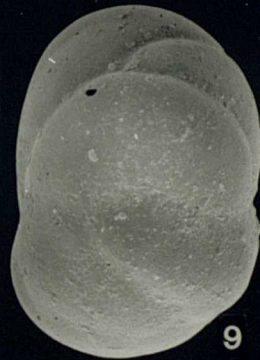
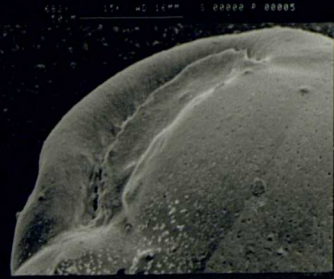
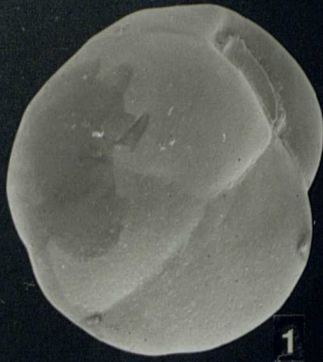


Plate 14

figs.1,2. *Islandiella norcrossi* (Cushman), side view and apertural detail of specimen from VE 57/-09/89 2.9-3.0 m. X140.

figs.3,4,5,6. *Stainforthia* (*Fursenkoina*) *fusiformis* (Williamson). 3 & 4, side views of adult specimens X180 and X155 respectively; 5 & 6, side views of juvenile specimens X162.5 and X290 respectively (all different specimens from VE 57/-09/89 2.35-2.40 m.).

figs.7,8,9. *Stainforthia loeblichii* (Feyling-Hanssen). 7 & 8, side views of specimens from VE 56/-09/142 4.23-4.25 m. X81 and X65 respectively; 9, apertural detail of specimen from VE 57/-09/46 3.63-3.66 m. X250.

fig.10. *Stainforthia* cf. *loeblichii* (Feyling-Hanssen), side view of specimen from VE 57/-09/89 2.35-2.40 m. X110.

figs.11,12. *Stainforthia* cf. *schreibersiana* (Czjzek), side views of specimens from VE 57/-09/89 2.9-3.0 m. X200 and X200 respectively.

figs.13,14. *Bulimina* cf. *alazanensis* Cushman. 13, side view of specimen from VE 57/-09/46 0.43-0.47 m. X102.5; 14, side view of specimen from VE 57/-10/17 0.20-0.25 m. X135.

figs.15,16,17. *Bulimina elongata* d'Orbigny. 15 & 16, side views of specimens from VE 57/-10/17 3.55-3.65 m. X87.5 and X117.5 respectively; 17, side view of specimen from Laugharne, Taf estuary, S. Wales X125.

fig.18. *Bulimina gibba* Fornasini, side view of specimen from VE 57/-10/17 3.55-3.65 m. X125.

figs.19,20. *Bulimina marginata* d'Orbigny, side views of specimens from VE 57/-10/17 3.55-3.65 m. X127.5 and X106 respectively.



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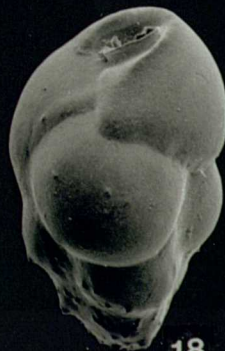
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Plate 15

figs.1,2. *Bulimina marginata* d'Orbigny. 1, side view of specimen from VE 57/-10/17 3.55-3.65 m. X115; 2, side view and apertural detail of specimen from southern Celtic Sea X70 (inset X4).

figs.3,4. *Globobulimina auriculata* (Bailey) aff. forma *arctica* Höglund. 3, side view of specimen from VE 57/-09/46 0.05-0.10 m. X87.5; 4, side view of specimen from VE 56/-09/142 0.17-0.19 m. X85.

fig.5. *Globobulimina auriculata* (Bailey) cf. forma *gullmarensis* Höglund, side view of specimen from VE 57/-10/21 1.88-1.91 m. X75.

figs.6,7. *Buliminella elegantissima* (d'Orbigny). 6, side view of specimen from Aberdaron, sample no.A10 X280; 7, side view of specimen from VE 57/-09/60 3.30-3.33 m. X245.

figs.8,9,10. *Uvigerina peregrina* Cushman. 8 & 10, side view and apertural detail of specimen from VE 56/-09/142 0.17-0.19 m. X62.5; 9, oblique side view of specimen from VE 56/-09/142 1.63-1.67 m. X165.

figs.11,12,13 *Trifarina angulosa* (Williamson), side views of specimens from VE 56/-09/142 1.63-1.67 m. X82.5; VE 57/-10/17 1.70-1.75 m. X85; VE 57/-09/60 0.35-0.39 m. X170 respectively.

fig.14. *Trifarina bradyi* Cushman, side view of specimen from VE 57/-09/46 4.79-4.82 m. X175.

figs.15,16,17,18. *Trifarina fluens* (Todd), side views of specimens from VE 57/-09/46 4.68-4.73 m. X190; VE 56/-09/142 5.10-5.12 m. X165; Aberdaron, sample no.A12 X131; VE 57/-09/46 4.17-4.20 m. X130 respectively.

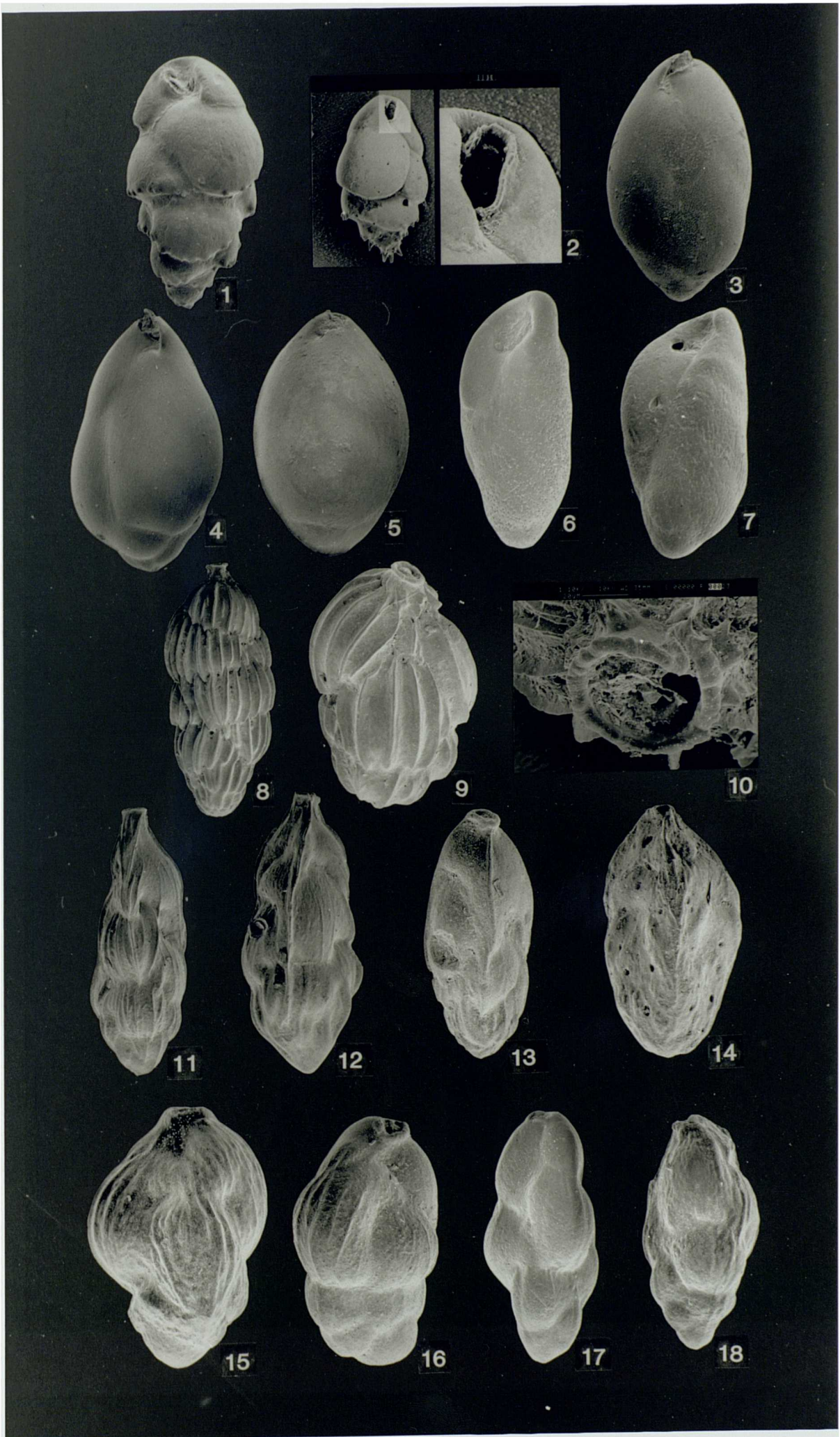


Plate 16

figs.1,2,3. *Cancris oblongus* (Williamson). 1, ventral view of specimen from VE 57/-09/89 0.2-0.3 m. X47; 2, peripheral view of specimen from VE 57/-09/89 0.8-0.9 m. X48; 3, ventral view of specimen from VE 57/-09/60 0.22-0.24 m. 'outer' X110.

figs.4,5. ?*Discorbis* (*Rotaliella*) *chasteri* (Heron-Allen and Earland), oblique ventral and ventral view of the same specimen from VE 57/-09/89 2.40-2.45 m. X370 and X340 respectively.

figs.6,7. ?*Discorbis* (*Discorbinella*) *bertheloti* (d'Orbigny). 6, ventral view X107.5; 7, dorsal view X115 (different specimens from VE 57/-09/89 0.65-0.70 m.).

figs.8,9,10. *Rosalina anomala* Terquem. 8, dorsal view of specimen from VE 57/-09/89 2.25-2.35 m. X130; 9 & 10, ventral views of specimens from VE 57/-10/17 2.1-2.2 m. X122.5 and VE 56/-09/142 1.22-1.25 m. X117.5 respectively.

figs.11,12,13. *Rosalina* cf. *bradyi* (Cushman). 11 & 12, ventral views of specimens from Laugharne, Taf estuary, S. Wales X115 and VE 48/-10/51 X72.5 respectively; 13, dorsal view of specimen from VE 57/-10/17 2.1-2.2 m. X105.

fig.14. *Rosalina praegeri* (Heron-Allen and Earland), ventral view of specimen from Laugharne, Taf estuary, S. Wales X200.

fig.15. *Rosalina* cf. *williamsoni* (Chapman and Parr), ventral view of specimen from VE 57/-10/17 2.1-2.2 m. X150.

fig.16. *Rosalina* sp.A, ventral view of specimen from VE 57/-09/44 2.4-2.6 m. X360.





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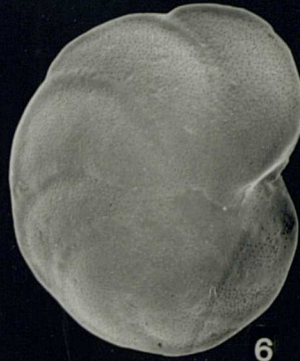
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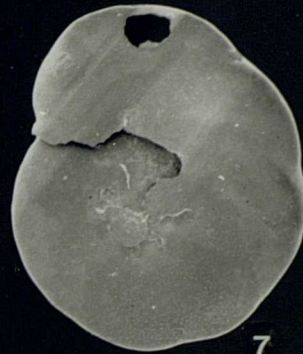
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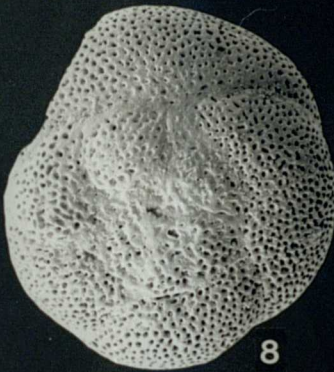
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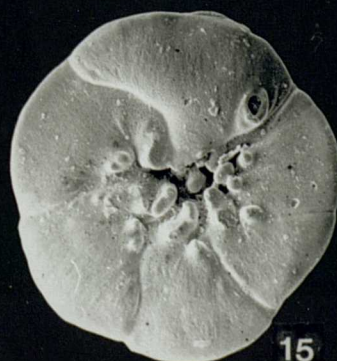
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Plate 17

figs.1,2. *Epistominella* cf. *naraensis* (Kuwano), ventral views of specimens from VE 57/-10/17 1.70-1.75 m. X390 and VE 56/-09/142 2.83-2.85 m. X440 respectively.

figs.3,4,5. *Epistominella vitrea* Parker, ventral views of specimens from VE 57/-09/46 5.04-5.07 m. X235; VE 57/-10/17 1.70-1.75 m. X195; BH 81/34 135.9 m., southern North Sea X195.

figs.6,7,8. *Hyalinea balthica* (Schroeter). 6 & 7, side views of specimens from VE 57/-09/89 0.2-0.3 m. X95 and VE 57/-09/89 0.8-0.9 m. X95 respectively; 8, side view detail of umbilical flaps of specimen from VE 57/-09/89 0.8-0.9 m. X140.

figs.9,10. *Planulina ariminensis* d'Orbigny. 9, ventral view of specimen from VE 57/-10/21 3.52-3.55 m. X71; 10, dorsal view of specimen from VE 48/-09/148 X80.

figs.11,12,13,14. *Cibicides lobatulus* (Walker and Jacob). 11 & 12, dorsal views of specimens from VE 57/-09/46 0.38-0.43 m. X82.5 and X75 respectively; 13 & 14, ventral views of specimens from VE 57/-09/46 0.38-0.43 m. X100 and VE 56/-09/142 1.22-1.25 m. X48.

fig.15. *Cibicides pseudoungerianus* (Cushman), ventral view of specimen from VE 57/-10/17 3.55-3.65m. X92.5.

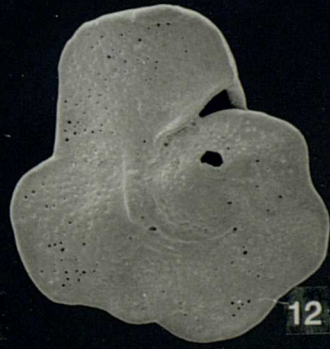


Plate 18

figs.1,2. *Cibicides pseudoungerianus* (Cushman), oblique dorsal and ventral views of specimens from VE 57/-10/17 3.55-3.65 m. X87.5 and X72.5 respectively.

figs.3,4,5. *Cibicides refulgens* Montfort. 3 & 4, ventral and oblique dorsal views of specimens from VE 57/-10/17 0.00-0.05 m. X70 and X66 respectively; 5, peripheral view of specimen from VE 57/-09/89 2.35-2.45 m. X65.

figs.6,7. *Planorbulina distoma* Terquem. 6, ventral view of specimen from VE 57/-09/46 0.30-0.33 m. X95; 7, dorsal view of specimen from VE 56/-09/142 1.63-1.67 m. X90.

figs.8,9. *Acervulina inhaerens* Schultze, ventral and oblique ventral views of the same specimen from VE 56/-09/142 1.22-1.25 m. X70 and X87.5 respectively.

fig.10. *Asterigerinata mamilla* (Williamson), ventral view of specimen from VE 57/-09/46 1.68-1.71 m. X245.

figs.11,12. *Nonion barleeanum* (Williamson), side and peripheral views of specimen from VE 57/-10/17 1.70-1.75 m. X75 and X79 respectively.

figs.13,14,15,16. *Nonion labradoricum* (Dawson). 13, oblique side view of specimen from VE 57/-10/17 1.70-1.75 m. X60; 14,15 & 16, peripheral and side views of specimens from VE 57/-10/17 3.55-3.65 m. X117.5, X102.5, and X180 respectively (14 & 15 = same specimen).



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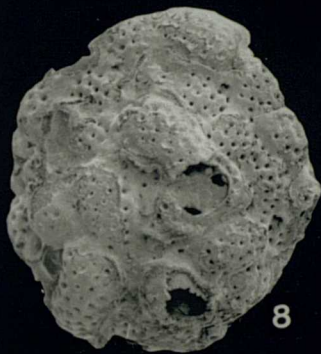
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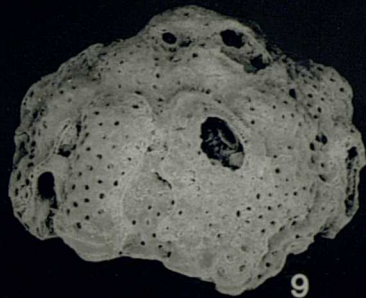
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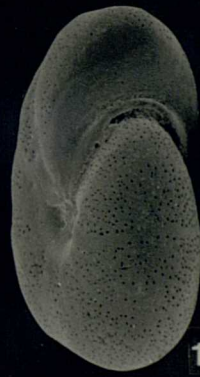
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Plate 19

figs.1,2. *Nonion orbiculare* (Brady), side and oblique peripheral views of different specimens from VE 57/-10/17 1.70-1.75 m. X82.5 and X84 respectively.

figs.3,4. *Nonion pauperatum* (Balkwill and Wright). 3, side view of specimen from Aberdaron, sample no.A1 X330; 4, oblique side view of specimen from VE 56/09/142 3.10-3.12 m. X285.

figs.5,6. *Nonionella auricula* Heron-Allen and Earland, dorsal views of specimens from VE 57/-09/89 3.02-3.04 m. X300 and VE 56/-09/142 1.08-1.10 m. X320.

figs.7,8. *Nonionella turgida* (Williamson). 7, ventral view of specimen from VE 57/-09/89 2.25-2.35 m. X155; 8, dorsal view of specimen from VE 56/-09/142 1.22-1.25 m. X135.

figs.9,10,11. *Nonionella* aff. *turgida* (Williamson). 9, side view of specimen from VE 57/-09/46 0.43-0.47 m. X125; 10, apertural-peripheral view of specimen from VE 57/-09/46 0.38-0.43 m. X136; 11, side view of specimen from VE 57/-09/46 0.75-0.82 m. X155.

fig.12. *Nonionella turgida* (Williamson) var. *digitata* Nørvang, ventral view of specimen from VE 57/-09/46 0.33-0.38 m. X235.

figs.13,14,15. *Astrononion (Laminonion) gallowayi* Loeblich and Tappan. 13, side view of specimen from VE 57/-10/17 3.55-3.65 m. X100; 14 & 15, oblique peripheral view and side view of specimens from VE 57/-09/60 0.26 -0.28 m. 'outer' X115 and X155 respectively.

fig.16 *Astrononion (Laminonion) tumidum* Cushman and Edwards, oblique side view of damaged specimen from VE 57/-10/17 1.30-1.35 m. X167.5.



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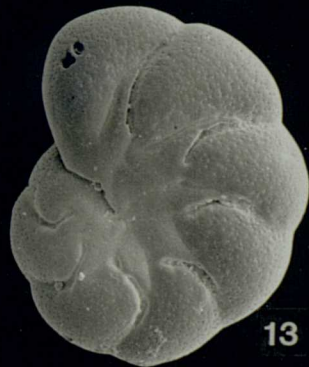
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Plate 20

fig.1. *Pullenia bulloides* (d'Orbigny), side view of specimen from VE 57/-09/46 3.69-3.72 m. X190.

figs.2,3. *Pullenia subcarinata* (d'Orbigny), side view X141 and oblique peripheral view of the same specimen from VE 57/-10/17 3.55-3.65 m.

fig.4. *Pullenia* sp.A, side view of specimen from VE 57/-09/60 0.35-0.39 m. X240.

figs.5,6. *Chilostomella oolina* Schwager, oblique apertural view X87.5 and side view X75 of the same specimen from VE 57/-09/32 0.0-0.1 m.

figs.7,8,9. *Anomalina* (*Anomalinoides*) cf. *globulosa* Chapman and Parr. 7 & 9, oblique peripheral view X340 and ventral view X300 of the same specimen from VE 57/-09/60 0.32-0.35 m.; 8, dorsal view of specimen from VE 56/-09/142 1.89-1.91 m. X250.

figs.10,11,12. *Paromalina* (*Discanomalina*) *crassa* (Cushman). 10, side view of specimen from VE 48/-09/137 X67.5; 11 & 12, peripheral view X51.5 and oblique peripheral view X49 of the same specimen from VE 57/-10/17 0.75-0.80 m.

fig.13. *Gyroidina neosoldanii* Brotzen, ventral view of specimen from VE 57/-10/84 X107.5.

fig.14. *Buccella frigida* (Cushman), ventral view of specimen from Aberdaron, sample no.A8 X320.

figs.15,16. *Buccella tenerrima* (Bandy). 15, ventral view of adult specimen from VE 57/-09/32 3.12-3.20 m. X75; 16, dorsal view of specimen from VE 56/-09/142 4.23-4.25 m. X200.



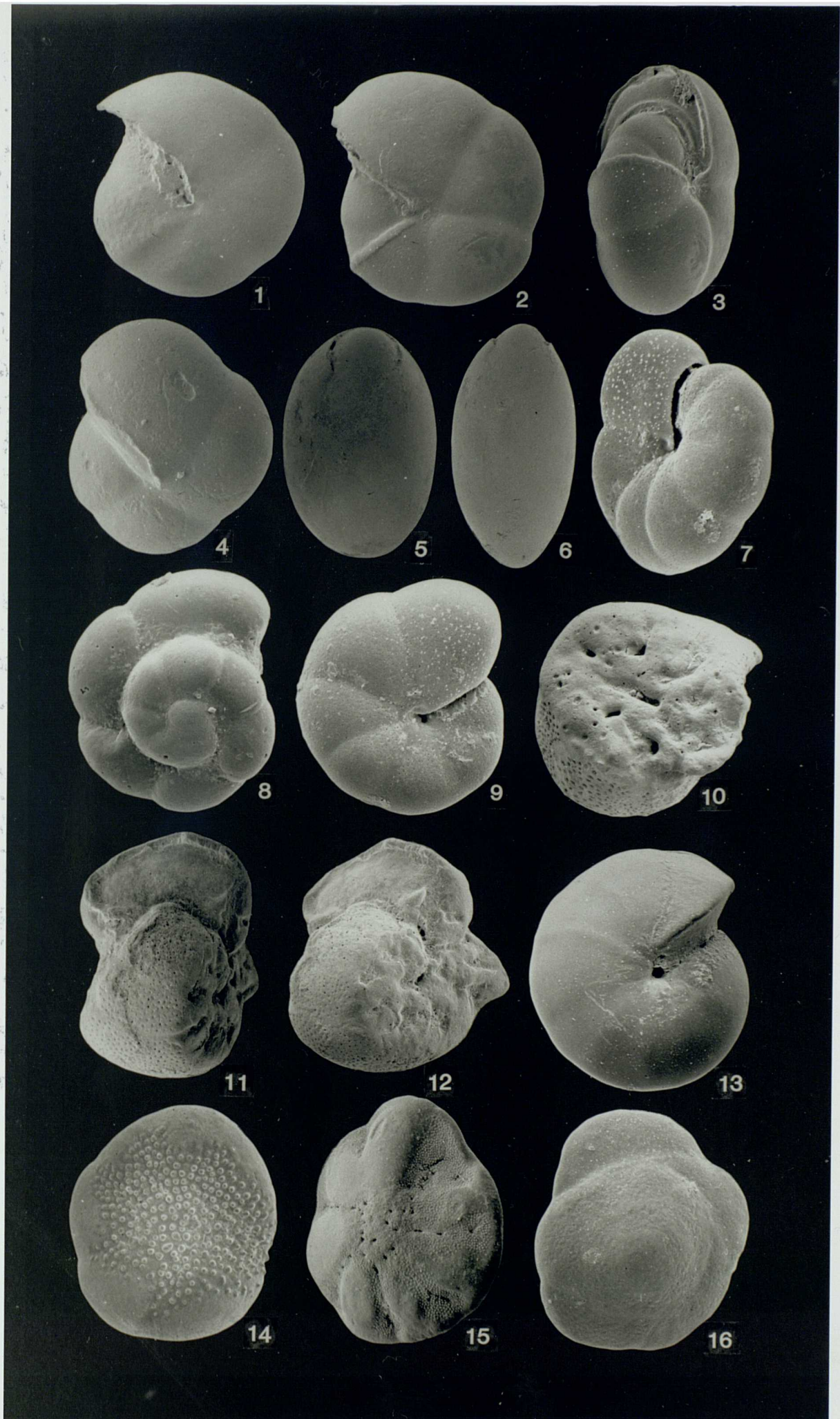


Plate 21

fig.1. *Buccella tenerrima* (Bandy), ventral view of juvenile specimen from VE 56/-09/142 4.23-4.25 m. X190.

figs.2,3,4. *Ammonia batavus* (Hofker). 2 & 3, ventral views X90 and X82.5 respectively; 4, dorsal view X82.5 (different specimens from VE 57/-09/89 2.15-2.25 m.).

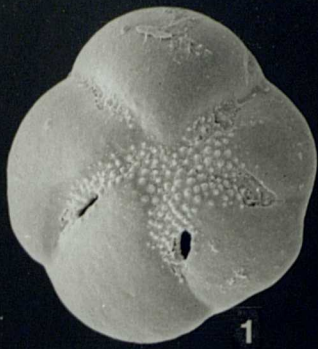
figs.5,6. *Elphidiella arctica* (Parker and Jones), side view X45 and oblique peripheral view X70 of different specimens from VE 57/-09/60 1.07-1.10 m.

figs.7,8. *Elphidium albiumbilicatum* (Weiss). 7, side view of specimen from VE 57/-09/46 1.33-1.37 m. X175; 8, side view of specimen from the Upper Saxicava Sand, Nørre Lyngby, Denmark X120.

figs.9,10,11. *Elphidium asklundi* Brotzen. 9, oblique side view X62.5; 10 & 11, oblique side view and apertural detail of the same specimen X54 (from VE 57/-09/89 4.1-4.2 m.).

fig.12. *Elphidium bartletti* Cushman, side view of specimen from VE 56/-09/142 1.89-1.91 m. X100.

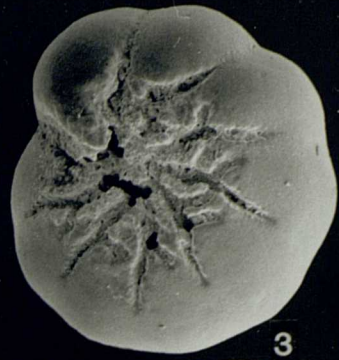
figs.13,14,15. *Elphidium crispum* (Linné), side views of variously abraded specimens from VE 57/-09/89 4.1-4.2 m. X60, X56, and X52 respectively.



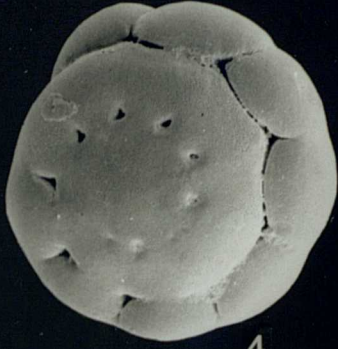
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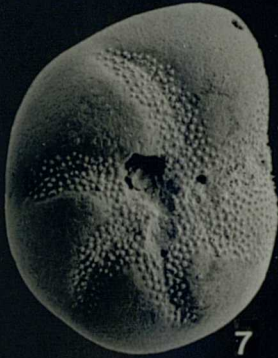
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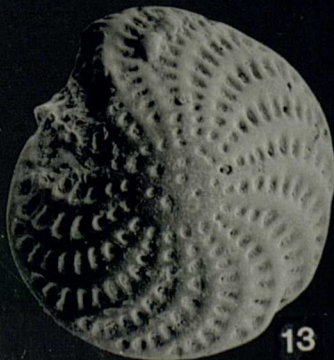
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Plate 22

figs.1,2. *Elphidium earlandi* Cushman, side views of specimens from VE 57/-09/46 0.05-0.10 m. X132.5 and VE 56/-09/142 0.17-0/19 m. X265 respectively.

figs.3,4,5,6,7,8,9,10,11. *Elphidium excavatum* (Terquem) forma *clavata* Cushman. 3-9 & 11, side views of different specimens from VE 57/-09/89, 3=X112.5, 4=X95, 5=X95, 6=X112.5, 7=X85, 8=X82.5, 9=X95, 11=X80; 10, side view of small specimen from Aberdaron, sample no.A1 X275.

figs.12,13,14. *Elphidium excavatum* (Terquem) forma *selseyensis* (Heron-Allen and Earland), side views of specimens from VE 57/-09/89 X115, X95, and X120 respectively.

fig.15. *Elphidium gerthi* Voorthuysen, side view of specimen from Laugharne, Taf estuary, S. Wales X107.5.

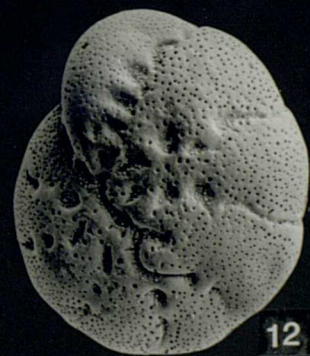
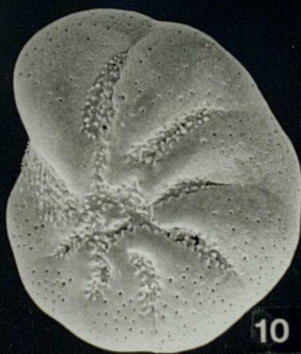
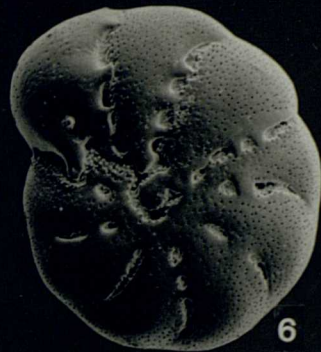
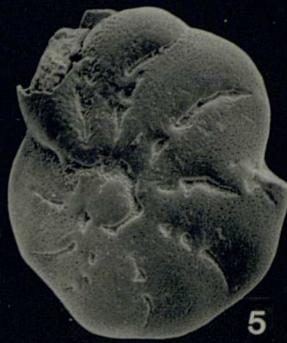


Plate 23

fig.1. *Elphidium groenlandicum* Cushman, oblique side view of specimen from VE 57/-09/89 4.1-4.2 m. X70.

figs.2,3. *Elphidium hallandense* Brotzen, side views of specimens from VE 57/-10/17 2.3-2.4 m. X75 and VE 57/-09/89 0.8-0.9 m. X70 respectively.

fig.4. *Elphidium* cf. *macellum* (Fichtel and Moll), side view of specimen from VE 57/-10/17 0.90-0.95 m. X97.5.

fig.5. *Elphidium margaritaceum* (Cushman), side view of specimen from Laugharne, Taf estuary, S. Wales X94.

fig.6. *Elphidium* cf. *ustulatum* Todd, side view of specimen from VE 57/-09/89 2.35-2.40 m. X320.

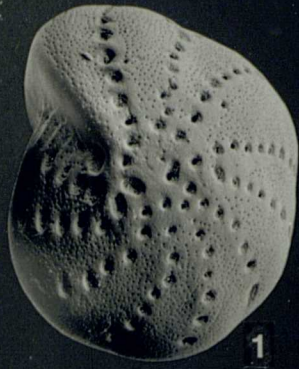
figs.7,8,9. *Elphidium williamsoni* Haynes, side views of specimens from VE 57/-09/46 1.68-1.71 m. X120, Laugharne salt marsh surface, Taf estuary, S. Wales X85, and BH CH1, Cork Harbour, Ireland, sample no.M1 X120.

fig.10. Indet. gen. et sp.1, side view of specimen from VE 57/-10/21 1.88-1.91 m. X65.

figs.11,12. Indet. gen. et sp.2, dorsal view X65 and ventral view X82.5 of different specimens from VE 48/-10/53.

figs.13,14. Indet. gen. et sp.3, oblique peripheral view X330 and ventral (?) view X350 of different specimens from VE 57/-09/46 5.66-5.69 m.

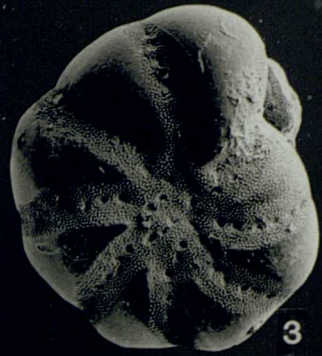
fig.15. Indet. gen. et sp.4, ventral view of damaged specimen from VE 57/-09/46 5.04-5.07 m. X102.5.



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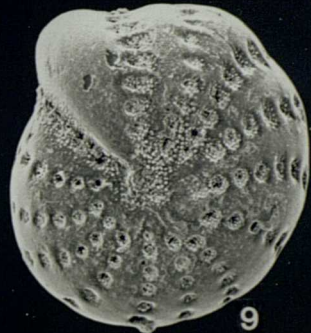
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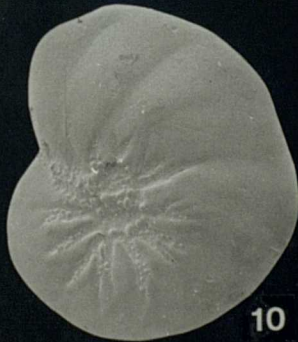
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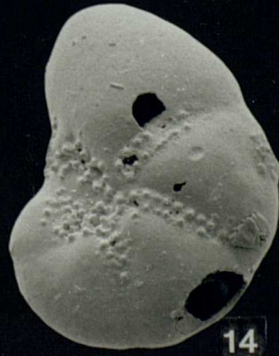
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Plate 24

figs.1,2,3,4,5,6. *Neogloboquadrina pachyderma* (Ehrenberg). 1,2,3 & 4, ventral views of sinistral coiling forms from VE 57/-10/17 3.55-3.65 m. X170, VE 57/-09/89 3.1-3.2 m. X215, VE 57/-10/17 3.55-3.65 m. X150, and VE 57/-09/89 3.1-3.2 m. X280 respectively; 5, ventral view of dextral coiling form from VE 57/-09/89 3.1-3.2 m. X212.5; 6, dorsal view of sinistral coiling form from VE 57/-09/89 3.1-3.2 m. X195.

figs.7,8. ? *Hedbergella* sp., side views of different specimens from Aberdaron, sample no.A2 X430 and X460 respectively.

figs.9,10. *Eouvigerina* sp., side views of different specimens from Aberdaron, sample no.A10 X250 and Aberdaron, sample no.A3 X240 respectively.



