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**RECENT DEEP WATER BENTHONIC FORAMINIFERA
OF THE NORTH WEST ATLANTIC OCEAN**

by

● CHRISTIANE H. HUOT LAROUCHE, B.Sc. (Hons.)

A thesis submitted to the Faculty of
Graduate Studies in partial fulfilment
of the requirements for the degree of
Master of Science

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ABSTRACT

Twenty-one core top samples from the western North Atlantic Ocean yielded a benthonic foraminiferal fauna of 208 species. This study describes the fauna and relates the distribution of abundant species to the deep water masses in the western North Atlantic Ocean.

Fifteen samples were collected in the Mid Atlantic Ridge area near latitude 45° N., two samples were recovered from the continental slope off the Grand Banks and four samples from the continental slope off Nova Scotia.

Four assemblages, defined in terms of the abundant species (i.e. abundance greater than or equal to 5% of the population), are correlated with temperature and salinity values of the deep water masses. Assemblage I is established with a high degree of confidence; it is recognized at eleven stations and has been described in previous studies. Assemblage II is proposed with less confidence. Though its distribution has been documented in the literature, it is recognized at only one station. Assemblages III and IV are presented as suggestions: each is defined on the basis of a unique sample and there is no published information available to substantiate the existence of these assemblages.

Assemblage I is characterized by *Epistominella exigua* (Brady), *Eponides tumidulus* (Brady) and *Loxostomum truncatum* Phleger and Parker. These species comprise approximately 50% of the population in eleven samples from the Mid Atlantic Ridge area. This assemblage is associated with North Atlantic Deep Water (NADW).

Alabamina ? umbonifera (Cushman), which has been correlated by authors with the presence of Antarctic Bottom Water (AABW), characterizes Assemblage II.

Assemblage II is present at only one station in the Mid Atlantic Ridge area. It is suspected that small size specimens, including species characteristic of NADW, have been selectively removed from this sample by bottom currents. This view is further supported by the temperature-salinity values which are of NADW. AABW is known to be present in the deepest part of the North American basin only. Thus the presence of *Alabamina ? umbonifera* in the Mid Atlantic Ridge area suggests a localised phenomenon.

Two species, *Cassidella complanata* (Egger) and *Elphidium excavatum* (Terquem), both of which are believed to be indicative of Labrador Sea Water, form Assemblage III. The assemblage is recognized at a single Nova Scotian Slope station with temperature-salinity values of Labrador Sea Water.

Assemblage IV is recognized at a single station on the Grand Banks Slope. It is defined by the abundance of *Cassidulina obtusa* (Williamson). The temperature-salinity values are those of Labrador Sea Water.

Five samples contain elements from a mixture of assemblages. The fauna from these samples is believed to be transitional, indicating areas of mixed water masses.

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CHAPTER 1. INTRODUCTION

1.1 Purpose.

Benthonic foraminifera occur in most marine environments and are considered excellent environmental indicators. Fossil benthonic foraminifera are useful in reconstructing depositional environments and paleobathymetry. In early ecological studies, depth was often the only environmental variable measured. Consequently there has been a general tendency to describe the bathymetric distribution of benthonic foraminifera while the influence of other environmental factors has been neglected. Depth *per se* is not an environmental variable; it is only a reference point in the vertical plane of three dimensional space. Light and hydrostatic pressure vary directly with depth. The distribution of benthonic foraminifera is controlled by physical, chemical and ecological factors. It is closely related to water mass and sediment properties.

The present study identifies the dominant benthonic foraminiferal species from bottom sediment samples recovered between the West Atlantic continental margin and the Mid Atlantic Ridge, from latitude 41°N. to 46°N. and examines the relationship between the abundant species and the physical properties of the deep water masses of the western North Atlantic Ocean.

Recent studies of modern benthonic foraminifera have concentrated on understanding the factors influencing their distribution. Streeter (1973) noted that the distribution of benthonic foraminifera at depths greater than 2,500 m in the North Atlantic Ocean was controlled by deep ocean currents. He recognized three modern benthonic foraminiferal assemblages and showed that they are related to water mass properties. Furthermore, he proposed that changes in the abundant species in core samples over the past 150,000 years are indicative of changes in water mass circulation brought about by glacial-interglacial shifts. Schnitker (1974) studied the benthonic foraminifera of the West Atlantic Ocean and identified three assemblages which can be

related to those of Streeter (1973). He also examined the benthonic fauna of a glacial period, 17,000 years B.P., and the last interglacial period, 120,000 years B.P. The distribution of faunal assemblages of the interglacial samples corresponded well with present faunas while those of the glacial differed markedly. This suggests a change in the circulation pattern of deep water masses. Streeter and Shackleton (1979) have correlated the relative abundance of *Uvigerina peregrina* with oxygen isotope distribution. *U. peregrina* is abundant in waters with low oxygen concentration such as the Antarctic Bottom Water (AABW). It is generally absent from the North Atlantic which is occupied by the oxygen rich North Atlantic Deep Water (NADW). The occurrence of this species in a North Atlantic core is interpreted as a cessation of NADW formation while the presence of *Epistominella exigua* and *Cibicides wuellerstorfi* assemblages indicate conditions similar to the present. Comparison of the down core faunal distribution with isotope stratigraphy demonstrates that the benthonic fauna is sensitive to water mass variations which in turn reflect climatic changes.

Lohman (1978) identified benthonic foraminiferal indicators for the western South Atlantic Ocean deep water masses. He carried the concept one step further by attempting to transform qualitative paleontological data into quantitative oceanographic information: he correlated the relative abundance of the indicator species to the variations in chemical and physical properties of each water mass. By recognizing the hydrographic properties to which each indicator species is sensitive, Lohman hoped to identify the deep water environmental parameters which could be reconstructed from paleontological information. He then derived regression equations to estimate quantitatively individual hydrographic properties from benthonic foraminiferal abundance. Unfortunately, Lohman considered only foraminifera larger than 250 μ . Results obtained herein indicate that the majority of deep water benthonic foraminiferal specimens are smaller than 250 μ and that specimens retained in the 60 mesh size sieve are usually not representative of the abundant species contained in the sample.

Figure 1. Study areas; A- Mid Atlantic Ridge, B- Scotian slope, C- Grand Banks slope.

Figure 2. Mid Atlantic Ridge - sample location.

LEGEND

- DEPTH LESS THAN 1200 m.
- DEPTH 1200-2000 m.
- DEPTH GREATER THAN 2800 m.
- Sample Location
- Hydrographic stations (Garner & Ford, 1969)

Figure 3. Continental slope - sample location. (after Piper, 1975).

1.2 Location of the study area.

Bottom sediment samples were recovered from two regions of the western North Atlantic Ocean (Figure 1) surveyed by the Bedford Institute of Oceanography (cruise numbers: BIO 19-66, BIO 22-68 and BIO 74-021). Fifteen, collected by the C.S.S. HUDSON in 1966 and 1968 from the Mid Atlantic Ridge between $45^{\circ}10'$ N. and $45^{\circ}56'$ N. and $26^{\circ}40'$ W. and $29^{\circ}56.3'$ W. (Figure 2), were obtained from the Atlantic Geoscience Centre. Extensive geophysical and geological programs carried out in that area supplied sedimentological and hydrological data for this project (e.g. Loncarevic *et al.*, 1966; Garner and Ford, 1969; Keen and Manchester, 1970; Bartlett and Greggs, 1970 and Schafer, 1974).

Six samples from the continental slope off eastern Canada, between $41^{\circ}17.5'$ N. and $43^{\circ}06.9'$ N. and $51^{\circ}39.6'$ W. and $63^{\circ}21.9'$ W. (Figure 3), were obtained from Dr. Piper, Dalhousie University. Four of these samples are located off Nova Scotia and two off the southern tip of the Grand Banks. Although several sedimentological reports resulted from the 1974 and subsequent cruises of the C.S.S. HUDSON (e.g. Piper, 1974; Stow, 1976; Alam, 1976; and Piper and Slatt, 1977), no specific hydrological information is available on the area.

There are no detailed taxonomical foraminiferal studies reported from the areas considered in this thesis. Recent ecological studies, however, have been carried out in adjacent areas. Pflum and Frerichs (1976) gave a detailed description of the distribution pattern and controlling environmental factors of deep water foraminifera from the Gulf of Mexico. Caralp and Pujos-Lamy (1970) and Pujos-Lamy (1973) conducted similar but less comprehensive studies in the Gulf of Gascogne in the eastern North Atlantic Ocean, and Streeter and Bélanger (unpub. manuscript) have described the Late Quaternary fauna of the Norwegian Sea.

1.3 Method.

The first three to twelve centimetres of each core top were processed. The age of the sediments was obtained from sedimentological reports published by Stewart

(1972) and Stow (1977) and from data obtained from Bartlett and Alam (pers. comm.).

The four samples from the Nova Scotian Slope are part of a suite of cores studied by Stow (1977). He used down core analysis of the planktonic fauna to establish climatic curves. From these curves along with two C^{14} dates he suggested that sedimentation rates for the past 16,000 years were 10-12 cm per 1,000 years. Stow concluded that these late Holocene sediments accumulated by hemipelagic settling with some bottom current reworking. The clay mineralogy of the samples consists of illite (56%), chlorite (19%) and montmorillonite (12%) with smaller amounts of feldspar, amphibole and calcite (Stow, 1977). Piper and Slatt (1977) indicated that the main source of illite is located in Baffin Bay and on the outer continental margin of Labrador and Newfoundland and is carried along slope by the Western Boundary Undercurrent (WBUC). If sediment transport was perpendicular to the slope, then according to Piper and Slatt (1977) kaolinite and montmorillonite along with some chlorite would be the main constituents of the clay fraction. This observation further supports the hemipelagic nature of late Holocene sediments of the Nova Scotian Slope.

Sedimentological analysis and isotopic dates have confirmed that the two samples collected on the Grand Banks Slope are modern and undisturbed (Alam, pers. comm. 1979).

The seven samples from the 66-19 series, collected in the Mid Atlantic Ridge area, were described in detail by Stewart (1972). Based on down core analysis of planktonic foraminifera and two C^{14} dates, Stewart established a sedimentation rate of 10 cm per 1,000 years for the past 100,000 years and proposed that the first 50 cm of each core (57 cm in the case of 66-19-27) is of Holocene age. Calcium carbonate analyses were used to demonstrate the excellent stratigraphic correlation that exists between samples from different valleys, again indicating hemipelagic settling.

Down core distribution of planktonic foraminifera in samples from the 68-22 series, also from the Mid Atlantic Ridge area, indicated that the tops of the cores contain a modern, temperate fauna representative of present surface conditions with no evidence of turbidity flows (Bartlett, pers. comm., 1979).

On the basis of the previous observations it is concluded that all samples contain a modern indigenous fauna representative of present physical and chemical conditions at each station.

Approximately 5 gms of sediment were processed according to the method described in Appendix I. Residues which yielded a large number (greater than 1,000) of specimens of benthonic foraminifera were split. The entire sample was picked, producing an average of 750 individuals per sample. These were identified and counted. The counts for each species were processed by computer using the Fortran program BMATRIX (Rodrigues, unpub.). This program expresses the counts as a percentage of the total number of specimens in each sample. Appendices IIA and IIB summarize the data. The information was qualitatively evaluated to determine assemblages. The assemblages were defined on the repeated occurrence of species with abundances greater than 5% in the samples. This percentage value was arbitrarily chosen; it is the same as that used by Lohman (1978).

Scanning electron micrographs were obtained for the most abundant species along with some of the more common species. All figured and unfigured specimens were deposited in the Carleton University collection under the series CUCL. . . .

CHAPTER 2

STUDY AREA

2.1 Physiography.

Fifteen samples were collected in an area of 110 x 185 km. near the Mid Atlantic Ridge. Bhattacharyya and Ross (1972) published a detailed topographic map which covers the area between latitudes 45°N . and 46°N . and longitudes 27°W . and 30°W . Three stations, 68-22-181, 68-22-191 and 68-22-195, are located outside the map area. Garner and Ford (1969) extended the topographic map as far east as longitude $26^{\circ}45'\text{W}$. but their map does not cover the area where the three samples were collected. Shipboard reports made available by the Atlantic Geoscience Centre indicate that sample 68-22-191 is on a gradually sloping grade between mountains. No comments accompanied the shipboard reports for sample 68-22-181 and 68-22-195, but these two samples are at the limit of the map published by Garner and Ford (1969). Sample 68-22-195 appears to be located on a sill complex, whereas sample 68-22-181 is probably at or near the bottom of a valley.

The Mid Atlantic Ridge can be divided into two physiographic provinces, the crestal area and the flank area (Figure 2). Three samples were collected in the crestal area: sample 66-19-50 was recovered at the bottom of the Median Valley and samples 68-22-145 and 68-22-191 were collected on sedimentary highs: one, 580 km. west of the Median Valley and the other, 460 km. east of it. The remaining twelve stations are located in the flank area which is a series of high, fractured plateaus. Samples 68-22-163 and 68-22-154 are situated farthest to the west. There is no detailed topographic map of the area immediately to the west, but examination of regional maps reveals that these two samples are located near the border between the flank province and the abyssal plains. Samples 68-22-158 and 68-22-160 were recovered from a sill complex, and samples 66-19-27, 66-19-20, 66-19-18 and 66-19-12 were collected from the bottom of an interconnecting valley system.

Samples 66-19-15 and 66-19-26 were taken at the base of an isolated mountain. As mentioned above, samples 68-22-181 and 68-22-195, collected in the flank province east of the Median Valley, are believed to be situated at the bottom of a valley and on a sill complex, respectively.

Compared with the relief of the Ridge area, the continental slope has relatively uniform terrain. The four Nova Scotian Slope samples, collected in an approximately linear pattern along 160 km., are on a slope grade of 1.3 (Figure 3). The two samples recovered from the Grand Banks Slope are situated very close to one another with an approximate 400 m vertical displacement. The continental slope off the Grand Banks has a greater relief than that off Nova Scotia, but both areas are physiographically much less complex than the Mid Atlantic Ridge area.

2.2 Sedimentation processes.

Sedimentary processes affect the distribution of benthonic foraminifera in several ways. One is direct by determining the nature of the substrate. Another is by the indirect displacement of fauna through catastrophic events such as turbidity flows.

Van Andel and Komar (1969), in a study of two intermountain valleys of the Mid Atlantic Ridge near 22° N., established that sliding and turbidity flows effectively remove sediments accumulated on the surrounding hills and deposit them on the valley floor. Seismic reflection studies of the Mid Atlantic Ridge near latitude 45° N. were conducted by Keen and Manchester (1970). These studies evaluated sediment thickness and distribution in the area. Their results suggest that turbidity currents may be an important sedimentary process in the intermountain valleys of the crestal area where topography is relatively steep. They have also established that sedimentation rates are higher near the Median Valley as local erosion supplies more material where volcanic rocks are not buried.

Schäfer (1974) reported that ice-rafted debris is a significant source of material west of the Median Valley near latitude 45° N. and may account for as much as 75% of the surficial coarse sediment fraction collected from mountain tops. These were

Figure 4. Mid Atlantic Ridge: substrate characteristics

transported by drift ice and pack ice which is believed to have reached as far south as 30°N . during the last glacial maximum (Davies and Laughton, 1972). Schafer (*op. cit.*) also mentioned that for hydrographic stations located on mountain tops, the bottom current velocity is close to 42 cm per sec., compared to 2.6-8.2 cm per sec. reported by Keller, Anderson and Lavelle (1975) for stations located at the bottom of the Median Valley. The current velocities encountered at shallow depths would effectively remove the finer sediments from the mountain tops, possibly explaining why turbidite sequences were not reported by Stewart (1972) even in the Median Valley.

Samples 68-22-158, 68-22-160, 68-22-145, 68-22-191 and 68-22-195 are located on sill complexes and consequently cannot be a result of turbidities. They are therefore considered possibly to be bottom current reworked sediments of hemipelagic origin. The rest of the 68-22 series (68-22-163, 68-22-154 and 68-22-181) are located at the bottom of valleys. Because the fauna from the first two samples is similar to those located at other valley stations in the Ridge area, it is assumed that these samples are also the result of hemipelagic settling. Sample 68-22-181 was discarded as it contained only 27 specimens.

The amount of material provided by the Atlantic Geoscience Centre was insufficient to perform any sedimentary analysis. A description of the sample lithology and of the washed residue is included in Appendix IIIB. The nature of the substrate as evaluated from the sample lithology, microscopic examination of the sample residue and the percentage of sand content (Appendix IIIA, % sed. out, which indicates the weight % of residue recovered) is given for each station (Figure 4).

Stow (1977) described the Holocene sedimentation process on the Nova Scotian Slope as hemipelagic settling with bottom current reworking which during Late Holocene was responsible for depositing clays. He described the top section of the cores as containing 3-6% sand composed almost entirely of foraminifera. Thirty-five percent of the silt size fraction is carbonate and quartz while the rest is mostly foraminifera. As previously mentioned, the clays consist of illite (56%), chlorite (19%) and montmorillonite (12%). There is no evidence of turbidity currents and along-slope transport is

Figure 5. Continental slope — substrate characteristics

avored over down-slope migration. The large percentage of broken foraminiferal tests and the numerous echinoderm spines (e.g. sample 74-021-06) indicate that predators are abundant. Stow (1977) also noticed that bioturbational mottling was ubiquitous in the sediments from the top section of the cores.

The two stations located east of the Laurentian Fan (Figure 3), on the Grand Banks Slope, are out of reach of turbidity currents (Piper, 1975). Alam (1976) noted that although the Grand Banks Slope is cut by numerous small canyons, none of them reach below the 200 m level. Piper and Slatt (1977) described an olive grey mud facies from the margin of the Grand Banks which they correlated with the Holocene olive grey mud facies of the Nova Scotian Slope. The two grab samples from the Grand Banks belong to this facies. These samples also accumulated as a result of hemipelagic settling and bottom current reworking. At both stations there is evidence of reducing environments. In addition to pyrite grains and small pyrite concretions, foraminifera and other biological material are infilled with pyrite.

The nature of the substrate at each station is illustrated in Figure 5 and the sample lithologies and compositions of the washed residues are given in Appendix IIB.

2.3 Oceanography.

Water masses of the North Atlantic Ocean are circulated by two types of current systems, density currents and anticyclonic gyres (Worthington, 1976). Both of these systems result from the action of the atmosphere on the water surface. Density generated currents are found in the Norwegian and Mediterranean Seas where excess cooling and evaporation, respectively, form dense water masses that flow downward over sills into the North Atlantic Ocean. These dense southward flowing waters are displaced to the west by the Coriolis Force. Only a small amount of water enters the Atlantic at its northern end by way of the North Polar Sea in the form of the East Greenland, West Greenland and the Labrador currents. This meridional flow needs to be counterbalanced by lighter northward moving waters. The displacement of water masses of different density is the less important of the two circulatory systems in

Figure 6. Basins of the North Atlantic (after Worthington, 1976).

Figure 7. Temperature and salinity values of the deep water masses of the North Atlantic (after Worthington, 1976). - Mediterranean Outflow and Iceland-Scotland Overflow combine between $S = 34.95-35.95$ p.p.t. and $\theta = 2.5-3.0^{\circ}\text{C}$

terms of the actual amount of water transported.

The greater volume of water is transported by two powerful anticyclonic gyres located in the western part of the North Atlantic basin. The major one, the Gulf Stream system, is confined to the Sargasso Sea area, whereas the Northern Gyre is located to the east of the Grand Banks. The driving mechanism of these gyres is not fully understood. It is believed that they are caused by a steady wind system that forms high pressure cells around which currents move anticyclonically. The gyres are maintained by the formation of a deep, seasonal thermocline. Winter polar continental air reaching the Gulf Stream and the Northern Gyre causes vertical mixing of the thermocline.

Worthington and Wright (1970) divided the North Atlantic into four horizontal thermal layers. The deepest layer is composed of water colder than 4°C . The North Atlantic Deep Water (NADW) accounts for 71% of all the water colder than 4°C . By definition (Worthington and Wright, 1970), the NADW must be represented in all of the six basins of the North Atlantic (Figure 6). These restrictions define a water mass with a Θ/S class (where Θ = potential temperature in $^{\circ}\text{C}$ and S = salinity in parts per thousand) between $\Theta = 1.8^{\circ}\text{C}$ and $S = 34.89$ p.p.t. and $\Theta = 4^{\circ}\text{C}$, and $S = 35$ p.p.t. (Figure 7). It has five sources:

1. The Norwegian Sea overflow through the Denmark Strait.
2. Norwegian Sea overflow through the Iceland-Scotland Passage.
3. Inflow of Antarctic Bottom Water north of Brazil.
4. Overflow of Mediterranean Sea Water.
5. Winter convergence at the surface of the Labrador Sea.

The Θ/S values of the water masses which exist as distinct entities in different parts of the North Atlantic are illustrated in Figure 7. With the exception of a small amount of cold South Atlantic Water, all of these contribute to the formation of NADW. They are distributed in the following manner:

1. The Mediterranean water mass rapidly spreads both vertically and laterally as

Figure 8. North Atlantic deep water mass circulation diagram (after Worthington, 1976).

it passes through the Straits of Gibraltar. It can be traced throughout the ocean at various levels. At depth it forms a wedge which covers most of the North African basin and enters the southern part of the North American basin.

2. The Iceland-Scotland overflow is restricted to the European basin except for a small amount that passes through the Gibbs fracture zone into the Labrador basin.
3. The Denmark Strait overflow water is found only in the Labrador and North American basins.
4. The Antarctic Bottom Water (AABW) is located only at the greatest depths of the Guiana and North American basins.
5. The South Atlantic Water is known only in the Guiana and the Guinea basins, within 10° of the equator.
6. Although most of the Labrador Sea water remains in the Labrador basin, some is found in the European and a small amount in the North American basins.

Worthington (1976) provided a detailed description of deep water circulation in the North Atlantic. A brief summary is given here without references to the actual quantities of circulating water. The first current system considered is the meridional flow which results from water mass formation. Water from the Norwegian Sea enters the North Atlantic at the Denmark Strait, the Iceland Faroes Ridge and the Faroes Bank Channel (Figure 8). The Iceland-Scotland overflow follows a southerly route along the eastern flank of the Reykjanes Ridge until it turns west passing through the Gibbs fracture zone. Once through this passage, the flow reverts northward along the western flank of the Reykjanes Ridge and joins the Denmark Strait overflow. The combined southward current swings north again at the level of Cape Farewell, Greenland, and finally moves southward past Newfoundland. This deep countercurrent can be traced along the western margin of the ocean basin as far south as North Carolina. Direct current measurements are not available past that point. The countercurrent is often referred to as the Western Boundary Undercurrent (WBUC), or sometimes as the Slope Waters. With the exception of a small quantity of Mediterranean Water, all

the water that enters the South Atlantic is presumed to result from the flow of NADW in the deep countercurrent.

Until recently the Gulf Stream system had been described as a single giant anticyclonic gyre occupying most of the North Atlantic Ocean. Evidence for a major circulatory pattern composed of two lesser anticyclonic gyres, the Northern Gyre and the Gulf Stream Gyre, appeared when the potential temperature versus dissolved silicates and potential temperature versus potential salinity curves were plotted for the deepest waters of the Labrador and North American basins. In the Labrador basin these waters come from the Norwegian Sea and those of the North American basin, from the Antarctic Ocean. Although there is no physical barrier between the basins, for the most part the water masses remain separate. Between 2.0°C and 2.8°C , however, there is little physical or chemical difference between water of the Gulf Stream system and that of the Northern Gyre. Above 2.8°C differences increase until, in the range of $3.4\text{--}3.6^{\circ}\text{C}$, there is no water in common. The Northern Gyre contains primarily Labrador Sea Water while the Gulf Stream is of NADW.

Worthington (1976) represented both gyres as closed systems. In the case of the Gulf Stream, the deepest water is assumed to return west of the Mid Atlantic Ridge while in that of the Northern Gyre the return flow is confined to the western side of the Mid Atlantic Ridge at the greatest depths. At lesser depths, the eastern border of the return flow becomes the Mediterranean water that fills the eastern North Atlantic basin at the lower thermocline and mid thermocline layers. These assumptions are consistent with water mass distribution but they are inconsistent with geostrophy in that the southward return flow takes place without the appropriate pressure gradient. Worthington (1976) concluded that a truly geostrophic solution to the North Atlantic circulation is not obtainable.

Although nine hydrological stations were monitored during the 1968 HUDSON cruise (Garner and Ford, 1969) no hydrological data were obtained from the sampled locations. Temperature and salinity values for the fifteen stations of this study had to

be extrapolated from known values provided by Worthington and Wright (1970) and Garner and Ford (1969). Worthington and Wright published temperature and salinity charts along with depths of surfaces for isotherms from 1 to 4° C. Temperature and salinity values were obtained by plotting the station location on the appropriate depth chart. Garner and Ford only provided temperature readings; therefore, salinity values were obtained from Worthington and Wright.

Temperature values reported by Garner and Ford (1969) fall into two categories. Of the nine stations surveyed, six are located each in a basin of the Median Valley of the Mid Atlantic Ridge (Figure 2). Their values plot together and are distinct from the results obtained at the three remaining stations. Two of these three are located west of the Median Valley, whereas the other is on the east side. Measurements from these three outside stations are similar to one another and differ from those obtained in the Median Valley in that the temperature registered in the Median Valley is greater than that recorded outside of the Valley at similar depth. Fehn *et al.* (1977) in a study of deep water temperatures across the Mid Atlantic Ridge south of the Azores (FAMOUS area) stated that sill depth determines temperature distribution in closed basins because only water at temperatures greater than those at the lowest sill depth can enter a closed basin. Because the Median Valley is surrounded by the highest mountains of the mid oceanic rise, it follows that the bottom temperature in the Valley should be the same as that found at the level of the enclosing sills at about 2,100 m. According to Worthington and Wright (1970), water temperature at that level is approximately 3.4° C, close to the 3.55° C registered by Garner and Ford.

Because of the influence of the sill depth on the temperature in the valleys, it is felt that temperature values for most of the fifteen samples cannot be read directly from the charts published by Worthington and Wright (1970) or extrapolated from Garner and Ford's diagram. The following discussion presents the rationale behind the temperature values assigned to each station.

Station 66-19-50, located in the Median Valley (Figure 2), is also situated in the same basin as Garner and Ford's station 175. Consequently, their temperature

Figure 9. Mid Atlantic Ridge – temperature values.

Figure 10. Mid Atlantic Ridge - salinity values.

LEGEND

- DEPTH LESS THAN 1200 m.
- DEPTH 1200-2000 m.
- DEPTH 2000-2800 m.
- DEPTH GREATER THAN 2800 m.
- Sample Location
- Hydrographic stations (Garner & Ford, 1969)

value is considered to be representative. Garner and Ford suggested that above 2,250 m the temperature-depth curves of all stations are similar. For station 68-22-191, located on a hill east of the Median Valley at a depth of 2,180 m, their results indicate a temperature of $3.5\text{--}3.55^{\circ}\text{C}$. Stations 68-22-158 and 68-22-160 are on a rise west of the Median Valley at 2,770 m and 2,634 m, respectively. Garner and Ford's station 151 is located on the same sill complex at approximately 2,750 m. In this case also, their values recorded for the given depths are used. Also on a sill, station 68-22-195 at 2,760 m is located to the east of the Median Valley. Worthington and Wright's charts indicate a temperature of 3.0°C for that depth. Although station 68-22-181 is outside of the mapped area, it is at the same depth as and close enough to Garner and Ford's station 179 to probably be in the same valley system. A reading of 3.15°C for station 68-22-181 is accepted as reasonable. Station 66-19-12, 66-19-18, 66-19-20 and 66-19-27 are all located in a valley system which is bounded to the west by a sill at a depth of 2,200 m. The sill is cut by a 20 km. wide passage at 3,000 m connecting the valley system to one immediately west of it. It is believed that the water found in the valley system has the properties of this 3,000 m deep water which, according to Worthington and Wright, is 2.8°C . Stations 66-19-15 and 66-19-26 are located at the base of a mountain with water entering the valley at 2,800 m where the temperature is 3.0°C (Worthington and Wright, 1970). Stations 68-22-154 and 68-22-163 are farthest from the Median Valley. As the relief to the west of these locations is that of the abyssal plains, it is believed that water entering that area does not encounter any sills. Temperature values for those two stations are obtained directly from Worthington and Wright. Station 68-22-145 is located on the western flanks of the crestal area at a depth of 2,670 m. There is no obstruction to water movement at that level in the area. Worthington and Wright suggested the temperature at that depth to be 3.5°C .

These results along with the accompanying salinity values obtained from Worthington and Wright's charts are summarized in Appendix IIIA and on Figures 9 and 10.

Figure 11. Continental slope - temperature values.

Figure 12. Continental slope - salinity values.

They indicate that NADW is the only deep water mass circulating in that area of the Mid Atlantic Ridge.

Only surface and near surface hydrographic surveys were conducted during the Bedford Oceanographic cruise 74-021. Temperature and salinity data for the slope stations were obtained from Worthington and Wright's (1970) charts. This area is physiographically less complex than the Ridge area. There are no mountain chains to impede the movement of water masses and the values obtained from Worthington and Wright are believed to be representative of the conditions existing at the stations surveyed (Figures 11 and 12, and Appendix IIIA). The deepest Nova Scotian station has water characteristics of both NADW and AABW, the shallowest that of Labrador Sea Water. The two intermediate stations, 74-021-06 and 74-021-7G, exhibit properties which are indicative of NADW. The two stations on the Slope off the Grand Banks are in Labrador Sea Water.

CHAPTER 3

RESULTS

3.1 Composition of the benthonic foraminiferal fauna.

Using the classification of Loeblich and Tappan, 1964, a total of 208 species belonging to 32 families were identified. Arenaceous (agglutinating) forms account for 29 species, porcelaneous 14 species and hyaline 165 species (Appendix IIA).

With the exception of *Hyperammina elongata*, *Textularia candeiana* and *Siphotextularia affinis*, most of the arenaceous species are uncommon and are only found at a few stations. At station 74-021-7G arenaceous foraminifera, mostly *Hyperammina elongata*, constitute a major portion of the benthonic fauna. Because this species consists of a long branching tube which is easily broken, it is impossible to ascertain the absolute number of individuals present. Nevertheless, the number of fragments recovered indicates that the species is abundant. Sample 66-19-50 is unusual in that it contains several specimens of two species restricted to it, *Textularia candeiana* and *Siphotextularia aff. affinis*. *Glomospira charoides*, *G. gordialis*, *Haplophragmoides sphaeriloculum*, *Trochammina globigeriniformis*, *T. pauciloculata* and *Eggerella bradyi* are common species especially in the Ridge area, but only a few specimens were recovered at any one station.

Although there are fewer species of porcelaneous than arenaceous foraminifera, the number of specimens recovered per station is higher. The family Nubeculariidae is poorly represented with occasional specimens occurring at 12 stations. The family Miliolidae on the other hand, is common in samples from the Ridge area with *Miliolinella circularis* restricted to these samples and species of *Pyrgo* and *Quinqueloculina* most abundant in them. Except for high numbers of *Sigmoilopsis schlumbergeri* at station 74-021-06, porcelaneous foraminifera are not abundant in the slope area.

Most of the 165 calcareous hyaline species which form the bulk of the deep water benthonic foraminifera identified in this study are not significant in terms of

specimen abundance. Ninety six species belonging to the families Eouvigerinidae, Glabratellidae, Glandulinidae, Nodosariidae, Polymorphinidae, Robertinidae, Spirillinidae and Turrilinae, are represented by rare specimens occurring at some of the stations.

Another type of distribution pattern is illustrated by species belonging to the families Bolivinitidae, Buliminidae, Caucasinidae, Elphidiidae and Islandiellidae. These 23 species are rare or absent at most stations. Occasionally, however, *Bolivina subspinescens*, *Bulimina aculeata*, *B. costata*, *B. elongata*, *Cassidella complanata*, *Elphidium excavatum* and *Islandiella helenae* are abundant at one or two stations, perhaps in response to some unique environmental factor.

The remaining 46 calcareous species can be divided into two groups: a) species which are common but which have low numbers of specimens except at a few stations where the number of specimens increases, b) species which are common and which have a high number of specimens except at a few stations where they are rare or absent. The first group is composed of 22 species belonging to the families Alabaminidae, Anomalinidae, Ceratobuliminidae, Nonionidae and Uvigerinidae. The second group contains 24 species of the families Cassidulinidae, Cibicididae, Discorbidae, Eponididae and Loxostominidae.

3.2 Assemblages.

The number of specimens recovered at stations 68-22-181 and 74-021-06 is low (27 and 29, respectively). The two samples are therefore omitted from the following discussion.

Each sample contains only a few species with relatively high specimen abundance (Appendix IIB). Four assemblages named after the most abundant species (Appendix IIC) are defined on the presence of species with abundance greater than 5% for a given assemblage.

Assemblage I is established with a high degree of confidence; it is recognized at eleven stations and has been described in previous studies (Streeter, 1973;

ASSEMBLAGES	I												II	III	IV
STATION NUMBERS	66-19-12	66-19-15	66-19-18	66-19-20	66-19-26	66-19-27	66-19-50	68-22-154	68-22-160	68-22-163	68-22-191	68-22-145	74-021-4G	74-021-25	
<i>Epistominella exigua</i> (%)	10	12	12	11	12	13	10	18	17	10	9				
<i>Eponides tumidulus</i> (%)	34	24	30	36	22	40	43	19	20	19	27				
<i>Loxostomum truncatum</i> (%)	10	23	14	9	14	5	9	7	17	11	13				
<i>Alabamina ? umbonifera</i> (%)												15			
<i>Cassidella complanata</i> (%)													18		
<i>Elphidium excavatum</i> (%)													41		
<i>Cassidulina obtusa</i> (%)														50	
<i>Melonis zaandami</i> (%)														6	
<i>Nonionellina labradorica</i> (%)														6	
Total percentage	54	59	56	56	48	58	62	44	54	40	49	15	59	62	
No. arenaceous species	9	8	9	13	9	16	6	6	6	15	5	8	1	0	
No. calcareous species	61	50	52	54	58	65	51	50	54	43	59	49	32	28	
No. porcelaneous species	8	7	8	6	7	7	4	7	10	9	7	9	2	0	
Substrate	Sds	Sds	Sds	Sds	Sds	Ssd	S	Ssd	Ssd	Ssd	Ssd	Ssd	S	S	

Table 1. Composition of assemblages I, II, III and IV. Substrate symbols: Sds = sandy silt, Ssd = silty sand, S = silt.

Schnitker, 1974; Streeter and Shackleton, 1979). Assemblage II is proposed with less confidence. Though its distribution has been documented in the literature (Streeter, 1973; Schnitker, 1974; Lohman, 1978; Streeter and Shackleton, 1979), it is recognized at only one station. Assemblages III and IV are presented as suggestions.

Assemblage I: *Epistominella exigua*-*Eponides tumidulus*-*Loxostomum truncatum*. This assemblage predominates in the Ridge area where it occurs at 11 out of 14 stations (Table 1). The three recurrent abundant species account for 40-62% of the benthonic fauna. Relative abundance of the abundant species (Table 1) does not vary with the different types of substrate present nor does the relative abundance of the various types of foraminifera (arenaceous, calcareous and porcelaneous). The substrates range from a silty sand to a silt.

Specimens of *Globacassidulina crassa rossensis* are abundant in all but one sample of Assemblage I (66-19-18), where they are present in numbers too low to satisfy the definition of an abundant species. This trend in abundance and occurrence is similar for *Eponides polius* and *E. tener*. Although considered abundant in only one sample each (66-19-12 and 68-22-163, respectively), they are numerous at the remaining nine stations but again not sufficiently to satisfy the definition of an abundant species.

Assemblage I has been recovered in the Median Valley and from the crest and flank areas of the Mid Atlantic Ridge. The residues (Appendix IIIB) of ten of the samples consist of foraminiferal sands and at one station, 68-22-154, the sand-sized fraction is made up of an equal mixture of mineral and biogenic material.

Assemblage II: *Alabamina* ? *umbonifera*.

The definition of this assemblage is based on the abundance of *Alabamina* ? *umbonifera*. *Cibicides wuellerstorfi* is also abundant and is present in large numbers at all but three stations. However, its ubiquity precludes its use in differentiating between various assemblages. Assemblage II is recognized at only one station from the Ridge area (Table 1).

Examination of sample 68-22-145 abundant fauna (Appendix IIC) reveals that it bears little resemblance to that of Assemblage I. The residue from sample

STATION NUMBERS	68-22-195	74-021-06	74-021-7G	68-22-158	74-021-08
<i>Alabamina ? umbonifera</i>	0	0	3	6	22
<i>Bulimina elongata</i>	0	0	11	0	1
<i>Cassidella complanata</i>	0	6	1	0	0
<i>Cibicides wuellerstorfi</i>	7	0	8	6	5
<i>Elphidium excavatum</i>	0	14	0	0	1
<i>Epistominella exigua</i>	20	3	9	13	12
<i>Eponides tumidulus</i>	9	13	26	16	18
<i>Loxostomum truncatum</i>	4	0	0	12	0
Total percentage	40	36	58	53	59
No. arenaceous species	4	4	12	13	8
No. calcareous species	56	59	39	63	24
No. porcelaneous species	6	5	3	10	1
Substrate	Sand	Silt	Silt	Ssd	Silt

Table 2. Composition of mixed assemblages. (Substrate symbol: Ssd = Silty sand).

68-22-145 is composed of an even proportion of biogenic and mineral material. Because Assemblage II is recovered at only one station, it is impossible to evaluate the influence of substrate on the distribution of abundant species or of the various types of benthonic foraminifera.

Assemblage III: *Cassidella complanata*-*Elphidium excavatum*.

This assemblage was recovered at one Nova Scotian Slope station only (Table 1). Examination of Appendix IIC shows that the abundant species of sample 74-021-4G do not occur in Assemblages I or II.

Again no relationship between fauna and substrate can be established on the basis of a unique sample. The substrate is composed of silt and the residue is made up almost exclusively of biogenic material.

Assemblage IV: *Cassidulina obtusa*.

This species forms almost 50% of the population of sample 74-021-25. Other abundant species are *Melonis zaandami* and *Nonionellina labradorica* (Table 1).

The assemblage differs from the other three in that it contains neither arenaceous nor porcelaneous species. The sample is further differentiated from the others in that the residue of the silt substrate is composed mostly of mineral grains.

Though recovered at only one station, on the Grand Banks Slope, the sample bears little resemblance to other samples and has no abundant species in common with the other assemblages (Appendices IIA and IIC).

Five samples represent mixed assemblages (Table 2). Samples 68-22-158 and 74-021-08 are composed of a mixture of elements from two assemblages. Both samples contain an abundant *Alabamina ? umbonifera* fauna indicative of Assemblage II along with the Assemblage I species *Epistominella exigua* and *Eponides tumidulus*. *Loxostomum truncatum* is abundant in sample 68-22-158 and absent in sample 74-021-08. The substrate at station 68-22-158 is a silty sand and the residue is composed almost exclusively of biogenic material. At station 74-021-08 the residue of the silty substrate is composed of 75 % biogenic material.

Sample 74-021-06 contains abundant species from both Assemblages I and III.

Figure 13. Mid Atlantic Ridge - Assemblage and water mass characteristics
 I - assembly I; II - mixed assembly; M - NADW, Sample 68-22-181 not included in analysis.

LEGEND

Figure 14. Continental slope - Assemblage and water mass characteristics:
 III - assemblage III; IV - assemblage IV; M - Mixed assemblage;
 ★ - Labrador Sea Water; ★ - NADW.
 Sample 74-021-26 not included in analysis.

Elphidium excavatum and *Cassidella complanata*, species characteristic of Assemblage III, are recovered in this Nova Scotian Slope sample along with *Eponides tumidulus*, a species indicative of Assemblage I. Other abundant Assemblage I species, *Epistominella exigua* and *Loxostomum truncatum*, are either rare or absent. The silty substrate yielded a residue composed almost exclusively of biogenic material.

The remaining two samples (68-22-195 and 74-021-7G) are related to Assemblage I. They both have an abundant *Epistominella exigua*-*Eponides tumidulus* fauna but *Loxostomum truncatum* is rare or absent. Sample 74-021-7G differs in that it has a strong arenaceous fauna and is also characterized by the presence of *Bulimina elongata*. In addition to Assemblage I species, sample 74-021-7G also contains *Alabamina ? umbonifera* of Assemblage II. The silty substrate is composed of biogenic material. Station 68-22-195 differs from others in that it has a sandy substrate. The residue is composed of biogenic material.

Figures 13 and 14 indicate the nature of the water mass and the type of assemblage encountered at each Ridge and Slope station.

3.3 Discussion.

Temperature-salinity values for the samples of the four assemblages when plotted on Figure 7 indicate the presence of two water masses, NADW and Labrador Sea Water.

Except for stations 66-19-50 and 68-22-191, Assemblage I is found at temperatures between 2.8 and 3.0°C and the salinities between 34.94 and 34.98 p.p.t. Stations 66-19-50 and 68-22-191 have temperature values between 3.5 and 3.55°C and salinities between 34.96 and 34.98 p.p.t. These values indicate that Assemblage I occurs in NADW (Figure 7).

Alabamina ? umbonifera, the species which characterizes Assemblage II, is associated with the presence of AABW (Streeter, 1973; Schnitker, 1974 and Lohman, 1978). Worthington (1976) indicated that AABW is present at the greatest depths of the North American and Guiana basins. AABW exists at temperatures below 2.2°C

and salinities less than 34.89 p.p.t. (Figure 7). The fauna recovered at station 74-021-08 along with the temperature-salinity values extrapolated from Worthington and Wright (1970) would indicate that it is situated in mixed AABW and NADW (Page 33). The temperature-salinity values for sample 68-22-145 and 68-22-158, collected in the Mid Atlantic Ridge area, are indicative of NADW. AABW has not been identified in this part of the North Atlantic Ocean. Lohman (1978) correlated the abundance of *Alabamina ? umbonifera* with decreasing temperatures and increasing alkalinity, depth and silica content. Depth and temperature values do not justify the presence of *Alabamina ? umbonifera* in the Ridge area. It is assumed that some unmeasured environmental parameter, such as alkalinity or silica content, may be responsible for the presence of this species in the Ridge area.

The complete disappearance of *Eponides tumidulus* and the low abundance of *Epistominella exigua*, *Globocassidulina crassa rossensis* and *Loxostomum truncatum* at station 68-22-145 may be indicative of some local phenomenon. When considering the size of these rare or absent species it is noted that they are all small with *Eponides tumidulus* the smallest. Examination of the average size of the specimens recovered at station 68-22-145 reveals that the specimens are significantly larger than those collected at other Ridge stations. Because sample 68-22-145 is located on a sedimentary high (from shipboard reports), bottom currents could have selectively removed the fine sediments and small-sized species at that station. The mixed fauna of sample 68-22-158 is thought to indicate mixed water masses, rather than winnowing, because of the wide size range of its fauna (Page 33). Thus the evidence for establishing the presence of Assemblage II in the Mid Atlantic Ridge area is not conclusive.

Temperature-salinity values for assemblages III and IV indicate the presence of a mixture of Labrador Sea Water and South Atlantic Water when plotted on Figure 7. Worthington (1976) stated that South Atlantic Water is found only within 10° of the Equator in the Guiana and Guinea basins. Therefore only Labrador Sea Water is present at the two upper slope stations. The salinity values for assemblages III and IV are the same but the temperatures at station 74-021-25 are slightly higher than at station 74-021-4G. As both stations are located near the shelf-slope break, the Labrador

Sea Water is probably mixed with water masses from the shelf. The temperature differences could reflect unmeasured environmental factors that in turn affect the nature of the abundant species present. Another factor which may explain the different benthonic fauna is the type of substrate recovered at each station. At station 74-021-4G the residue consists almost entirely of foraminifera, the mineral fraction having been washed out. At station 74-021-25 the residue consists predominantly (80%) of mineral grains (mostly quartz). With only two samples to compare it is impossible to evaluate the importance of substrate on the distribution of abundant species from Assemblages III and IV.

Temperature-salinity values at stations 74-021-06 and 74-021-7G are of NADW, but the fauna recovered at these two stations indicates that they are influenced by three water masses, Labrador Sea Water, NADW and AABW. The temperature-salinity values on the Nova Scotian Slope are transitional, from sample 74-021-4G, located in Labrador Sea Water, to sample 74-021-08 which has temperatures indicative of AABW but salinities of NADW. Between these two extremes are temperature-salinity values indicative of NADW. The fauna reflects this gradual change as species associated with Assemblage III and Labrador Sea Water in sample 74-021-4G are replaced by species from Assemblage I correlated with the presence of NADW in samples 74-021-06 and 74-021-7G, which in turn are replaced by species correlated with the presence of AABW and Assemblage II in sample 74-021-08.

The topography at station 68-22-195, known only from shipboard reports, indicates that it is situated on a gradually sloping grade between two mountains. The temperature-salinity values for this station are rough approximations as it is located outside the map area and the adjacent relief which affects the water mass movements is not known. The nature of the abundant fauna at station 68-22-195 may be explained in part by the substrate encountered at this station. The residue makes up 70% of the sample. In all other samples the residue accounts for less than 30% of the material.

	STREETER (1973)	SCINITKER (1974)	THIS STUDY
ASSEMBLAGE I			
Abundant species	? <i>Epistominella umbonifera</i>	<i>Epistominella exigua</i>	<i>Epistominella exigua</i> <i>Epionides tunidulus</i> <i>Loxostomum truncatum</i>
Water mass characteristics	deeper than 4,000 m. colder than 2.2°C AABW	1.9°C Arctic Bottom Waters (Denmark Strait overflow)	2.6-3.55°C 34.94-34.98 p.p.t. NADW
Distribution	Abyssal plains of the East and West Atlantic	Deepest West Atlantic North of 45°N	Mid Atlantic Ridge
ASSEMBLAGE II			
Abundant species	<i>Cibicides wuellerstorfi</i> <i>Epistominella exigua</i>	<i>Oxangularia umbonifera</i>	<i>Alabamina ? umbonifera</i>
Water mass characteristics	2,500-4,000 m. Iceland-Scotland overflow NADW (Streeter & Schackleton, 1979)	1.5°C AABW	3.0-3.2°C 34.94-34.95 p.p.t. NADW
Distribution	Margins of Central and South American continents Mid Atlantic Ridge	South West Atlantic	Mid Atlantic Ridge
ASSEMBLAGE III			
Abundant species	Mixed Assemblage: 1. <i>Nummuloculina irregularis</i> <i>Cibicides kullenbergi</i> 2. <i>Uvigerina hollicki</i>	<i>Hocglundina</i> <i>Uvigerina</i> <i>Gyroldina</i>	
Water mass characteristics	less than 2,500 m. 3-4°C 34.95 p.p.t.	2-4°C NADW	
Distribution	North of 45°N. East of the Mid Atlantic Ridge	Mid Atlantic Ridge Margins of the North and Central-American continents	

Table 3. Summary of Results from Streeter (1973), Scinitker (1974) and this study. Excluding Slope Samples

3.4 Comparison of results.

The comparison of studies by different researchers is complicated by varying sampling procedures, preparation techniques and taxonomic approaches.

The results of studies by Streeter (1973) and Schnitker (1974) are described and compared with those obtained by the author. The data from these three studies is summarized in Table 3. Neither Streeter (1973) nor Schnitker (1974) described assemblages similar to the writer's Assemblages III and IV. Therefore these were omitted from Table 3.

Streeter (1973) described three deep-water benthonic assemblages on the basis of the dominant species identified in fifty-eight core tops from the North Atlantic Ocean. Forty-eight were piston cores previously described by Phleger, Parker and Peirson (1953) and the remaining ten were gravity or trigger weight cores from the Lamont-Doherty Laboratory. These ten samples were washed through a 230 mesh size sieve and the residues were further sieved such that only specimens larger than 140μ were picked. This procedure insured that the Lamont-Doherty samples had been processed in the same fashion as those studied by Phleger, Parker and Peirson (1953). The hydrological data used to define the deep water masses was obtained from Worthington and Wright (1970). Streeter's (1973) sampling procedure was similar to that used in the present study, but the sample preparation techniques differ. All specimens larger than 62.5μ were examined herein. This could explain the prominence of *Eponides tumidulus* and *Loxostomum truncatum* in Assemblage I, associated with NADW, in this study although the species are not mentioned by Streeter (1973). Streeter (*op. cit.*) essentially used the fauna as identified and figured by Phleger, Parker and Peirson (1953) which makes it possible to compare his work with the present writer's.

The three assemblages recognized by Streeter (1973) are named after the abundant species which characterize them. They are as follows:

Assemblage I: ? *Epistominella umbonifera* was found in waters deeper than 4,000 m. This water is colder than 2.2°C and is identified as the AABW. The species tentatively identified as ? *Epistominella umbonifera* by Streeter (1973) is believed to

be the same as *Alabamina ? umbonifera* of this paper. According to Streeter (1973), Assemblage I occupies the abyssal plains of the East and West Atlantic Ocean. In this study *Alabamina ? umbonifera* was recovered at station 74-021-08, at a depth of 3,815 m. This location is consistent with Streeter's distribution pattern for Assemblage I. However, the presence of *Alabamina ? umbonifera* in the Ridge area at stations 68-22-145 and 68-22-158 is not compatible with Streeter's distribution pattern nor with the known position of AABW.

Assemblage II is recovered at a water depth between 2,500 and 4,000 m and is dominated by *Cibicides wuellerstorfi* and *Epistominella exigua*. It corresponds to the *Epistominella exigua* - *Eponides tumidulus* and *Loxostomum truncatum* assemblage herein defined as Assemblage I. This assemblage is characteristic of NADW (Streeter and Shackleton, 1979). Streeter (1973) limited the distribution of Assemblage II to the Mid Atlantic Ridge area and to a narrow area adjacent to the Central American and South American continents. The Mid Atlantic Ridge samples belonging to Assemblage I of this paper are within Streeter's delineation of the *Epistominella exigua* assemblage.

Assemblage III. This less well defined assemblage is characterized by *Nummuloculina irregularis* and *Cibicides kullenbergi*. It occurs at shallow depths (less than 2,500 m) and in waters located north of 45°N and east of the Mid Atlantic Ridge. Streeter (1973) suggested that the assemblage may be composite with *Uvigerina hollicki* being a dominant species of the North East Atlantic Ocean at temperatures between 3-4°C and salinities of approximately 34.95 p.p.t. Streeter and Shackleton (1979) described the present day distribution of *Uvigerina peregrina* (*U. hollicki* herein and of Streeter, 1973) as congruent with the distribution of dissolved oxygen. When the oxygen content falls below 5 ml per litre *U. peregrina*

becomes important. Today the species occurs in Circumpolar Deep Water (CDW), a water mass produced in the Southern Ocean. In the Equatorial and North Atlantic Ocean *U. peregrina* is found at an intermediate oxygen minimum (IOM) of which the Mediterranean waters are an important component. This assemblage was not recognized by the author. The only significant occurrence of *U. hollicki* is found in sample 74-021-08. According to Worthington (1976) Mediterranean waters are not present in the North Atlantic at that water depth. The presence of *U. hollicki* may indicate a lower oxygen content at this station but it is impossible to speculate on the presence of an additional water mass on the basis of one sample.

Schnitker (1974) studied deep-water benthonic foraminiferal assemblages from the West Atlantic Ocean. He mentioned neither the type nor the number of samples he examined. An approximation based on the sample location map would indicate that as many as 92 samples may have been processed. The sample processing techniques were not reported. Schnitker also described three assemblages based on the occurrence of abundant benthonic species. His assemblages are as follows:

Assemblage I. It is characterized by *Epistominella exigua* and is indicative of Arctic Bottom Waters. This water mass is presumed to be the Denmark Strait overflow water described by Worthington (1976). It is confined to the deeper areas of the West Atlantic, north of 45°N where water temperatures are 1.9°C.

Assemblage II. This assemblage is defined by the presence of *Osangularia umbonifera* (? *Epistominella umbonifera* of Streeter, 1973 and *Alabamina* ? *umbonifera* of the author). It is found in the Southern West Atlantic Ocean in water temperatures of 1.5°C and is characteristic of AABW.

Assemblage III. It is composed of *Hoeglundina*, *Uvigerina* and *Gyroidina* species. Schnitker associated this fauna with the NADW. It occurs between 2°C and 4°C and is found in the Mid Atlantic Ridge area and along the margin of the North and Central American continents.

When the distribution of benthonic foraminiferal assemblages described by Schnitker (1974) and Streeter (1973) are compared, a major difference is apparent. Schnitker described the abyssal plains of the West Atlantic Ocean as containing two assemblages: an *Epistominella exigua* assemblage north of 45°N and an *Osangularia umbonifera* assemblage south of latitude 45°N. Streeter (1973) described the abyssal plains of the East and West Atlantic as being occupied by an ? *Epistominella umbonifera* assemblage. According to Worthington and Wright (1970) AABW exists in its pure form at temperatures less than 1.9°C. Above this point it mixes with NADW. Worthington (1976) further described AABW as occupying the deepest parts of the Guiana and North American basin. Therefore both *Epistominella exigua* and ? *Epistominella umbonifera* are probably present in the abyssal plains of the West Atlantic Ocean and the proportion of abundant species recovered probably depends on the relative amount of NADW vs AABW present at a given station.

Assemblage III of Schnitker indicates that species of *Hoeglundina*, *Uvigerina* and *Gyroidina* are present in the Mid Atlantic Ridge between 2-4°C and are indicative of NADW. This is substantiated neither by Streeter nor by the present author. Assuming that the species recognized by Schnitker are *Hoeglundina elegans* and *Uvigerina peregrina*, it would appear that Assemblage III of Schnitker (1974) is probably composite. Streeter and Shackleton (1979) have established that *U. peregrina* is not characteristic of NADW, as this water is too rich in oxygen, and Lohman (1978) reached similar conclusions. Streeter and Shackleton (1979) also indicated that *U. peregrina* is rarely found below 2,200m in surface sediments of the Mid Atlantic Ridge. *Hoeglundina elegans* was reported by Lohman (1978) to be indicative of NADW and was found to be abundant between 2,500 and 3,500m in the western South Atlantic Ocean. The *Uvigerina* fauna recovered by Schnitker (1974) may be representative of the IOM described by Streeter and Shackleton (1979) and indicate the presence of Mediterranean Waters. The *Hoeglundina* fauna probably represents NADW.

Lohman's (1978) studies are not directly applicable to this project as its main purpose was not to relate the presence of abundant benthonic species to deep water masses but rather to identify the specific chemical or physical parameters to which these species responded. He was able to observe that the abundance of *Alabamina ? umbonifera* is related to decreasing temperatures and increasing alkalinity, depth and silica content. With decreasing oxygen content the abundance of *Uvigerina peregrina*, *Globocassidulina subglobosa* and *Ehrenbergina* sp. increases while the abundance of miliolids and *Cibicides wuellerstorfi* decreases. Some of these observations were verified by the author. *Alabamina ? umbonifera* is present at the deepest stations (74-021-08) where temperatures are low (1.9-2.0°C). But is also present at stations 68-22-145 and 68-22-158, located in relatively shallow warm waters (2.670 and 2.770m, respectively and 3.0-3.2°C). Though values for oxygen are not available, the only station where *Uvigerina peregrina* was recovered in high numbers (station 74-021-08) has low numbers of miliolids. Values for *Cibicides wuellerstorfi* and *Globocassidulina subglobosa*, though not mutually exclusive, vary indirectly at several stations.

CHAPTER 4

SUMMARY OF RESULTS

1. The purpose of the study was to identify the benthonic foraminiferal species which are indicative of deep water masses circulating in the western North Atlantic Ocean, within the constraints imposed by the restricted areal and bathymetric distribution of the available samples.
2. The late Holocene age of the samples is established on the basis of sedimentological studies and planktonic foraminifera distribution.
3. Results indicate the presence of four benthonic foraminiferal assemblages, defined on the repeated occurrence of abundant species in each sample. These assemblages are referred to the NADW and the Labrador Sea Water masses.
4. Assemblage I is characterized by *Epistominella exigua* (Brady), *Eponides tumidulus* (Brady) and *Loxostomum truncatum* Phleger and Parker which comprise 50% of the sample population. It is found at eleven Ridge stations with temperature-salinity values indicative of NADW and was also recognized at two Ridge area and three Nova Scotian Slope stations mixed with species indicative of other water masses.
5. Assemblage II is tentatively defined on the presence of *Alabamina ? umbonifera* (Cushman). Though recognized in previous studies the existence of this assemblage in the study area is proposed with a lesser degree of confidence than that of Assemblage I. Assemblage II occurs at one Ridge station only. *A. ? umbonifera* is abundant in two samples from the Ridge area and one from the Nova Scotian Slope. In one of the Ridge samples it is found associated with species characteristic of NADW. In the other Ridge sample it is the only abundant species present. There it is suspected that species usually associated with Assemblage I have been selectively removed by bottom currents. In the Nova Scotian Slope sample *A. ? umbonifera* is present with species indicative of NADW.
6. Assemblage III is defined by *Elphidium excavatum* (Terquem) and *Cassidella complanata* (Egger). It has not been previously described in the literature and because its presence is established on the basis of two samples only, the proposal is tentative. It is restricted to the upper part of the Nova Scotian Slope where temperature-salinity values are indicative of Labrador Sea Water. It is also present, combined with fauna characteristic of Assemblage I, at another Nova Scotian Slope station which is located in deeper waters.

7. Assemblage IV was recognized at only one station which is located on the slope of the Grand Banks. The existence of the assemblage is questionable and it is put forward herein only as a suggestion. *Cassidulina obtusa* Williamson characterizes this assemblage. Temperature-salinity values are indicative of Labrador Sea Water. Assemblages III and IV differ in that the associated substrates (silts) are predominantly biogenic material in the case of Assemblage III and mineral material in the case of Assemblage IV.

CHAPTER 5

SYSTEMATICS

General Statement.

The classification used in the systematic description is that of the Treatise on Invertebrate Paleontology, Part C, Protista 2, volumes 1 and 2, Foraminifera (Loeblich and Tappan, 1964).

References cited in the synonymy have been abbreviated to avoid unnecessary repetition. The complete reference for each author cited can be found in the References Cited at the end of this work.

In a few instances positive identification could not be achieved. This is the case when insufficient numbers of specimens were recovered, when the specimens were broken, or when only immature forms were present. The size range following each species description is that of the sampled species population. The size of the figured specimens can be calculated by measuring the figure and dividing by the given magnification factor.

All figured and unfigured specimens have been deposited in the Carleton University collection under the series CUCL.

Order FORAMINIFERIDA Eichwald, 1830

Family ASTRORHIZIDAE Brady, 1881

Genus RHIZAMMINA Brady, 1879

RHIZAMMINA INDIVISA Brady

Rhizammina indivisa BRADY, 1884, pl.29, figs.5-7 (*fide* Barker, 1960) – CUSHMAN, 1918, p.32, pl.12, figs. 7-12.

REMARKS: Differs from *Reophax agglutinatus* in the shape of the test which is cylindrical and not tapering, in the colour of the cement which is reddish brown as opposed to grey; and finally in the type of particles used as building material. *Rhizammina indivisa* is composed of foraminifera of various types and sizes along with sand grains whereas *Reophax agglutinatus* is made up exclusively of foraminifera of similar size. Rare; a few broken fragments recovered at 4 slope stations.

Length: 0.63-1.13 mm.; diameter: 0.25-0.38 mm.

Genus HYPERAMMINA Brady, 1878

HYPERAMMINA ELONGATA Brady

Hyperammina elongata BRADY, 1878, p.433, pl.20, fig.2 (*fide* Ellis & Messina, 1940, *et seq.*) – CUSHMAN, 1918, p.74, pl.29, fig.4. – LOEBLICH & TAPPAN, 1953, p.19, pl.1, fig.6.

Hyperammina sp. LAGOE, 1977, pl.1, fig.1.

REMARKS: Only rare specimens are found at most stations except station 74-021-7G on the slope off Nova Scotia, where the species is considered abundant. It contributes to the sample's uniqueness in being dominated by arenaceous species. The size of the sand grains used in the construction of the test varies. Specimens recovered on the slopes use large sand particles as building material, forming a rough and uneven test, while specimens recovered in the Ridge area are composed of smaller sand grains producing an almost smooth test. Because all specimens are broken, the diameter is used as a guide to distinguish between small and large individuals.

Length: 0.75-1.63 mm.; diameter: 0.11-0.3 mm.

Family AMMODISCIDAE Reuss, 1862

Genus AMMODISCUS Reuss, 1862

AMMODISCUS INCERTUS (d'Orbigny)

Operculina incerta D'ORBIGNY, 1839a p.49, pl.6, figs.16,17. (*fide* Ellis & Messina, 1940, *et seq.*).

Ammodiscus incertus (d'Orbigny), BRADY, 1884, pl.39, figs.1-3. (*fide* Barker, 1960)
– CUSHMAN, 1918, p.95, pl.39, figs.1-8.

REMARKS: Only one broken specimen recovered.

Length: 0.21 mm.; diameter: 0.04 mm.

Genus **GLOMOSPIRA** Rzehak, 1885

GLOMOSPIRA CHAROIDES (Jones & Parker)

Plate 1, figure 1

Trochammina squamata Jones and Parker var. *charoides* JONES & PARKER, 1860, p.304. (*fide* Ellis & Messina, 1940, *et seq.*).

Ammodiscus charoides (Jones and Parker), BRADY, 1884, p.334, pl.38, figs.10-16. (*fide* Barker, 1960).

Glomospira charoides (Jones and Parker), CUSHMAN, 1918, p.100, pl.36, figs.10-15.

REMARKS: Rare; a total of 21 specimens was recovered at 8 stations both from the slope and from the Ridge area.

Diameter: 0.1-0.13 mm.; height: 0.08-0.09 mm.

GLOMOSPIRA GORDIALIS (Jones & Parker)

Plate 1, figure 2

Trochammina squamata Jones and Parker var. *gordialis* JONES & PARKER, 1860, p.304. (*fide* Ellis & Messina, 1940, *et seq.*).

Glomospira gordialis (Jones and Parker), LOEBLICH & TAPPAN, 1964, p.C212 fig.122,6. – LAGOE, 1977, p.116, pl.1, fig.11.

REMARKS: The initial stage of *G. gordialis* resembles that of *G. charoides*. They differ in that *G. gordialis* is irregularly enrolled while *G. charoides* is streptospirally enrolled.

G. gordialis is slightly more abundant than *G. charoides* but it is still considered as rare.

Most of the specimens were recovered from the Ridge area with one slope station yielding 5 individuals.

Diameter: 0.14-0.24 mm.; height: 0.10 mm.

Family **HORMOSINIDAE** Haeckel, 1894

Genus **REOPHAX** Montfort, 1808

REOPHAX AGGLUTINATUS Cushman

Reophax agglutinatus CUSHMAN, 1913b, p.637, pl.79, fig.6.

REMARKS: Test made up of foraminiferal tests incrustated in a grey-white cement.

Rare; a few broken pieces found at 4 stations.

Length: 0.44-0.69 mm.; diameter: 0.24-0.29 mm.

REOPHAX BACILLARIS (Brady)

Lituola (Reophax) bacillaris BRADY, 1881, p.49, type fig. in Brady, 1884, pl.30, figs.

23,24 (as *Reophax bacillaris*), (fide Ellis & Messina, 1940, et seq.).

Reophax bacillaris (Brady), CUSHMAN, 1920, p.19, pl.5, fig.6.

REMARKS: Differs from *R. agglutinatus* by being composed of sand grains, not foraminifera and in having as many as 30 chambers. The earlier chambers are close and indistinct; the later ones are distinct with constrictions between them. Only broken fragments were recovered. The largest piece was measured as it was the only one deemed to be complete enough to be of significance. Rare; a few fragments recovered at 2 stations.

Length: 0.35 mm.; diameter: 0.36 mm.

REOPHAX DISTANS (Brady)

Lituola (Reophax) distans BRADY, 1881, p.50, type fig. in Brady, 1884, pl.31, figs.

18-22 (as *Reophax distans*). (fide Ellis & Messina, 1940, et seq.).

Reophax distans (Brady), CUSHMAN, 1920, p.12, pl.3, figs.5,6.

REMARKS: No connected chambers were recovered.

The size of the sand grains used in building the test varies from coarse to fine with a corresponding texture varying from irregular to smooth. The specimens are all reddish brown in color. Rare; with a total of 15 globular chambers distributed amongst 4 stations.

Diameter: 0.15-0.30 mm.; length: 0.20-0.31 mm.

Family LITUOLIDAE de Blainville, 1825

Genus HAPLOPHRAGMOIDES Cushman, 1910

HAPLOPHRAGMOIDES ROTALUM (Brady)

Haplophragmium rotalum BRADY, 1881, p.50. (fide Ellis & Messina, 1940, et seq.).

Haplophragmoides rotalum (Brady), CUSHMAN, 1920, p.47, pl.9, figs.3,4.

REMARKS: Test typically planispiral and biconcave, made up of coarse sand grains. Color ranges from grey to reddish brown. Rare; single specimens recovered at 3 stations and 7 specimens were recovered at a 4th station.

Length: 0.33-0.73 mm.; width: 0.25-0.59mm.; thickness: 0.16-0.31 mm.

HAPLOPHRAGMOIDES SPHAERILOCULUM Cushman

Plate 1, figures 4-5

Haplophragmoides sphaeriloculum CUSHMAN, 1910, p.107, t.f.165, - 1920, p.44, pl.8, fig.3.

Length: 0.13-0.30 mm.; width: 0.10-0.23 mm.; thickness: 0.08-0.23 mm.

HAPLOPHRAGMOIDES SUBGLOBOSUM (G.O. Sars)

Lituola subglobosa M. SARS, 1869, p.250 (nomen nudum). SARS, G.O., 1872, p.253. (fide Ellis & Messina 1940. et seq.)

Haplophragmoides subglobosum (G.O. Sars), CUSHMAN, 1910, p.105, type fig., p.106, text figs.162-164; - 1920 p.45, pl.8, fig.5.

REMARKS: Cushman indicated that the individuals range in diameter from 1.5-2.5 mm.

The largest specimen recovered in this collection is 0.6 mm. in diameter. Caralp, Lamy and Pujos (1970) reported that specimens from the gulf of Gascogne, recovered at depths greater than 1500 metres, are only .39 mm. in diameter. Rare; 17 individuals recovered from 4 stations.

Diameter: 0.14-0.81 mm.; thickness: 0.10-0.44 mm.

Genus CYCLAMMINA Brady, 1879

CYCLAMMINA TRULLISATA (Brady)

Trochammina trullissata BRADY, 1879, p.56, pl.5, figs.10-11. (fide Ellis & Messina, 1940, et seq.).

REMARKS: All specimens have the final chamber broken. Rare; single specimens found at 4 stations in the Ridge area.

Diameter: 0.18-0.38 mm.; 0.08-0.15 mm.

Genus ALVEOLOPHRAGMIUM Shchedrina, 1936

ALVEOLOPHRAGMIUM WIESNERI (Parr)

Labrospira wiesneri PARR, 1950, p.272, pl.4, figs.25,26.

Trochammina trullissata BRADY, 1884, pl.40, figs.14,15 (not fig.13, pl.40). (fide Barker, 1960):

Haplophragmoides trullissata (Brady), CUSHMAN, 1918, p.43, pl.9, fig.5.

REMARKS: Rare; single specimens found at 3 stations, and 4 specimens found at another station.

Diameter: 0.21-0.38 mm.; thickness: 0.09-0.10 mm.

Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES AGGLUTINANS (d'Orbigny) emend. Bartenstein

Spiroloculina agglutinans D'ORBIGNY, 1846, p.137, pl.7, figs.10-12. (*fide* Ellis & Messina, 1940, *et seq.*).

Haplophragmium agglutinans (d'Orbigny), BRADY, 1884, pl.32, figs.22,23. (*fide* Barker, 1960).

Haplophragmium agglutinans (d'Orbigny), MARKS, 1951, p.35. (*fide* Ellis & Messina, 1940, *et seq.*).

Ammobaculites agglutinans (d'Orbigny), BARTENSTEIN, 1952, p.318, pl.1, fig.1, pl.2, figs.10-16. (*fide* Ellis & Messina, 1940, *et seq.*).

REMARKS: Very rare, only one specimen recovered.

Length: 0.29 mm.; thickness: 0.06 mm.

Genus AMMOMARGINULINA Wiesner, 1931

AMMOMARGINULINA FOLIACEA (Brady)

Haplophragmium foliaceum BRADY, 1881, p.50, type fig. in Brady, 1884, pl.33, figs.20-25. (*fide* Ellis & Messina, 1940, *et seq.*).

Ammobaculites foliaceus (Brady), CUSHMAN, 1920, p.64, pl.13, figs.1,2.

REMARKS: No more than 2 chambers developed in the uncoiled stage.

Length: 0.21-0.26 mm.; thickness: 0.063 mm.

Family TEXTULARIIDAE Ehrenberg, 1838

Genus TEXTULARIA Defrance in de Blainville, 1824

TEXTULARIA CANDEIANA d'Orbigny

Plate 1, figures 3,5

Textularia candeiana D'ORBIGNY, 1839a, p.143, pl.1, figs.25-27. (*fide* Ellis & Messina, 1940, *et seq.*). Cushman, 1922a, p.8, pl.1, figs.1-3. — ROCHA & UBALDO, 1964, p.29, est.1, fig.4.

REMARKS: Rare, all 17 specimens were recovered from one station in the Median Valley of the Mid Atlantic Ridge.

Length: 0.14-0.21 mm.; width: 0.10-0.15 mm.; thickness: 0.05-0.08 mm.

TEXTULARIA PSEUDOGRAMEN Chapman & Parr

Textularia gramen BRADY (non d'Orbigny), 1884, pl.43, figs.9-10. (*fide* Barker, 1960).

Textularia pseudogramen CHAPMAN & PARR, 1937, p.153, type fig. in Brady, op. cit. pl.43, figs.9-10. (*fide* Ellis & Messina, 1940, *et seq.*).

REMARKS: Only two broken specimens were recovered so that the identification is tentative. Brady's illustration shows specimens with one angular side (as seen from above) and one rounded side. The two specimens I have show both sides as being

angular. This could result from the fact that the final chambers have been broken off.

Rare; single specimens recovered at 2 stations.

Length: 0.31 mm.; width: 0.29 mm.; Thickness: 0.16 mm.

Genus SIPHOTEXTULARIA Finlay, 1939

SIPHOTEXTULARIA AFFINIS (Fornasini)

Plate 1, figures 7-8

Sagrina affinis FORNASINI, 1883, p.189, pl.2, fig.10. (*vide* Ellis & Messina, 1940, *et seq.*).

Siphotextularia affinis (Fornasini), PHLEGER & PARKER, 1951, p.4, pl.1, fig.22.

REMARKS: Common in the Ridge area but absent from the slopes. The number of specimen per station ranges from 1-10.

Length: 0.16-0.43 mm.; width: 0.13-0.23 mm.; thickness: 0.09-0.18 mm.

SIPHOTEXTULARIA aff. AFFINIS (Fornasini)

REMARKS: These specimens differ from the type by being spinose. The sutures are obscured by a multitude of short spines. The test appears to be circular when viewed from above but is biserial throughout and has the typical siphotextularid aperture. Thirteen specimens found at one station only, in the Median Valley of the Mid Atlantic Ridge.

Length: 0.14-0.33 mm.; width: 0.08-0.14 mm.; thickness: 0.08-0.1 mm.

Family TROCHAMMINIDAE Schwager, 1877

Genus TROCHAMMINA Parker & Jones, 1859

TROCHAMMINA ANTARCTICA Parr

Trochammina antarctica PARR, 1950, p.280, pl.5, figs.2-4

REMARKS: Characterised by its numerous small chambers with radial sutures on the spiral side and by 5 or 6 inflated chambers with depressed sutures on the umbilical side. Parr describes the wall as being coarsely arenaceous but having a smooth finish. The specimens I have are made up of very fine grains. This could simply be a function of the material available for construction. Rare; 5 specimens recovered at 3 stations.

Diameter: .11-.29 mm.; thickness: .09-.16 mm.

TROCHAMMINA GLOBIGERINIFORMIS (Parker & Jones)

Plate 1, figure 9, Plate 2, figure 1

Lituola nautiloidea Lamark var. *globigeriniformis* PARKER & JONES, 1865, p.407, pl.15, figs.46-47, pl.17, figs.96-98. (*fide* Ellis & Messina, 1940, *et seq.*).
Haplophragmium globigeriniformis (Parker & Jones), BRADY, 1884, pl.35, fig.10. (*fide* Barker, 1960).
Trochammina globigeriniformis (Parker and Jones), CUSHMAN, 1920, p.78, pl.16, figs. 5,6.

REMARKS: Some specimens have tests entirely made up of planktonic foraminifera. This is not mentioned in any reference, but as other specimens incorporate both sand grains and foraminifera in their tests, it is assumed that when sand grains are not available foraminifera are used interchangeably. Therefore, in this case the nature of the detrital material used in the construction of the test is not judged to be of specific importance. Present at all but 3 of the Ridge stations, it is also found in one of the slope samples, but nowhere is it abundant.

Diameter: 0.14-0.68 mm.; thickness: 0.11-0.56 mm.

TROCHAMMINA PAUCILOCLATA Brady

Plate 2, figures 2-3

Trochammina pauciloculata BRADY, 1879, p.58, pl.5, figs.13-14. (*fide* Ellis & Messina, 1940, *et seq.*).
Ammonochilostoma pauciloculata (Brady), CUSHMAN, 1920, p.86.

REMARKS: The species is common in the Ridge area but the number of specimens is low. It is absent from the slope.

Diameter: 0.1-0.45 mm.; thickness: 0.08 - 0.25 mm.

TROCHAMMINA ROTALIFORMIS Wright

Trochammina rotaliformis Wright, HERON-ALLEN & EARLAND, 1911, p.309, type fig. in Balkwill & Wright, 1885, pl.13, figs.11-12. (*fide* Ellis & Messina, 1940, *et seq.*) - CUSHMAN, 1920, p.77, pl.16, figs.1-2.
Trochammina inflata (Montagu) var., BALKWILL & WRIGHT, 1885, p.331, pl.13, figs.11,12 (*fide* Ellis & Messina, 1940, *et seq.*).

REMARKS: Characterized by its loosely enrolled chambers, depressed umbilical region and rather flat chambers as opposed to the usually inflated chambers seen in the other species. Rare; 9 specimens found at 4 stations.

Diameter: 0.11-0.25 mm.; thickness: 0.04-0.06 mm.

TROCHAMMINA SOROSA Parr

Trochammina sorosa PARR, 1950, p.278, pl.5, figs.15-17.

REMARKS: *T. sorosa* is characterized by its high spire, giving it a subconical appearance.

Rare; 4 specimens found at 2 stations.

Diameter: 0.13-0.16 mm.; thickness: 0.09-0.13 mm.

Family ATAXOPHRAGMIIDAE Schwager, 1877

Genus DOROTHIA Plummer, 1931

DOROTHIA EXILIS Cushman

Dorothia exilis CUSHMAN, 1936, p.30, pl.4, fig.17; - 1937a, p.98, pl.11, figs.1,2.

Gaudryina filiformis BRADY (not Berthelin), 1884, pl.46, fig.12. (fide Barker, 1960).

REMARKS: Only 2 specimens were found at a station on the slope off Nova Scotia.

Length: 0.49-0.83 mm.; thickness: 0.26-0.28 mm.

DOROTHIA SCABRA (Brady)

Gaudryina scabra BRADY, 1884, pl.44, figs.12-13, pl.46, fig.7. (fide Barker, 1960).

REMARKS: Only one specimen recovered. It has a broken chamber and only one pair of biserial chambers developed so that the identification is tentative.

Length: 0.19 mm.; thickness: 0.14 mm.; breadth: 0.21 mm.

Genus EGGERELLA Cushman, 1933

EGGERELLA BRADYI (Cushman)

Plate 2, figures 7-8

Verneuilina bradyi CUSHMAN, 1911, p.54, p.55, tf.87.

Eggerella bradyi (Cushman), PHLEGER, PARKER & PEIRSON, 1953, p.27, pl.5, figs.8,9.

REMARKS: Present in all but 4 samples, this is a fairly common species with the number of specimens per station ranging between 1 and 21.

Length: 0.31-0.59 mm.; thickness: 0.24-0.030 mm.

EGGERELLA SCABRA (Williamson)

Bulimina scabra WILLIAMSON, 1858, p.65, pl.5, figs.136-137. (fide Ellis & Messina, 1940, et seq.).

Verneuilina polystropha (Reuss), BRADY, 1884, pl.47, figs. 15-17. (fide Barker, 1960).

Eggerella scabra (Williamson), CUSHMAN, 1937a, p.50, pl.5, figs.10-11.

REMARKS: Initial end broken on single slope station specimen.

Length: 0.18 mm.; breadth: 0.09 mm.

Genus KARRERIELLA Cushman, 1933

KARRERIELLA BRADYI (Cushman)

Gaudryina bradyi CUSHMAN, 1911, p.67, t.f.107.

KarrerIELla bradyi (Cushman), ROCHA & UBALDO, 1964, p.34, est.1, fig.11.

REMARKS: These large specimens are easy to recognize. The species is common in the Ridge area, occurring at 6 stations. The number of specimens is low. Two individuals were also recovered at a station on the Scotian slope.

Length: 0.35-0.84 mm.; breadth: 0.25-0.41 mm.

Family NUBECULARIIDAE Jones, 1875

Genus OPHTHALMIDIUM Kübler & Zwingli, 1870

OPHTHALMIDIUM ACUTIMARGO (Brady)

Spiroloculina acutimargo BRADY, 1884, pl.10, figs.12-15. (*fide* Barker, 1960).

Spirophthalmidium acutimargo (Brady), PHLEGER, PARKER & PEIRSON, 1953, p.29, pl.5, figs.28,29. — CUSHMAN, 1929, p.90, pl.22, fig.1.

Ophthalmidium acutimargo (Brady), LOEBLICH & TAPPAN, 1964, p.C448, fig.340,2.

REMARKS: Single specimens found at 3 stations, at the 4th station 9 specimens were recovered. There are only 2 adult specimens in the entire population which is limited to the Ridge area.

Length: 0.09-0.27 mm.; thickness: 0.01 mm.; breadth: 0.08-0.13 mm.

OPHTHALMIDIUM PUSILLUM (Earland)

Spiroloculina pusilla EARLAND, 1934, p.47, pl.1, figs.3-4.

Spiroloculina tenuis (Czjzek), BRADY, 1884, pl.10, figs.9-10. (*fide* Barker, 1960).

Sigmoilina tenuis PHLEGER, PARKER & PEIRSON (not Czjzek), 1953, p.28, pl.5, fig.18.

REMARKS: This species is distinguished from *O. acutimargo* by its narrow, tightly enrolled chambers which give it a leaf-like appearance. Rare; one or two specimens recovered at 5 Ridge stations.

Length: 0.26-0.43 mm.; thickness: 0.03 mm.; breadth: 0.05-0.09 mm.

Genus CORNULOCULINA Burbach, 1886

CORNULOCULINA INCONSTANS (Brady)

Hauerina inconstans BRADY, 1879, p.168. Type fig. in Brady, 1884, pl.12, figs.5,7-8. (as *Ophthalmidium inconstans*) (*fide* Ellis & Messina, 1940, *et seq.*).

Ophthalmidium inconstans (BRADY), 1884, pl.12, figs. 5, 7-8 (*fide* Barker, 1960). —
 PHLEGER, PARKER & PEIRSON, 1953, p.29, pl.5, fig.27. — CUSHMAN &
 HENBEST, 1940, p.36, pl.9, fig.11.
Cornuloculina inconstans (Brady), LOEBLICH & TAPPAN, 1964, p.448, figs. 340, 3-7.

REMARKS: As none of the individuals assigned to this species have developed the loose coiling stage, it is assumed that all of them are juveniles. They have a circular outline. The initial globular proloculus is followed by a secondary chamber of approximately 3 whorls in length. The following chambers of one and a half coil in length are closely enrolled as opposed to the more loosely coiled chambers illustrated by Loeblich and Tappan. Rare, a total of 10 individuals divided amongst 6 stations, all located in the Ridge area.

Diameter: 0.23-0.34 mm.; thickness: 0.03-0.04 mm.

Genus SPIROLOCULINA d'Orbigny, 1826

SPIROLOCULINA ROTUNDA d'Orbigny

Spiroloculina rotunda d'Orbigny?, BARKER, 1960, pl.9, figs.15,16.

REMARKS: The synonymy of this species is confusing. Barker gives two references: *Spiroloculina limbata* d'Orbigny and *Spiroloculina excavata* d'Orbigny, both of which have a variety named *rotundata* and neither of which is illustrated (*Spiroloculina limbata* var. *rotundata* Silvestri, 1898 and *Spiroloculina excavata* d'Orbigny var. *rotundata* Costa, 1856). No other mention of this species was found in the literature. Rare; single specimens occur at 3 stations and 2 individuals recovered at a fourth one. All stations are in the Ridge area.

Length: 0.16-0.56 mm.; width: 0.15-0.49 mm.; thickness: 0.05-0.19 mm.

Family MILIOLIDAE Ehrenberg, 1839

Genus QUINQUELOCULINA d'Orbigny, 1826

QUINQUELOCULINA AMYGDALOIDES (Brady)

Miliolina amygdaloides BRADY, 1884, pl.6, Fig.10. (*fide* Barker, 1960).
Quinqueloculina amygdaloides (Brady), CUSHMAN, 1917, p.51.

REMARKS: Brady describes this species as being small, with a smooth surface and tapering ends. The specimens recovered possess these characteristics but they do not have a sharp periphery as described by Brady. Found in the Ridge area only, it occurs at 9 stations with a few specimens per station being the rule except for one station

where 17 individuals were recovered.

Length: 0.18-0.5 mm.; width: 0.06-0.24 mm.; thickness: 0.08-0.2 mm.

QUINQUELOCULINA LAMARCKIANA d'Orbigny

Plate 3, figures 1-2

Quinqueloculina lamarckiana D'ORBIGNY, 1839a, p.189, pl.11, figs.14,15. (fide Ellis & Messina, 1940, et seq.). - CUSHMAN, 1929, p.26, pl.2, fig.6.

REMARKS: The adult specimens are nearly as broad as they are long, the chambers are triangular in transverse section and the angles subacute but not carinate. The juveniles are nearly twice as long as broad and the aperture is on an extended neck. Common: found at most stations both in the slope and in the Ridge area; the number of specimens per sample varies between 1 and 13.

Length: 0.15-0.5 mm.; width: 0.1-0.34 mm.; thickness: 0.08-0.29 mm.

QUINQUELOCULINA SEMINULUM (Linnaeus)

Conchula minima PLANCUS, 1739, pl.2, fig.1. (fide Ellis & Messina, 1940, et seq.).
Tubulus etc. GUALTIERI, 1742, pl.19, fig.1. (fide Ellis & Messina, 1940, et seq.).
Serpula seminulum LINNAEUS, 1758, p.786, type fig. Plancus, pl.2, fig. 1, Gualtieri, pl.19, fig.5. (fide Ellis & Messina, 1940, et seq.).
Quinqueloculina seminulum (Linnaeus), CUSHMAN, 1929 p.24, pl.2, fig.1,2. - VILKS, 1969, p.47, pl.2, fig.10.

REMARKS: Similar to *Quinqueloculina vulgaris* except that it is longer than wide and has a rounded periphery. Not recovered from the slope area. The species is common in the Ridge area but the number of specimens recovered is low.

Length: 0.11-0.69 mm.; width: 0.09-0.54 mm.; thickness: 0.06-0.38 mm.

QUINQUELOCULINA VENUSTA Karrer

Plate 3, figures 4-5

Quinqueloculina venusta KARRER, 1868, p.147, pl.2, fig.6. (fide Ellis & Messina, 1940, et seq.). - PHLEGER, PARKER & PEIRSON, 1953, pl.5, figs.11,12. - LOHMAN, 1978, p.25, pl.4, figs. 8,9.
Miliolina venusta (Karrer), FLINT, 1897, p.298, pl.44, fig.2.

REMARKS: Test twice as long as wide; the aperture projecting only slightly in adults, more so in juveniles. Mature specimens characterised by the development of well defined keels along the margins of the final chambers. These keels are absent in the juvenile forms, resulting in a subrounded periphery. This is the most abundant species

of the genus. It is rare in the slope area with a single specimen occurring at one station.

It is present in all but one of the Ridge samples.

Length: 0.21-0.76 mm.; width: 0.06-0.39 mm.; thickness: 0.05-0.19 mm.

QUINQUELOCULINA VULGARIS d'Orbigny

Plate 3, figures 7-8

Frumentaria semiluna SOLDANI, 1789-1799, p.228, fig.E? (not available) (*fide* Ellis & Messina, 1940, *et seq.*).

Quinqueloculina vulgaris D'ORBIGNY, 1826, p.302, type fig. in PARKER, JONES & BRADY, 1871, pl.8, fig.15: fig.E, after Soldani op. cit., also Fornasini, 1902, p.23, fig.13: Dal disegno inedito di d'Orbigny. (*fide* Ellis & Messina, 1940, *et seq.*).
- CUSHMAN, 1921, p.417, pl.87, fig.1, - 1929, p.25, pl.2, fig.3.

REMARKS: In transverse section *Quinqueloculina vulgaris* has a triangular outline with rounded edges. The aperture has a bifid tooth. Found at 6 stations in the Ridge area, the number of specimens per sample varies between 4 and 16.

Length: 0.14-0.82 mm.; width: 0.1-0.7 mm.; thickness: 0.06-0.5 mm.

Genus PYRGO DeFrance, 1824

PYRGO BULLOIDES (d'Orbigny)

Biloculipa bulloides D'ORBIGNY, 1826, p.297, pl.16, figs.1-4. (*fide* Ellis & Messina, 1940, *et seq.*) - FLINT, 1897, p.293, pl.38, fig.5.

Biloculina lucernula Schwager, CUSHMAN, 1921, p.475, pl.98, fig.1 (not pl.97, fig.2).

REMARKS: Two of the three specimens are typical *Pyrgo bulloides* (d'Orbigny), the other one resembles *Pyrgo lucernula* (Schwager) in that it has a groove along one side only, whereas *P. lucernula* (Schwager) is described as having a deep groove on both sides. Rare; present only at 2 stations.

Length: 0.8-2.0 mm.; width: 0.75-1.35 mm.; thickness: 0.7-1.35 mm.

PYRGO DEPRESSA (d'Orbigny)

Testaceographiae etc., SOLDANI, 1789-1799, p.231, tab.156, fig.yy,zz (not available.)

Biloculina depressa D'ORBIGNY, 1826 p.298, type fig. in PARKER, JONES & BRADY, 1871, pl.8, fig.5 (fig. after Soldani, op. cit.) (*fide* Ellis & Messina, 1940, *et seq.*). - FLINT, 1897, p.294, pl.40, fig.1).

Pyrgo depressa (d'Orbigny), BOLTOVSKOY, 1959b, p.55, lam.5, fig.10 (not figs.11,12,15).

REMARKS: Rare; a few specimens found at 7 stations both in the Ridge and in the slope area.

Diameter: 0.45-1.1 mm.; thickness: 0.25-0.65 mm.

PYRGO MURRHINA (Schwager)

Bilqulina murrhina SCHWAGER, 1866, p.203, pl.4, fig.15. (fide Ellis & Messina, 1940, et seq.).

Pyrgo murrhina (Schwager), PHLEGER & PARKER, 1951, p.7, pl.3, fig.11.

REMARKS: *Pyrgo murrhina* differs from *P. depressa* in that the aperture is circular with a neck and has a bifid tooth whereas *P. depressa* has a broad aperture without a neck and has a wide tooth. It also has a slight fold at the aboral end while *P. murrhina* has a sinus, often with spines at each angle. The juveniles are hard to categorize. They are elongated, have a long tubular neck and a rounded margin without sinus or fold. Because there exists what is believed to be a complete gradation between juvenile and mature specimens they were assigned to *P. murrhina*, even though Cushman (1921) describes juveniles as circular, with a neck not exceeding the periphery. This most common species of the genus is found at nearly every station though the number of specimens is usually low. Specimens are often broken and hard to identify.

Length: 0.31-0.75 mm.; width: 0.24-0.73 mm.; thickness: 0.18-0.41 mm.

Genus SIGMOILOPSIS Finlay, 1947

SIGMOILOPSIS SCHLUMBERGERI (Silvestri)

Plate 2, figures 4-5

Planispirina celata & *Sigmoilina* (*Planispirina*) *celata* SCHLUMBERGER, 1887, p.111 & 18 (481-483). text figs. 6 & 7, tav.7, figs. 12 & 14. (fide Ellis & Messina, 1940, et seq.).

Sigmoilina schlumbergeri SILVESTRI, 1904, p.267, type fig. in Schlumberger, 1887, pl.7, figs.12-14, p.481, t.f.6, p.482, t.f.7. (fide Ellis & Messina, 1940, et seq.) - CUSHMAN, 1929, p.49, pl.11, figs.1-3.

Sigmoilopsis schlumbergeri (Silvestri), LOEBLICH & TAPPAN, 1964, p.C466, fig.353,2.

REMARKS: This species is common though not abundant except for one station located on the slope off Nova Scotia where 34 specimens were recovered.

Length: 0.15-0.86 mm.; width: 0.1-0.5 mm.; thickness: 0.06-0.35 mm.

Genus MILIOLINELLA Wiesner, 1931

MILIOLINELLA CIRCULARIS (Bornemann)

Plate 2, figures 6,9

Triloculina circularis BORNEMANN, 1855, p.349, pl.19, fig.4. (fide Ellis & Messina, 1940, et seq.) - CUSHMAN, 1929, p.58, pl.13, figs.6,7, pl.14, figs. 1,2.

REMARKS: Common though not abundant, it occurs at 10 stations in the Ridge area.

Length: 0.15-0.51 mm.; breadth: 0.10-0.24 mm.; thickness: 0.13-0.50 mm.

Family NODOSARIIDAE Ehrenberg, 1838

Genus NODOSARIA Lamarck, 1812

NODOSARIA CALAMORPHA Reuss

Nodosaria calamorpha REUSS, 1866, p.129, pl.1, figs.15-19. — BRADY, 1884, pl.61, fig.12. (*fide* Ellis & Messina, 1940, *et seq.*). — PARKER, 1964, p.626, pl.97, figs.21,22. — ROCHA & UBALDO, 1964, p.49, est.3, fig.12.

REMARKS: Only 3 specimens are positively identified, the fourth one has only the proloculus and the first chamber developed which is insufficient to determine its identity. A common problem in the Nodosariidae is that numerous immature specimens were recovered with only one or two chambers developed. In the case of genera such as Dentalina, Lenticulina or Nodosaria I often found it impossible to decide what genus, let alone what species, the individual belonged to based on so little information. Usually such specimens are assigned to the most abundant mature species.

Length: 0.36 mm.; thickness: 0.10 mm.

NODOSARIA FLINTI Cushman

Nodosaria flinti CUSHMAN, 1923, p.85, pl.14, fig.1.
Nodosaria obliqua (Linnaeus), BRADY, 1884, pl.64, figs.20-22. (*fide* Barker, 1960).

REMARKS: Only one broken specimen was recovered from a station on the slope off Nova Scotia.

Length: 1.63 mm.; thickness: 0.16 mm.

NODOSARIA RADICULA (Linnaeus) var. GLANDULIFORMIS Dervieux

Nodosaria radicula (Linnaeus) var. *glanduli formis* DERVIEUX, 1894, p.599, pl.5, figs.3-7 (*fide* Ellis & Messina, 1940, *et seq.*). — ROCHA & UBALDO, 1964, p.51, est.3, fig.3.
Nodosaria radicula (Linnaeus), BRADY, 1884, pl.61, figs.28-31. (*fide* Barker, 1960).

REMARKS: Single specimens found at three Ridge stations.

Length: 0.26-0.44 mm.; width: 0.14-0.21 mm.

Genus DENTALINA Risso, 1826

DENTALINA INORNATA d'Orbigny var. BRADYENSIS (Dervieux)

Nodosaria inornata d'Orbigny var. *bradyensis* DERVIEUX, 1894, p.610, pl.5, figs. 30-31. (*fide* Ellis & Messina, 1940, *et seq.*).

Nodosaria communis (pars), BRADY, 1884, pl.62, figs.19-20. (*fide* Barker, 1960).

REMARKS: Single specimens are found at 3 stations and occurs both in the slope and in the Ridge area. Differs from the type in having sutures that are only slightly depressed.

Length: 0.65-0.71 mm.; thickness: 0.13-0.18 mm.

Genus LAGENA Walker & Jacob in Kanmacher, 1798

LAGENA ADVENA Cushman

Lagena advena CUSHMAN, 1923, p.6, pl.1, fig.4.

Lagena striata (part) BRADY (not d'Orbigny), 1884, pl.57, figs.29,30. — SIDEBOTTOM (part). 1912, p.389, pl.15, fig.9. (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena striata (d'Orbigny) var. *haidingeri* CUSHMAN (not Czjzek), 1913a, p.19, pl.7, fig.6.

REMARKS: The specimens recovered resemble Brady's fig.29, pl.57, none of the more globose forms (as in Brady's fig.30) were observed. Single specimens occur in the Ridge area only.

Length: 0.22-0.29 mm.; diameter: 0.09-0.11 mm.

LAGENA APIOPLEURA Loeblich & Tappan

Lagena apiopleura LOEBLICH & TAPPAN, 1953, p.59, pl.10, figs.14-15. — VILKS, 1969, p.47, pl.2, fig.5.

Lagena sulcata (Walker and Jacob), PARKER & JONES, 1865 (part), p.351, pl.13, figs.28-31 (not figs.24,32). (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena acuticosta Reuss, BRADY, 1884 (part), pl.58, fig.21 (not pl.57, figs.31-32, not pl.58, fig.20).

Lagena acuticosta Reuss (var.), CUSHMAN & McCULLOCH, 1950, p.329, pl.43, figs.9-10.

REMARKS: Four of the 5 specimens recovered are as illustrated by Brady, with no incipient reticulate ornamentation at the upper end of the test below the aperture. The fifth specimen differs slightly from Loeblich and Tappan's illustrations in having two reticulate ornamentations, one above the other. Barker (1960) has suggested that this may be a type of *Oolina williamsoni* but as no entosolenian tube is visible, it is left with *Lagena apiopleura*.

Length: 0.16-0.23 mm.; breadth: 0.11-0.19 mm.

LAGENA CLYPEATO-MARGINATA CRASSA Sidebottom

Lagena clypeato-marginata Rymer Jones var. *crassa* SIDEBOTTOM, 1912, p.425, pl.21, fig.7. (*fide* Ellis & Messina, 1940, *et seq.*).

REMARKS: Single specimens were recovered at two stations in the Ridge area.

Length: 0.44 mm.; breadth: 0.26 mm.

LAGENA ELONGATA (Ehrenberg)

Miliola elongata EHRENBURG, 1845, p.371, type fig. (not given). (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena elongata (Ehrenberg), BRADY, 1884, pl.56, fig.29. (*fide* Barker, 1960). — CUSHMAN, 1923, p.15, pl.3, fig.4. — ROCHA & UBALDO, 1964, p.57, est.4, fig.4.

Lagena gracillima BRADY (part), 1884, pl.56, figs.27,28. (*fide* Barker, 1960).

REMARKS: Single specimens found at 3 stations. They resemble Brady's fig.27, pl.56.

None of the specimens was intact.

Length: 0.58 mm.; breadth: 0.13 mm.

LAGENA FLINTIANA Cushman

Lagena flintiana CUSHMAN, 1923, p.18, pl.3, figs.11-13.

Lagena orbignyana FLINT (not Seguenza), 1897, p.308, pl.54, fig.4.

REMARKS: Three specimens recovered from 2 samples.

Length: 0.35 mm.; breadth: 0.28 mm.

LAGENA GRACILLIMA (Seguenza)

Amphorina gracillima SEGUENZA, 1862, p.51, pl.1, fig.37. (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena gracillima (Seguenza), BRADY, 1884, pl.56, figs.21,22,24-26, 19?, 20?, 23?, 27?, 28? (*fide* Barker, 1960). — CUSHMAN, 1923, p.23, pl.4, fig.5. — LOEBLICH & TAPPAN, 1953, p.60, pl.11, figs.1-4. — LAGOE, 1977, p.121, pl.2, fig.15.

REMARKS: Single specimens recovered at 2 stations, resemble Brady's fig.19, pl.56.

Length: 0.19-0.33 mm.; breadth: 0.1 mm.

LAGENA GRACILIS Williamson

Lagena gracilis WILLIAMSON, 1848, p.13, pl.1, fig.5. — BRADY, 1884, pl.58, figs. 2,3, 7-9,10(?),19,22,23,24(?). (*fide* Ellis & Messina, 1940, *et seq.*). — CUSHMAN, 1923, p.22, pl.4, figs.3,4. — ROCHA & UBALDO, 1964, p.57, est.4, fig.5. — VILKS, 1969, p.47, pl.2, fig.17.

REMARKS: Several of Brady's (1884) forms are recognized: figs.2,3,8,22 and 23, pl.58. This species is fairly common. It was recovered from 8 stations, both in the Ridge and in the slope areas.

Length: 0.21-0.43 mm.; breadth: 0.08-0.11 mm.

LAGENA HISPIDA Reuss

Lagena hispida REUSS, 1858, p.43 (nomen); 1863, p.335, pl.6, figs. 77-79. (*fide* Ellis &

Messina, 1940, *et seq.*). — CUSHMAN, 1923, p.13, pl.4, figs.4,5, pl.5, fig.1. — ROCHA & UBALDO, 1964, est.4, fig.6.

REMARKS: Only one specimen recovered. It has a globular test, resembling Cushman's illustration pl.3, fig.5.

Length: 0.18 mm.; width: 0.23 mm.

LAGENA HISPIDULA Cushman

Lagena hispidula CUSHMAN, 1913a, p.14, pl.5, figs.2,3. — ROCHA & UBALDO, 1964, p.58, est.4, fig.6.

Lagena laevis BRADY (part) (not Montagu), 1884, pl.56, figs.10,11. (*fide* Barker, 1960).

REMARKS: Differs from *L. hispida* in being flask shaped with a broadly rounded base and in being so finely spinose as to appear frosted. Some of the specimens are rounded in section while others are compressed. *L. hispida* on the other hand, has a variety of shapes, from globose to pyriform with fewer and longer spines. Single specimens found at 6 stations and 2 individuals at a 7th station.

Length: 0.14-0.34 mm.; width: 0.09-0.19 mm.

LAGENA MERIDIONALIS Wiesner

Lagena meridionalis Williamson var. *meridionalis* WIESNER, 1931, p.117, pl.18, fig.211. (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena meridionalis Wiesner, LOEBLICH & TAPPAN, 1953, p.62, pl.12, fig.1. — VILKS, 1969, p.47, pl.2, fig.19.

REMARKS: Only one specimen recovered at a Ridge station.

Length: 0.36 mm.; breadth: 0.11 mm.

LAGENA MOLLIS Cushman

Lagena gracillima (Seguenza) var. *mollis* CUSHMAN, 1944, p.21, pl.13, fig.3.

Lagena mollis Cushman, LOEBLICH & TAPPAN, 1953, p.63, pl.11, figs.25-27.

REMARKS: Loeblich and Tappan observed that this could very well be the same as *Lagena distoma* Parker and Jones, 1884. The difference seems to be one of degree: *L. mollis* has very faint striations while those of *L. distoma* are more pronounced.

Three specimens found at 2 slope stations.

Length: 0.35-0.43 mm.; width: 0.09 - 0.1 mm.

LAGENA PACIFICA Sidebottom

Lagena pacifica SIDEBOTTOM, 1912, p.398, pl.16, fig.29. (*fide* Ellis & Messina, 1940, *et seq.*). — PARR, 1950, pl.8, fig.1.

REMARKS: The width of each individual varies depending on whether the porous outside layer is worn out or not. Rare; four specimens found at 3 stations.

Length: 0.15-0.19 mm.; width: 0.08-0.09 mm.

LAGENA PARADOXA Sidebottom

Lagena faviolata Reuss? var. *paradoxa* SIDEBOTTOM, 1912, p.395, pl.16, figs.22-23. (fide Ellis & Messina, 1940, et seq.).

Lagena paradoxa Sidebottom, CUSHMAN, 1933c, p.29, pl.7, figs.9-10. — ROCHA & UBALDO, 1964, p.59, est.4, fig.10.

REMARKS: One specimen found in sample 68-22-191 is tentatively identified as *L. paradoxa*. It appears to be one of those specimens stripped of the outside wall with only fine spines arranged in close rows remaining. When the outer layer of the composite test is removed it resembles *L. pacifica*; they differ in that in *L. paradoxa* the base of the neck is joined rather abruptly to the test whereas in *L. pacifica* the test gradually tapers. Rare; 5 specimens recovered at 4 Ridge stations.

Length: 0.20-0.25 mm.; breadth: 0.09-0.11 mm.

LAGENA PLUMIGERA Brady

Lagena plumigera BRADY, 1881, p.62, type fig. in Brady, 1884, pl.58, figs.25-27. (fide Ellis & Messina, 1940, et seq.).

REMARKS: One specimen recovered in sample 66-19-27, is identical to Brady's illustration pl.58, fig.26. The other specimens differ in that only 4 of the feather-like ribs are present, the rest are simple costae which have not developed the feather-like extension. Rare; five specimens recovered at 4 Ridge stations.

Length: 0.29 mm.; width: 0.15 mm.

LAGENA STRIATA (d'Orbigny)

Oolina sulcata D'ORBIGNY, 1839b, p.21, pl.5, fig.12. (fide Ellis & Messina, 1940, et seq.).
Lagena striata (d'Orbigny), BRADY, 1884, pl.57, figs.22,24. (fide Barker, 1960). — CUSHMAN, 1923, p.54, pl.10, fig.9.

REMARKS: Various forms have been included in this species from globular to fusiform. All are finely striated, have a rounded aboral end and an elongated neck. Most abundant species of the genus; 19 specimens recovered at 10 Ridge stations.

Length: 0.14-0.35 mm.; width: 0.08-0.11 mm.

LAGENA SULCATA (Walker & Jacob)

"*Serpula (Lagena) striata sulcata rotundata*" WALKER & BOYS, 1784, p.2, pl.1, fig.6.
 (fide Ellis & Messina, 1940, et seq.).
Serpula (Lagena) sulcata WALKER & JACOB, 1798, p.634, pl.14, fig. 5. (fide Ellis & Messina, 1940, et seq.).
Lagena sulcata (Walker & Jacob), BRADY, 1884, pl.57, figs.23,26,33,34. (fide Barker, 1960). – CUSHMAN, 1923, p.57, pl.11, fig.1.

REMARKS: Distinguished from *L. gracilis* by a subglobose instead of fusiform test and a greater number of costae. Rare; 6 specimens found at four Ridge stations.
 Length: 0.16-0.23 mm.; breadth: 0.11 mm.

LAGENA SP.1

There are only two specimens in this grouping. They somewhat resemble *Fissurina quinquelatera* (Brady) in that the test is made up of longitudinally concave faces. They differ in that *L. sp.1* has no entosolenian tube, it is not fusiform but subglobular and the number of faces is variable: one of the specimens has 3 faces, the other 4. Each ridge is carinated as is the case for *F. quinquelatera*. There is no apertural neck, the aperture sits on top of the test.

Length: 0.16 mm.; width: 0.11 mm.

Genus LENTICULINA Lamarck, 1804

LENTICULINA CONVERGENS (Bornemann)

Cristellaria convergens BORNEMANN, 1855, p.327, pl.13, figs.16-17. (fide Ellis & Messina, 1940, et seq.). – CUSHMAN, 1913a, p.69, pl.34, fig.3.

REMARKS: Only one specimen was found at a station on the slope off Nova Scotia.
 Diameter: 0.25 mm.; thickness: 0.16 mm.

LENTICULINA GIBBA (d'Orbigny)

Cristellaria gibba D'ORBIGNY, 1826, p.126 (292), no.17 (nom. nudum); – 1839a, p.40, pl.7, figs.20-21. (fide Ellis & Messina, 1940, et seq.).
Robulus gibbus (d'Orbigny), CUSHMAN, 1933c, p.6, pl.2, figs.2,6,7.

REMARKS: Only one specimen recovered at a station on the slope off Nova Scotia.
 Diameter: 0.18 mm.; thickness: 0.11 mm.

LENTICULINA OCCIDENTALIS (Cushman)

Cristellaria occidentalis CUSHMAN, 1923, p.102, pl.25, fig.2, pl.26, figs.1,2.

REMARKS: As opposed to Cushman's specimens, these are not found on the slope but only in the Ridge area. Many immature forms, 7 out of a total of 24 specimens, have been included with this species. Whether they are truly *L. occidentalis* is not known for sure as only the first chamber is formed.

Diameter: 0.25-0.50 mm.; thickness: 0.13-0.21 mm.

Genus MARGINULINA d'Orbigny, 1826

MARGINULINA OBESA Cushman

Marginulina glabra d'Orbigny var. *obesa* CUSHMAN, 1923, p.128, pl.37, fig.1.

Marginulina glabra d'Orbigny, BRADY, 1884, pl.65, figs.5-6. (fide Barker, 1960).

Marginulina obesa Cushman, PARR, 1950, p.326.

REMARKS: Though much shorter than Cushman's specimens, these stout forms are still believed to be *M. obesa*. Only four specimens are positively identified, the other two individuals are juveniles and may be microspheric forms as the proloculus is very small.

Length: 0.56-0.81 mm.; breadth: 0.31-0.53 mm.

Genus ORTHOMORPHINA Stainforth, 1952

ORTHOMORPHINA CHALLENGERIANA (Thalman)

Nodogenerina challengeriana THALMAN, 1937, p.341, type fig. in Brady, 1884, pl.64, figs.25-27. (fide Ellis & Messina, 1940, et seq.).

Nodosaria perversa Schwager, BRADY, 1884, pl.64, figs.25-27. (fide Barker, 1960).

REMARKS: From Brady's illustrations it can be seen that this is a highly variable species both in terms of ornamentation and chamber shape. The ornamentation ranges from numerous fine striations, to fewer larger costae, to only a very few costae. The chamber can be subglobular if the sutures are very depressed or they can be tubular if the sutures are flush. All these variations can be seen within the same individual. The aperture is always circular. Rare; several broken pieces recovered at 8 Ridge stations.

Length: 0.15-0.68; width: 0.09-0.11 mm.

Genus SARACENARIA Defrance in de Blainville, 1824

SARACENARIA ITALICA Defrance

Saracenaria italica DEFRANCE, 1824, p.176, type fig. Atlas, pl.13, fig.6. (fide Ellis & Messina, 1940, et seq.).

Cristellaria italica (Defrance), CUSHMAN, 1923, p.125, pl.35, figs.2,5-7.

REMARKS: Rare; single specimens found at two stations.

Height: 0.46-0.58 mm.; breadth: 0.29 mm.; thickness: 0.30-0.34 mm.

SARACENARIA LATIFRONS (Brady)

Cristellaria latifrons BRADY, 1884, pl.68, fig.19, pl.113, fig.11. (*fide* Barker, 1960). — CUSHMAN, 1923, p.126.

REMARKS: The specimens recovered resemble Brady's illustration, pl.68, fig.19 (not pl.113, fig.11). The juveniles reported under *Lenticulina occidentalis* could belong to *Saracenaria latifrons* as only the first chamber is developed and this does not supply enough information to differentiate between the two genera. Rare; single specimens found at three stations.

Length: 0.19-0.48; width: 0.13-0.24 mm.; breadth: 0.13-0.15 mm.

Genus PLECTOFRONDICULARIA Liebus, 1902

PLECTOFRONDICULARIA ADVENA (Cushman)

Fronidularia advena CUSHMAN, 1923, p.141, pl.66, figs.1,2.

Fronidularia inaequalis Costa, BRADY, 1884, pl.66, figs.8-12. (*fide* Barker, 1960).

REMARKS: Only one broken specimen from the slope off the Grand Banks.

Length: 0.76 mm.; width: 0.21 mm.; thickness: 0.09 mm.

Family POLYMORPHINIDAE d'Orbigny, 1839

Genus PARADENTALINA Uchio, 1960

PARADENTALINA MURAI (Uchio)

Enantiodentalina murai UCHIO, 1953, p.152, pl.14, figs.1,2.

Paradentalina murai (Uchio), LOEBLICH & TAPPAN, 1964, p.C533; fig.417.

REMARKS: Only one specimen located in the Median Valley of the Mid Atlantic Ridge.

Length: 0.24 mm.; width: 0.08 mm.; thickness: 0.07 mm.

Genus PYRULINA d'Orbigny in de la Sagra, 1839

PYRULINA ANGUSTA (Egger)

Polymorphina angusta EGGER, 1857, p.290, pl.13, figs.13-15. (*fide* Ellis & Messina, 1940, *et seq.*). — BRADY, 1884, pl.72, figs.1-3 (*fide* Barker, 1960). — CUSHMAN, 1923, p.149.

REMARKS: Rare; 12 specimens recovered at 6 stations.

Length: 0.23-0.44 mm.; width: 0.08-0.13 mm.; thickness: 0.10-0.15 mm.

PYRULINA FUSIFORMIS (Roemer)

Polymorphina (Globulina) fusiformis ROEMER, 1838, p.386, pl.3, fig.37. (fide Ellis & Messina, 1940, *et seq.*). — BRADY, 1884, pl.71, figs.17,18,19. (fide Barker, 1960).

REMARKS: Rare; 5 specimens recovered at 4 stations.

Length: 0.13-0.61 mm.; width: 0.11-0.21 mm.; thickness: 0.11-0.21 mm.

Family GLANDULINIDAE Reuss, 1860

Subfamily GLANDULININAE Reuss, 1860

REMARKS: A single specimen was recovered (station no. 66-19-50, in the Median Valley of the Mid Atlantic Ridge) which is thought to belong to this subfamily though it fits none of the generic description. The test is free, elongate, circular in section and uniserial throughout. In the initial stage the sutures are oblique and the chambers are strongly overlapping. There appear to be four of these chambers followed by three distinct chambers with straight sutures. There is a sudden increase in size between the initial portion of the test made of overlapping chambers and the later section with distinct chambers. The aperture is terminal, central and rounded. The short entosolenian tube is off slightly to one side.

Length: 0.21 mm.; thickness: 0.08 mm.

Genus OOLINA d'Orbigny, 1839

OOLINA BOTELLIFORMIS (Brady)

Lagena botelliformis BRADY, 1881, p.60, type fig.1884, pl.56, fig. 6. (fide Ellis & Messina, 1940, *et seq.*). — CUSHMAN, 1923, pl.1, fig.2.

REMARKS: Single specimen recovered at a slope station located off Nova Scotia.

Length: 0.30 mm.; thickness: 0.09 mm.

OOLINA COSTATA (Williamson)

Entosolenia costata WILLIAMSON, 1858, p.9, pl.1, fig. 18. (fide Ellis & Messina, 1940, *et seq.*).

Lagena costata (Williamson), CUSHMAN, 1923, p.12, pl.1, fig.16, pl.2, figs. 1,2, pl.3, fig.B.

Oolina costata (Williamson), LOEBLICH & TAPPAN, 1953, p.68, pl.13, figs.4-6.

REMARKS: Two types of specimens are grouped under this specific name. One is globular with costae of unequal length reaching 2/3-3/4 of the way up with the circular aperture directly on top of the test. The other type has a test which is slightly fusiform with

costae of equal length reaching the base of a circular aperture which sits on top of two rings. Rare; 9 specimens recovered at 6 stations located in the Ridge area.

Length: 0.14-0.18 mm.; width: 0.10-0.14 mm.

OOLINA GLOBOSA (Montagu)

Serpula (Lagena) laevis globosa WALKER & BOYS, 1784, p.3, pl.1, fig.8. (fide Ellis & Messina, 1940, et seq.).

Vermiculum globosum MONTAGU, 1803, p.523, type fig. in Walker & Boys, 1784, pl.1, fig.8. (fide Ellis & Messina, 1940, et seq.).

Lagena globosa (Montagu), BRADY, 1884, pl.56, figs.1-3. (fide Barker, 1960) — CUSHMAN, 1923, p.20, pl.4, figs.1,2.

Oolina globosa (Montagu), VILKS, 1969, p.48, pl.2, fig.27.

REMARKS: Present at several stations from both the slope and the Ridge area, it is the most abundant species of the genus.

Length: 0.14-0.29 mm.; width: 0.11-0.25 mm.

OOLINA HEXAGONA (Williamson)

Entosolenia squamosa (Montagu) var. *hexagona* WILLIAMSON, 1848, p.20, pl.2, fig.23. (fide Ellis & Messina, 1940, et seq.).

Lagena hexagona (Williamson), BRADY, 1884, pl.58, figs.32,33. (fide Barker, 1960) — CUSHMAN, 1923, p.24, pl.4, fig.6.

Oolina hexagona (Williamson), VILKS, 1969, p.48, pl.2, fig.28. — LAGOE, 1977, p.122, pl.2, fig.13.

REMARKS: Rare; occurs only at 4 stations, one specimen differs from the others in having a drawn out aperture as in Williamson's illustration, otherwise they are similar to Brady's specimens.

Length: 0.11-0.23 mm.; width: 0.10-0.20 mm.

OOLINA LINEATO-PUNCTATA (Heron-Allen & Earland)

Lagena globosa (Montagu) var. *lineato-punctata* HERON-ALLEN & EARLAND, 1922, p.142, pl.5, figs.12-14.

Oolina lineato-punctata (Heron-Allen & Earland), LOEBLICH & TAPPAN, 1953, p.70, pl.13, fig.8.

REMARKS: Rare; 4 specimens recovered at 3 stations.

Length: 0.18-0.25 mm.; width: 0.11-0.24 mm.

OOLINA MELO d'Orbigny

Oolina melo D'ORBIGNY, 1839a, p.20, pl.5, fig.9. (fide Ellis & Messina, 1940, et seq.). — VILKS, 1969, p.48, pl.2, fig.29. — LAGOE, 1977, p.122, pl.2, figs.1,16.

Lagena melo (d'Orbigny), CUSHMAN, 1923, p.38.

REMARKS: Differs from *O. hexagona* in that the raised ornamentation resembles inverted U's arranged in vertical rows as opposed to hexagons arranged in the typical beehive pattern. Rare; found at 6 stations in the Ridge area.

Length: 0.10-0.28 mm.; width: 0.08-0.24 mm.

OOLINA OVUM (Ehrenberg)

Miliola ovum EHRENBURG, 1843, p.166, type fig.1854, pl.23, fig.2, pl.29, fig.45, pl.31, fig. 4. (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena ovum (Ehrenberg), BRADY, 1884, pl.56, fig. 5. (*fide* Barker, 1960) – CUSHMAN, 1923, p.44, pl.8, figs.9,10.

REMARKS: One specimen was recovered.

Length: 0.18 mm.; width: 0.10 mm.

OOLINA STELLIGERA (Brady)

Lagena stelligera BRADY, 1881, p.60, type fig.1884, pl.57, figs.35-36. (*fide* Ellis & Messina, 1940, *et seq.*).

REMARKS: This species is highly variable with one end member having a simple large ring at the base and the aperture located directly on top of the test. At the other end of the spectrum the specimen has fine costae originating from a small basal ring, which run the length of the test and six of them continue as apertural wings along a long, thin apertural neck. As variations between these end members are present, they are all considered to be part of the same species. Rare; present in both the slope and the Ridge area.

Length: 0.14-0.30 mm.; width: 0.11-0.14 mm.

Genus FISSURINA Reuss, 1850

FISSURINA ALVEOLATA (Brady)

Lagena alveolata BRADY, 1884, p.487, pl.60, figs.30,32. (*fide* Barker, 1960).

Fissurina alveolata (Brady), ROCHA & UBALDO, 1964, p.64, est.4, fig.22.

REMARKS: Only 2 specimens recovered. One is the same as Brady's illustration, the other has a thinner perforated wall and the neck is not as drawn out but has similar keels. It may be a juvenile.

Length: 0.38-0.51 mm.; breadth: 0.21-0.36 mm.; width: 0.16-0.25 mm.

FISSURINA ANNECTENS (Burrows & Holland)

Lagena annectens Burrows & Holland, JONES, 1895, p.203, pl.7, fig.11. (fide Ellis & Messina, 1940, et seq.) – HERON-ALLEN & EARLAND, 1932, p.374, pl.10, figs.40-44.

Lagena quadricostulata, (pars.) BRADY (non Reuss), 1884, pl.59, fig.15. (fide Barker, 1960).

REMARKS: As indicated by Heron-Allen & Earland (1932), *F. annectens* is very similar to *F. fasciata* var. *spinosa*. The two species exhibit horse shoe hands and have a similar shape (*F. annectens* may or may not be carinated). They are distinguished on the basis of apertural characteristics. *F. annectens* has an arcuate, drawn out, fissurine aperture whereas *F. fasciata* has a rounded aperture. All but one specimen have 3 spines at the aboral end, the other one has a single basal spine. Rare; 5 specimens recovered at 3 stations.

Length: 0.28-0.40 mm.; width: 0.20-0.34 mm.; thickness: 0.15-0.35 mm.

FISSURINA AURICULATA (Brady)

Lagena auriculata BRADY, 1881, p.61, type fig.1884, pl.60, figs.29,31,33. (fide Ellis & Messina, 1940, et seq.).

Fissurina auriculata (Brady) var. *duplicata* (Sidebottom), ROCHA & UBALDO, 1964, p.65, est.4, fig.23.

REMARKS: A total of 12 specimens were recovered from 9 samples from both the Ridge and the slope areas. No attempt has been made to distinguish amongst the many varieties.

Length: 0.19-0.31 mm.; breadth: 0.09-0.11 mm.; width: 0.15-0.18 mm.

FISSURINA BIANCAE Seguenza

Fissurina biancae SEGUENZA, 1862, p.57, pl.1, figs.48-50. (fide Ellis & Messina, 1940, et seq.).

Lagena biancae (Seguenza), HERON-ALLEN & EARLAND, 1932, p.372, pl.10, figs.35-39.

REMARKS: Closely resembles Heron-Allen and Earland's fig.36, pl.10. It could be mistaken for *F. laevigata* but this is a compressed form whereas Reuss' species is rounded.

Rare; single specimens found at 4 stations.

Length: 0.14-0.29 mm.; width: 0.11-0.14 mm.; thickness: 0.10-0.11 mm.

FISSURINA BRADII Silvestri

Lagena orbignyana (Seguenza), BRADY, 1884, pl.59, fig.24. (fide Barker, 1960).

Fissurina bradii SILVESTRI, 1902, p.147, type fig. in Brady, pl.57, fig.24. (fide Ellis & Messina, 1940, et seq.).

Lagena orbignyana (Seguenza) var. *caribaea* CUSHMAN, 1923, p.41, pl.7, figs.6-9.

REMARKS: Though one of the more common species of *Fissurina*, found at eleven stations from both the slope and Ridge areas, the number of specimens is low. Few specimens are intact,

as the large carinae break off easily.

Length: 0.14-0.20 mm.; width: 0.13-0.18 mm.; thickness: 0.07 mm.

FISSURINA CREBRA (Matthes)

Lagena crebra MATTHES, 1939, p.72, pl.5, figs.66-70. (*fide* Ellis & Messina, 1940, *et seq.*).

Fissurina crebra (Matthes), ROCHA & UBALDO, 1964, p.66, est.4, fig.26.

REMARKS: Single specimens recovered at 2 stations. This species is similar to *F. semimarginata* but has a longer neck, a basal spine and is carinated.

Length: 0.21 mm.; width: 0.15 mm.; thickness: 0.13 mm.

FISSURINA EARLANDI Parr

Fissurina earlandi, PARR, 1950, p.306, pl.8, fig.8.

Lagena marginata (Walker & Boys), CHAPMANN, 1916, p.66, pl.4, fig. 28.

Lagena biancae (Seguenza), HERON-ALLEN & EARLAND, 1932, p.372, pl.10, fig.36 (not figs.35,37,38,39).

REMARKS: Parr's specimen is believed to be a juvenile as it does not exhibit the punctae seen in the mature forms recovered but rather is smooth as the juveniles are. The acquisition of punctae is demonstrated through various specimens. Rare; 7 specimens recovered at 5 stations.

Length: 0.15-0.40 mm.; width: 0.13-0.36 mm.; thickness: 0.10-0.18 mm.

FISSURINA FASCIATA (Egger) sub. SPINOSA (Sidebottom)

Lagena fasciata Egger var. *spinosa* SIDEBOTTOM, 1912, p.402, pl.17, figs.16-17. (*fide* Ellis & Messina, 1940, *et seq.*).

REMARKS: Three specimens recovered at 2 slope stations.

Length: 0.24-0.28 mm.; width: 0.16 mm.; thickness: 0.13 mm.

FISSURINA FIMBRIATA (Brady)

Lagena fimbriata BRADY, 1881, p.61, type fig., 1884, pl.60, figs.26-28. (*fide* Barker, 1960). — CUSHMAN, 1923, p.17, pl.3, fig.9.

Fissurina fimbriata (Brady), ROCHA & UBALDO, 1964, p.67, est.4, figs.27,28.

REMARKS: A highly variable form. All three types illustrated by Brady have been recovered. Rare; 7 specimens found at 6 Ridge stations.

Length: 0.20-0.34 mm.; width: 0.09-0.18 mm.; thickness: 0.08-0.10 mm.

FISSURINA aff. FORMOSA (Schwager)

Lagena formosa Schwager, BRADY 1884, pl.60, figs.18,19. (*fide* Barker, 1960). — CUSHMAN,

1933c, p.25, pl.6, figs.9,10.

REMARKS: Referred to as *L. formosa* by Brady, Parr (1950) notes that these specimens do not belong to this species. Barker (1960) makes the same observation. Rare; 13 specimens recovered at 5 Ridge stations.

Length: 0.30-0.34 mm.; width: 0.16-0.18 mm.; thickness: 0.09 mm.

FISSURINA GRATIOSA (Buchner)

Lagena gratiosa BUCHNER, 1940, p.487, pl.16, figs.300-302.

REMARKS: Resembles *F. clathrata* but lacks the ridge along the periphery. The specimens recovered closely resemble Buchner's illustrations except that the entosolenian tube is longer and is curved. Rare; 4 specimens recovered at 3 Ridge stations.

Length: 0.14 mm.; thickness: 0.21-0.25 mm.; width: 0.18-0.23 mm.

FISSURINA KERGUELENENSIS Parr

Fissurina kerguelensis PARR, 1950, p.305, pl.8, fig.7. — ROCHA & UBALDO, 1964, p.67, est.5, fig.2.

Lagena staphyllearia (Schwager), BRADY, 1884, p.474, pl.59, figs.8-11. (fide Barker, 1960).

REMARKS: Differs from Parr's specimens in having a more drawn out aperture and modified basal ornamentations: in many specimens the carina develops into a basal keel in which the spines can still be seen. This species is very similar to *Parafissurina arctica* except for the aperture which is fissurine. The species is common, it has been recovered in both the Ridge and the slope areas but the number of specimens present is low.

Length: 0.13-0.18 mm.; width: 0.13-0.18 mm.; thickness: 0.08-0.09 mm.

FISSURINA LAGENOIDES (Williamson)

Entosolenia marginata (Montagu) var. *lagenoides* WILLIAMSON, 1858, p.11, pl.1, figs.25-26. (fide Ellis & Messina, 1940, et seq.).

Lagena lagenoides (Williamson), CUSHMAN, 1923, p.30, pl.5, figs.6-8.

Lagena sp.B, LAGOE, 1977, p.121, pl.2, figs.2,3.

REMARKS: Rare; single specimens found at 3 stations.

Length: 0.19-0.25 mm.; width: 0.09-0.11 mm.; thickness: 0.05 mm.

FISSURINA LAGENOIDES (Williamson) sub. TENUISTRIATA (Brady)

Lagena tubulifera Brady var. *tenuistriata* BRADY, 1881, p.61, type fig., 1884, pl.60, figs.11,15,16 (as *Lagena lagenoides* (Williamson) var. *tenuistriata*). (fide Ellis & Messina, 1940, et seq.).

Fissurina lagenoides (Williamson) var. *tenuistriata* (Brady), ROCHA & UBALDO, 1964, p.69, est.5, fig.4.

REMARKS: Rare; single specimens found at 4 stations.

Length: 0.23-0.26 mm.; width: 0.10-0.13 mm.; thickness: 0.08 mm.

FISSURINA LAGENOIDES (Williamson) forma A

REMARKS: Resembles the type in being flask-shaped and compressed but it has a short apertural neck which is flanged. It differs also in having either a very narrow carina, almost a ridge, or no carina. The surface is nebulose and punctate. Rare; 9 specimens recovered at 5 Ridge stations.

Length: 0.18-0.21 mm.; width: 0.11 mm.; thickness: 0.09 mm.

FISSURINA MARGINATA (Montagu)

Serpula (Lagena) marginata WALKER & BOYS, 1784, p.2, pl.1, fig.7. (fide Ellis & Messina, 1940, et seq.).

Vermiculum marginatum MONTAGU, 1803, p.524, type fig. in Walker & Boys, 1784, pl.1, fig.7. (fide Ellis & Messina, 1940, et seq.).

Fissurina marginata (Montagu), MURRAY, 1971, p.97, pl.39, figs.4,5,6.

REMARKS: Differs from Murray's illustration in being more inflated and slightly more drawn out at the base. Rare; single specimens found in three Ridge samples.

Diameter: 0.15-0.23 mm.; thickness: 0.11-0.18 mm.

FISSURINA MARGINATA (Montagu) sub! SPINOSA Spandel

Fissurina marginata (Montagu) var. *spinosa* SPANDEL, 1909, p.201, pl.1, fig.7. (fide & Messina, 1940, et seq.).

REMARKS: Differs from the type in having a keel circumscribing the entire test. It also has numerous, minute, basal spines. Rare; 16 specimens present at 9 stations both in the slope and in the Ridge areas.

Length: 0.13-0.15 mm.; width: 0.11 mm.; thickness: 0.05-0.06 mm.

FISSURINA cf. F. MARGINATA (Montagu)

Fissurina sp. A, BOLTOVSKOY, 1959b, p.72, lam.9, fig.9.

Fissurina cf. *F. marginata* (Montagu), LAGOE, 1977, p.122, pl.2, fig.9.

REMARKS: These could be immature specimens of *F. marginata*. Test compressed, ovate with a pointed base and a bluntly rounded apertural end. Aperture fissurine with entosolenian tube half the length of the test. The species is common. It was recovered

from both the slope and the Ridge areas, but the number of specimens is low.

Length: 0.10-0.18 mm.; width: 0.09-0.11 mm.; thickness: 0.08-0.11 mm.

FISSURINA OBTUSA Egger

Fissurina obtusa EGGER, 1857, p.270, pl.5, figs.16-19. (fide Ellis & Messina, 1940, et seq.).

REMARKS: Resembles *Parafissurina abnormis* except for the fissurine aperture.

Egger's diagram is not very clear but it appears that the aperture is rounded with a fissurine opening. The specimens recovered have a compressed, arcuate aperture. Rare; single specimens found at 4 stations.

Height: 0.14-0.28 mm.; diameter: 0.10-0.24 mm.

FISSURINA ORBIGNYANA Seguenza

Fissurina orbignyana SEGUENZA, 1862, p.66, pl.2, figs.25-26. (fide Ellis & Messina, 1940, et seq.).

Lagena orbignyana (Seguenza), BRADY (pars), 1884, pl.59, figs.18,26 (not figs.20,24,25). (fide Barker, 1960). — CUSHMAN, 1923, p.39.

REMARKS: Some specimens differ slightly from the type by exhibiting faint costae in the central part of the test, while others are more globular. The species is common in both the slope and the Ridge areas though the number of specimens is low.

Length: 0.28-0.33 mm.; width: 0.15-0.23 mm.; thickness: 0.09-0.14 mm.

FISSURINA PACIFICA Parr forma A

Fissurina pacifica PARR, 1950, p.314, pl.9, fig.10.

REMARKS: Differs from the type in lacking the tubular openings on the side of the test and in that the inner ridges surrounding the body are thickened and pitted. The keels are damaged therefore it is hard to determine if the ornamentation is present. The entosolenian tube goes all the way down to the base of the test. Rare; single specimens found at 3 stations.

Length: 0.30-0.36 mm.; width: 0.25-0.29 mm.; thickness: 0.13-0.14 mm.

FISSURINA QUADRATA (Williamson)

Entosolenia marginata (Montagu) var. *quadrata* WILLIAMSON, 1858, p.11, pl.1, figs.27-28. (fide Ellis & Messina, 1940, et seq.).

Lagena quadrata (Williamson), CUSHMAN, 1923, p.47, pl.9, figs.5-6.

REMARKS: This specimen differs slightly from Williamson's illustration in that the entosolenian tube extends down one side of the test and up the other side to the center of the test forming an upside down question mark. Rare; one specimen only.

Length: 0.15 mm.; width: 0.09; thickness: 0.05 mm.

FISSURINA RADIATA Seguenza

Fissurina radiata SEGUENZA, 1862, p.70, pl.2, figs.42-43. (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena lagenoides (Williamson), BRADY, 1884, pl.60, figs.13,14. (*fide* Barker, 1960).

REMARKS: Rare; single specimen found at 3 stations.

Length: 0.24-0.29 mm.; width: 0.18-0.23 mm.; thickness: 0.10 mm.

FISSURINA RENIFORMIS (Sidebottom)

Lagena reniformis SIDEBOTTOM, 1913, p.204, pl.28, fig.14. (*fide* Ellis & Messina, 1940, *et seq.*). — HERON-ALLEN & EARLAND, 1916, p.255, pl.41, figs.30-34. — CUSHMAN, 1923, p.49, pl.9, figs.7-11.

REMARKS: The specimens recovered are identical to Heron-Allen and Earland's fig.30, pl.41. Rare; single specimens found at 2 stations.

Length: 0.09-0.11 mm.; width: 0.10-0.13 mm.; thickness: 0.06 mm.

FISSURINA SEGUENZIANA (Fornasini)

Fissurina marginata SEGUENZA, 1862, p.66, tav.2, fig.27. (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena orbignyana (Seguenza), BRADY, 1884, pl.59, fig.1, (*fide* Barker, 1960).

Lagena seguenziana FORNASINI, 1886, p.351, type fig. in Fornasini, 1886, pl.8, figs.1-8. (*fide* Ellis & Messina, 1940, *et seq.*).

REMARKS: The shape of the test varies from circular to ovate to flask-shaped. In all cases the test is bordered by a prominent ridge and the aperture is elongate. One specimen is frosted and the ridge is much less prominent, almost absent at the base. Rare; 5 specimens recovered at 4 stations.

Length: 0.24-0.29 mm.; width: 0.13-0.19 mm.; thickness: 0.09-0.10 mm.

FISSURINA SEMIMARGINATA (Reuss)

Lagena sp. (no.64,65) VON SCHLICHT, 1870, p.11, taf.4, figs.4-6, 10-12. (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena marginata (Montagu) var. *semimarginata* REUSS, 1870, p.468, type fig. in von Schicht, 1870, pl.4, figs.4-6, 10-12. (*fide* Ellis & Messina, 1940, *et seq.*).

Lagena marginata (Montagu) var., CUSHMAN, 1933c, p.17, pl.4, fig.9 (not figs.11,12,14-16).

REMARKS: The specimens recovered are very similar to Cushman's illustration. They are circular to flask-shaped, subglobular to compressed and in mature specimens the keel surrounds the test. The species is common in the Ridge area though the number of specimens is low.

Length: 0.21-0.34 mm.; width: 0.19-0.28 mm.; thickness: 0.15-0.21 mm.

FISSURINA SUBMARGINATA (Boomgart)

Entosolenia submarginata BOOMGART, 1949, p.107, pl.9, fig.7. (fide Ellis & Messina, 1940, et seq.).

Lagena marginata (Walker and Boys), BRADY, 1884 (part), pl.59, figs.21,22. (fide Barker, 1960). - CUSHMAN, 1913a, p.37, pl.22, figs.1-7.

REMARKS: This species is easy to confuse with juveniles of *Fissurina radiata*. Both species have rounded tests and a radial carina. *F. radiata* has a tubular aperture and the keel is circular, whereas *F. submarginata* has a drawn out slit-like aperture with a flaring keel. Brady illustrates two specimens with very different apertures. The individuals recovered are similar to that illustrated on pl.59, fig.21, which has a small tubular aperture. All but one individual have broken carinae. Absent in the slope area, the species is common in the Ridge area though the number of specimens is low.

Diameter: 0.13-0.20 mm.; thickness: 0.06-0.13 mm.

(FISSURINA WIESNERI Barker

Lagena marginata (Walker and Boys), BRADY, 1884, pl.59, fig.23. (fide Barker, 1960).

Lagena marginata var. *carinata* WIESNER, 1931, p.121. (fide Ellis & Messina, 1940, et seq.).

Fissurina wiesneri BARKER, 1960, p.124, pl.59, fig.23.

REMARKS: Single specimens recovered at 2 stations.

Diameter: 0.19 mm.; thickness: 0.05 mm.

FISSURINA SP.1

Test translucent, elongate, slightly compressed; sides nearly parallel; apical end slightly pointed; apertural end bluntly rounded and compressed with a slit-like opening. A short entosolenian tube is left with broken pieces scattered inside the test. This species is distinguished by a series of three short, frosted, parallel bands located on each side. Rare; 2 specimens only recovered.

Length: 0.26-0.35 mm.; width: 0.10-0.15 mm.; thickness: 0.08-0.13 mm.

FISSURINA SP.2

Only one specimen recovered. It has a rounded body and a slightly drawn out and compressed fissurine aperture with a long entosolenian tube which runs down the entire length of the dorsal face and three-quarters of the way up the ventral face. The sides are subcarinated but not the base which is strongly inflated.

Length: 0.11 mm.; thickness: 0.08 mm.; width: 0.13 mm.

FISSURINA SP.3

Test small, globular with six pairs of thin, unequal, evenly spaced ridges originating from the base of the test. One pair is more developed and forms a carina surrounding the test. The pair located at 90° to it reaches only one-third of the way, whereas the other two sets reach three-quarters of the way. The aperture is a very small slit located immediately on top of the test. Four specimens recovered at three stations in the Ridge area.

Length: 0.16-0.25 mm.; width: 0.16-0.28 mm.; thickness: 0.14-0.18 mm.

FISSURINA SP.4

Only one specimen. Test subglobular with a thin carina. The carina becomes thicker as it reaches the base of the test. Aperture is a slit with a long entosolenian tube which runs down the length of the dorsal wall and comes half way up the ventral wall.

Diameter: 0.15 mm.; thickness: 0.10 mm.

FISSURINA SP.5

Test compressed, subrounded or flaked shape with gradually tapering edges and slightly pointed base. The aperture is a rounded opening which lies in a slit-like depression. There is a short entosolenian tube running down the center of the dorsal wall.

Length: 0.16-0.20 mm.; width: 0.09-0.10 mm.; thickness: 0.06 mm.

FISSURINA SP.6

One specimen only. Test circular, compressed with a wide carina encircling the entire body. The test and the carina are finely pitted. Along the edge of the test is a band formed by a thickening of the shell material which is most prominent along the base. The aperture is a slightly drawn out, compressed slit with a short entosolenian tube.

Diameter: 0.26 mm.; thickness: 0.11 mm.

FISSURINA SP.7

One specimen only. Test circular, compressed with a narrow peripheral keel. The keel becomes narrower towards the base and overlaps for a short distance at the apical end.

Aperture is a slit with a short entosolenian tube.

Diameter: 0.15 mm.; thickness: 0.08 mm.

Genus PARAFISSURINA Parr, 1947

PARAFISSURINA ABNORMIS Parr, 1950

Parafissurina abnormis PARR, 1950, p.314, pl.9, fig.11.

REMARKS: Rare; seen only in the Ridge area. One of the characteristics of the species is the shape of the entosolenian tube. In the case of the specimens recovered it cannot be observed, as it is either broken or the tests are frosted.

Height: 0.11-0.26 mm.; width: 0.09-0.25 mm.; thickness: 0.08-0.18 mm.

PARAFISSURINA ARCTICA Green

Parafissurina arctica GREEN, 1960, p.70, pl.1, fig.2. – VILKS, 1969, p.48, pl.2, fig.30.
– LAGOE, 1977, p.122, pl.3, fig.15, t.f.7.

REMARKS: Most of the specimens recovered have a continuous keel at the base of the test which reaches up to the middle of each side. The width of the keel is variable. There are also a few specimens with the keel split at the base. Others have no keel, only spines. The aperture is also variable, usually it is wide and low but in a few cases it is very narrow and high, almost pinched. The species is common. It was recovered at 8 stations from both the slope and the Ridge areas, but the number of specimens present at each station is low.

Length: 0.14-0.21 mm.; width: 0.15-0.25 mm.; thickness: 0.09-0.15 mm.

PARAFISSURINA DORBIGNYANA (Wiesner)

Ellipsolagena dorbignyana WIESNER, 1931, p.127, pl.24, stereo fig.p. (fide Ellis & Messina, 1940, et seq.).

REMARKS: Only 6 specimens recovered at 3 stations.

Length: 0.18-0.28 mm.; width: 0.18-0.25 mm.; thickness: 0.11-0.15 mm.

PARAFISSURINA FUSULIFORMIS Loeblich & Tappan

Parafissurina fusuliformis LOEBLICH & TAPPAN, 1953, p.79, pl.14, figs.18-19. – LAGOE, 1977, p.122, pl.3, fig.7.

REMARKS: Rare; found at 6 stations from both the slope and the Ridge area.

Length: 0.20-0.30 mm.; thickness: 0.08-0.13 mm.

PARAFISSURINA HEMATIOSSTOMA Loeblich & Tappan

Parafissurina hematiostoma LOEBLICH & TAPPAN, 1953, p.80, pl.14, figs.12-14.

REMARKS: Differs from *P. fusuliformis* in that usually, but not always, the sides of the test are tapering, giving the test a tear drop shape. Also, the aperture sits on top of the test and does not appear dug out of the sides as in *P. fusuliformis*. The most abundant species of the genus, recovered at 13 stations from both the slope and the Ridge area.

Length: 0.11-0.20 mm.; width: 0.09-0.13 mm.

PARAFISSURINA LATERALIS (Cushman)

Lagena lateralis CUSHMAN, 1913a, p.9, pl.1, fig.1.

REMARKS: All specimens recovered are of equal size. Rare; 5 specimens recovered at 4 stations.

Length: 0.34 mm.; width: 0.16 mm.; thickness: 0.11 mm.

PARAFISSURINA SUBCARINATA Parr

Parafissurina subcarinata PARR, 1950, p.318, pl.10, fig.9.

REMARKS: Differs from *P. ventricosa* in having a more compressed test, a peripheral ridge or thick keel and a low aperture parallel to the periphery. The species is common, though the number of specimens is low. One or two specimens were recovered at 13 stations.

Length: 0.18-0.31 mm.; width: 0.15-0.28 mm.; thickness: 0.11-0.14 mm.

PARAFISSURINA SUBOVATA Parr

Parafissurina subovata PARR, 1950, p.319, pl.10, figs.12-14.

REMARKS: Differs from *P. subcarinata* in having a basal keel or in one case spines, and in being flask-shaped as opposed to circular. Rare; 7 specimens recovered at 4 stations.

Length: 0.19-0.33 mm.; width: 0.17-0.29 mm.; thickness: 0.11-0.20 mm.

PARAFISSURINA TECTULOSTOMA Loeblich & Tappan

Parafissurina tectulostoma LOEBLICH & TAPPAN, 1953, p.81, pl.14, fig.17. – VILKS, 1969, p.49, pl.3, fig.1. – LAGOE, 1977, p.125, pl.3, fig.11. (as *Parafissurina* cf. *P. tectulostoma*).

REMARKS: The adult specimens are flask-shaped with a rounded base and a subangular

periphery. The aperture resembles an inverted V. The juveniles appear fusiform due to the tapering base and they have a rounded periphery which makes them look inflated as opposed to the compressed adult form. The species is common. It was recovered at 9 stations, but the number of specimens present is low.

Length: 0.13-0.55 mm.; width: 0.10-0.41 mm.; thickness: 0.05-0.26 mm.

PARAFISSURINA VENTRICOSA (Silvestri)

Lagena ventricosa SILVESTRI, 1904b, p.11, type fig.p.11, t.f.6. (fide Ellis & Messina, 1940, *et seq.*).

Parafissurina sp.C, LAGOE, 1977, p.125, pl.3, fig.16.

REMARKS: One specimen is compressed and has a peripheral keel like Silvestri's type, the others however are globular and have no keel. The aperture is the same: a high hood pinched towards the front sitting on top of the globular test. Rare; 9 specimens recovered at 7 stations from both areas.

Length: 0.15 - 0.34 mm.; width: 0.14-0.31 mm.; thickness: 0.13-0.28 mm.

PARAFISSURINA WIESNERI Parr

Parafissurina wiesneri PARR, 1950, p.320, pl.10, figs.19-20.

REMARKS: The mature specimens resemble *Fissurina crebra* except for the aperture which is parafissurine. In the juveniles the basal spine is not formed and the apertural neck is absent. Rare; 7 specimens found at 4 stations.

Length: 0.14-0.22 mm.; width: 0.13-0.16 mm.; thickness: 0.08-0.13 mm.

PARAFISSURINA SP.1

Test pyriform, composed of three triangular faces with rounded edges. At the apertural end the faces of the test are re-entrant. The aperture is typically parafissurine, a rounded hood sitting on top of the test. The entosolenian tube is straight and it goes half way down the largest face of the test. Could be a variety of *P. tectulostoma*. Rare; 3 specimens recovered at 2 stations.

Length: 0.13-0.19 mm.; width: 0.09-0.11 mm.

PARAFISSURINA SP.2

Fissurina sp.3, ROCHA & UBALDO, 1964, p.73, est.5, fig.19.

Resembles *Fissurina seminiformis* except that the carina surrounds the test and the aperture

is parafissurine. Differs from Rocha and Ubaldo's illustration in having a circular test as opposed to an oval one. The wide carina is radial and a long entosolenian tube projects from the hooded aperture. Rare; 5 specimens recovered at 3 stations.

Length: 0.21-0.41 mm.; width: 0.19-0.35 mm.; thickness: 0.10-0.15 mm.

Family TURRILINIDAE Cushman, 1927

Genus BULIMINELLA Cushman, 1911

BULIMINELLA SP.

Test elongate, sides are parallel, both ends are rounded. The initial chambers are high and narrow with approximately six visible chambers per whorl. The later chambers are half the height of the earlier ones and there are four chambers per whorl. The aperture is typically bullimine. Only two specimens recovered, one of which is broken.

Length: 0.28 mm.; width: 0.14 mm.

Family BOLIVINITIDAE Cushman, 1927

Genus BOLIVINITA Cushman, 1927

BOLIVINITA QUADRILATERA (Schwager)

Textularia quadrilatera SCHWAGER, 1866, p.253, pl.7, fig.10. (*fide* Ellis & Messina, 1940. *et seq.*).

Bolivina quadrilatera (Schwager, CUSHMAN, 1922a, p.44, pl.8, fig.2.

Bolivinita quadrilatera (Schwager), CHAPMAN & PARR, 1937, p.101.

REMARKS: Test slightly twisted about long axis, no initial spine, raised longitudinal costae, some running the entire length of the test. Rare; 2 specimens only.

Length: 0.24 mm.; width: 0.16 mm.; thickness: 0.08 mm.

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA EARLANDI Parr

Bolivina earlandi PARR, 1950, p.339, pl.12, fig.16.

Bolivina punctata d'Orbigny, EARLAND, 1934, p.132, pl.6, figs. 5-7. - CHAPMAN & PARR, 1937, p.92, pl.8, fig.16. (not d'Orbigny, 1839)

REMARKS: The immature forms have a recurved initial end and have many more chambers than illustrated by Parr. This may be because this curved initial end is hidden in Parr's illustration as he shows only a front view in the plane of curvature. Rare; 4 specimens recovered at 2 stations.

Length: 0.73 mm.; thickness: 0.23 mm.

BOLIVINA INFLATA Heron-Allen & Earland

Bolivina inflata HERON-ALLEN & EARLAND, 1913, p.68, pl.4, figs.16-19.

REMARKS: Differs from the type in that the chambers are twisted around the long axis of the test so that the final chambers are at 90° to the initial ones. Rare; 6 specimens recovered at 3 stations.

Length: 0.13-0.20 mm.; thickness: 0.06-0.09 mm.

BOLIVINA ORDINARIA Phleger & Parker

Bolivina simplex PHLEGER & PARKER, 1951, p.14, pl.7, figs.4-6.

Bolivina ordinaria PHLEGER & PARKER, 1952, p.14, type fig., 1951, pl.7, figs.4-6.

REMARKS: Three specimens recovered at one station.

Length: 0.26 mm.; width: 0.16 mm.; thickness: 0.07 mm.

BOLIVINA PUSILLA Schwager

Bolivina pusilla SCHWAGER, 1866, p.254, pl.7, fig.101. (*vide* Ellis & Messina, 1940, *et seq.*) - CUSHMAN, 1937b, p.114, pl.14, figs.8-9. - PFLUM & FRERICHS, 1976, pl.1, fig.7.

REMARKS: Rare; 11 specimens found at 5 stations in both the slope and the Ridge areas.

Length: 0.24-0.29 mm.; width: 0.10-0.13 mm.; thickness: 0.03-0.08 mm.

BOLIVINA SEMINUDA Cushman

Bolivina seminuda CUSHMAN, 1911, p.34, t.f.55; - 1937b, p.142, pl.1, figs.13-15.

REMARKS: Rare in the Ridge area where 4 specimens were recovered at 3 stations and abundant at one slope station where 14 individuals were found.

Length: 0.25-0.59 mm.; width: 0.10-0.15 mm.; thickness: 0.05-0.09 mm.

BOLIVINA SUBSPINESCENS Cushman

Bolivina subspinescens CUSHMAN, 1922a, p.48, pl.7, fig.5.

REMARKS: Chambers not as sharply angular as the type and the initial portion of the test is slightly twisted from 10° - 90° . Rare; single specimen at one Ridge station, 12 individuals recovered at one slope station.

Length: 0.16-0.31 mm.; width: 0.10-0.14 mm.; thickness: 0.06-0.10 mm.

BOLIVINA SP.

A single specimen with initial end broken off. Test perforated, chamber three times as

wide as high, margins subacute initially but become rounded in the last chambers, sutures depressed at angle to horizontal and the entire test is twisted.

Length: 0.21 mm.; width: 0.09 mm.; thickness: 0.05 mm.

Family ISLANDIELLIDAE Loeblich & Tappan, 1964

Genus ISLANDIELLA Norvang, 1958

ISLANDIELLA HELENÆ Feyling-Hansen & Buzas

Plate 4, figures 1,3

Islandiella helenae FEYLING-HANSEN & BUZAS, 1976, p.154, text figs. 1-4.

REMARKS: Only 11 specimens have been recovered but they are present only at 2 stations on the slope off the Grand Banks.

Diameter: 0.19-0.44 mm.; thickness: 0.09-0.23 mm.

ISLANDIELLA NORCROSSI (Cushman)

Plate 4, figures 2,4

Cassidulina norcrossi CUSHMAN, 1933a, p.7, pl.2, fig.7.

REMARKS: Found only at three stations, the smallest specimen was recovered in the Median valley of the Mid Atlantic Ridge. The other ten specimens are found in the slope area off Nova Scotia and off the Grand Banks. One of these specimens is dark grey in color, the others are normal.

Diameter: 0.16-0.38 mm.; thickness: 0.09-0.24 mm.

Genus CASSIDULINOIDES Cushman, 1927

CASSIDULINOIDES TENUIS Phleger & Parker

Cassidulinoides tenuis PHLEGER & PARKER, 1951, p.27, pl.14, figs.14-17. - TODD, 1965, p.46, pl.7, fig.9.

REMARKS: Present at 5 stations, abundant in one slope station where the only mature individuals were recovered. These are larger than Phleger and Parker's specimens. Except for that one station in the slope area, this species is rare.

Length: 0.20-0.79 mm.; breadth: 0.09-0.20 mm.

Family EOUVIGERINIDAE Cushman, 1927

Genus SIPHONODOSARIA A. Silvestri, 1924

SIPHONODOSARIA CONSOBRINA (d'Orbigny)

2 2

OF/DE

Dentalina consobrina D'ORBIGNY, 1846, p.46, pl.2, figs.1-3. (fide Ellis & Messina, 1940, et seq.).

Nodosaria consobrina (d'Orbigny), BRADY, 1884, pl.62, figs.23,24. (fide Barker, 1960).

REMARKS: The aperture is circular with a projecting tooth. Rare; broken segments are found at 2 Ridge stations.

Length: 0.19 mm.; width: 0.10 mm.

Family BULIMINIDAE Jones, 1875.

Genus BULIMINA d'Orbigny, 1826.

BULIMINA ACULEATA d'Orbigny

Plate 3, figure 3

Polymorphium pineiformium SOLDANI, 1791, p.119, pl.127, fig.1, pl.130, fig.vv. (fide Ellis & Messina, 1940, et seq.).

Bulimina aculeata D'ORBIGNY, 1826, p.269, type fig. not given. — PARKER, JONES & BRADY, 1871, pl.11, fig.128 (fig. after Soldani). (fide Ellis & Messina, 1940, et seq.).
— CUSHMAN, 1922a, p.96, pl.22, figs.1,2.

REMARKS: Rare; single specimens recovered in three samples; at the other two stations where the species was found, one station had sixteen specimens, the other eight.

Length: 0.25-0.41 mm.; width 0.15-0.24 mm.

BULIMINA ALAZANENSIS Cushman forma A

Bulimina alazanensis CUSHMAN, 1927a, p.161, pl.25, fig.4. — BELFORD, 1966, p.62, pl.5, figs. 9-11. — UBALDO, 1973, p.102.

REMARKS: Though the longitudinal costae are continuous throughout the length of the test, they are indented at regular intervals and the costae are more numerous than in Cushman's type specimens. Rare; three specimens recovered at two stations.

Length: 0.28-0.63 mm.; breadth: 0.21-0.23 mm.

BULIMINA COSTATA d'Orbigny

Bulimina costata D'ORBIGNY, 1852, p.194, type fig. in Fornasini, 1901, p.174, t.f.1. (fide Ellis & Messina, 1940, et seq.). — CUSHMAN & PARKER, 1947, p.115, pl.17, figs.2-3. ROCHA & UBALDO, 1964, p.85. est.7, fig.10.

REMARKS: The costae start in the middle of each chamber and terminate as long spines in the initial chambers and shorter ones in later chambers. They are not continuous along the length of the test nor are they arranged in continuous lines. Rare; single specimen with atrophied spines recovered from the Ridge area and 23 specimens found at 2 slope stations.

Their condition varies from well preserved, to etched to broken specimens.

Length: 0.15-0.63 mm.; width: 0.16-0.05 mm.

BULIMINA ELONGATA d'Orbigny

Plate 3, figure 6

Bulimina elongata D'ORBIGNY, 1846, p.187, pl.11, figs.19-20. (fide Ellis & Messina, 1940, *et seq.*).

REMARKS: - Like the other *Bulimina* species this one also has a patchy distribution: at one station on the slope off Nova Scotia 70 specimens were recovered. Twenty-one specimens were found in the Median Valley of the Mid Atlantic Ridge. Three other stations yielded a total of 5 specimens.

Length: 0.16-0.26 mm.; breadth: 0.10 mm.

BULIMINA GIBBA Fornasini

Bulimina gibba FORNASINI, 1902, p.378, pl.10, figs.32,34. (fide Ellis & Messina, 1940, *et seq.*). - BRADY, 1884, pl.50, figs.1-4. (fide Barker, 1960).

REMARKS: Rare; 3 specimens recovered at 2 slope stations.

Length: 0.14-0.16 mm.; width: 0.09-0.10 mm.

Genus GLOBOBULIMINA Cushman, 1927

GLOBOBULIMINA AFFINIS d'Orbigny

Bulimina affinis D'ORBIGNY, 1839a, p.105, type fig. (in Atlas published separately), pl.2, figs.25,26. (fide Ellis & Messina, 1940, *et seq.*).
Globobulimina affinis (d'Orbigny), PHLEGER, PARKER & PEIRSON, 1953, p.34, pl.6, fig.32.

REMARKS: The specimens recovered resemble d'Orbigny's in that they have a pointed initial end as opposed to Phleger, Parker and Peirson's more rounded specimens. Rare; 10 specimens recovered at 2 slope stations.

Length: 0.21-0.89 mm.; width: 0.14-0.34 mm.

GLOBOBULIMINA PACIFICA Cushman

Globobulimina pacifica CUSHMAN, 1927b, p.67, pl.14, fig.12. - LOEBLICH & TAPPAN, 1964, p.C560, figs.442,4.

REMARKS: Only 4 specimens recovered at one station located on the slope.

Length: 0.31-0.59 mm.; width: 0.20-0.38 mm.

Family UVIGERINIDAE Haeckel, 1894

Genus UVIGERINA d'Orbigny, 1826

UVIGERINA AUBERIANA d'Orbigny

Plate 3, figure 9

Uvigerina auberiana D'ORBIGNY, 1839a, p.106, type fig. published separately in Atlas, pl.2, figs.23-24. – CUSHMAN, 1923, p.163, pl.42, figs.3,4. – PHLEGER, PARKER & PEIRSON, 1953, p.37, pl.7, fig.33 (not figs.30,31,32,34,35).

REMARKS: Figure 33 in Phleger, Parker and Peirson illustrates well the characteristics of the specimens recovered, especially the deep sutures at an acute angle to the long axis of the test. Quite common though never really abundant in the Ridge area, it is absent from the slope area.

Length: 0.23-0.64 mm.; thickness: 0.14-0.23 mm.

UVIGERINA CANARIENSIS d'Orbigny

Uvigerina canariensis D'ORBIGNY, 1839c, p.138, pl.1, figs.25-27. (fide Ellis & Messina, 1940, *et seq.*). – BRADY, 1884, pl.74, figs.1,2,3. (fide Barker, 1960).

REMARKS: D'Orbigny describes this species as having pointed extremities. The specimens recovered resemble more those illustrated by Brady in that they have a globular initial end. D'Orbigny also specifies that the test has a triangular appearance when viewed from the top due to the fact that each chamber is placed immediately above the preceding one in the previous spire. Again, the specimens recovered resemble those illustrated by Brady with a subrounded periphery. Rare; 5 specimens recovered at a Ridge station.

Length: 0.15-0.30 mm.; thickness: 0.09-0.20 mm.

UVIGERINA HOLLICKI Cushman

Plate 4, figures 7-9

Uvigerina peregrina Cushman, var. *bradyana* CUSHMAN, 1923, p.168, pl.42, fig.12. (not *Uvigerina bradyana* Fornasini, 1900).

Uvigerina hollicki THALMAN, 1950, p.45, type fig. in Cushman, 1923, pl.42, fig.12. (as *U. peregrina* Cushman var. *bradyana* Cushman). – PHLEGER, PARKER & PEIRSON, 1953, p.38, pl.8, figs.1,2,3.

REMARKS: *U. hollicki* closely resembles *U. peregrina*. The difference is one of degree.

▼ *U. hollicki* has a more elongate and slender test, is less punctate and has lower costae. Phleger, Parker and Peirson believe that *U. hollicki* "replaces" *U. peregrina* in deep waters. Abundant at two stations, one on the slope the other in the Ridge area, otherwise rare with 12 specimens recovered at 4 stations

Length: 0.14-0.76 mm.; width: 0.10-0.29 mm.

Genus TRIFARINA Cushman, 1923

TRIFARINA ALBATROSSI (Cushman) sub. ORNATA Cushman

Angulogerina albatrossi Cushman var. *ornata* CUSHMAN, 1932, p.45, pl.6, figs.13-14; — 1942, p.57, pl.15, figs.10,11.

REMARKS: *Trifarina* differs from *Uvigerina* in being angular in section and in tending to become uniserial in the adult stage. The specimens recovered do not resemble the type illustrated in that the final chambers are smaller, more elongate and costate. They are closer to Cushman's 1942 illustrations. Rare; though 15 specimens were recovered at a slope station, the remaining 8 specimens are distributed among 4 stations.

Length: 0.19-0.26 mm.; width: 0.09-0.11 mm.

Family DISCORBIDAE Ehrenberg, 1838

Genus DISCORBIS Lamarck, 1804

DISCORBIS BIAPERTURATA (Pokorny)

Plate 9, figure 8

Biapertorbis biaperturata POKORNY, 1956, p.265, fig. p.264, t.fs.4,5,6. (*fide* Ellis & Messina, 1940, *et seq.*).

Discorbis biaperturata (Pokorny), LOEBLICH & TAPPAN, 1964, p.C573, figs.451,6-7.

REMARKS: There is a certain degree of variability in the appearance of this species due to the fact that some specimens are more tightly enrolled than others, resulting in individuals with higher spire and more evolute spiral-sides. Quite common in both the slope and the Ridge area but never abundant.

Diameter: 0.11-0.18 mm.; height: 0.05-0.06 mm.

Genus BUCCELLA Andersen, 1952

BUCCELLA FRIGIDA (Cushman)

Pulvinulina repanda (Fichtel & Moll) var. *karsteni* (Reuss), PARKER & JONES, 1865, (part), p.396, pl.14, figs.14-15,17 (not pl.16, figs.38-40). (*fide* Ellis & Messina, 1940, *et seq.*).

Pulvinulina frigida CUSHMAN, 1922b, p.12, type fig. in Fichtel & Moll, op. cit. pl.14, figs.14,15,17.

Buccella frigida (Cushman), ANDERSEN, 1952, p.144, figs.p.147, t.fs.4-6. — LAGOE, 1977, p.126, pl.4, figs.3,4.

REMARKS: Twenty-three specimens recovered at 2 slope stations.

Diameter: 0.16-0.31 mm.; thickness: 0.06-0.14 mm.

Genus EPISTOMINELLA Husezima & Maruhasi, 1944.

EPISTOMINELLA EXIGUA (Brady)

Plate 5, figures 1-2

Pulvinulina exigua BRADY, 1884, pl. 103, figs. 13-14. (fide Barker, 1960).

Pseudoparella exigua (Brady), LIPPS, 1965, p. 133, pl. 1, fig. 9.

Epistominella exigua (Brady), TODD, 1965, p. 30, pl. 10, fig. 1.

REMARKS: This species comes in two varieties. The more abundant type has oblique spiral sutures and fewer chambers, 12-14 on the spiral side and 5 on the umbilical side. The other form has radial spiral sutures with 14-17 chambers visible on the spiral side and approximately 8 on the umbilical side. This is the only species recovered at all stations and it is one of the 3 most important species in terms of number of specimens per sample.

Diameter: 0.11-0.25 mm.; thickness: 0.08-0.13 mm.

Genus GAVELINOPSIS Hofker, 1951

GAVELINOPSIS LOBATULUS Parr

Discorbis lobatulus PARR, 1950, p. 354, pl. 13, figs. 23-25.

Discorbina isabelleana (d'Orbigny), BRADY, 1884, pl. 88, fig. 1. (fide Ellis & Messina, 1940, et seq.).

REMARKS: Though Parr's description fits very well the specimens recovered I find his illustrations misleading. His specimens appear concavo-convex and seem to be missing the umbilical plug. The 2 specimens recovered are biconvex with a prominent umbilical plug. They closely resemble Brady's illustration. Single specimens recovered at 2 stations.

Diameter: 0.13-0.18 mm.; thickness: 0.08-0.09 mm.

Genus LATICARININA Galloway & Wissler, 1927

LATICARININA PAUPERATA (Parker & Jones)

Pulvinulina repanda Fichtel & Moll var. *menardii* d'Orbigny sub. var. *pauperata* PARKER & JONES, 1865, p. 395, pl. 16, fig. 50. (fide Ellis & Messina, 1940, et seq.).

Laticarinina pauperata (Parker & Jones), BELFORD, 1966, p. 92, figs. 9-13. — PFLUM & FRERICHS, 1976, pl. 1, fig. 10.

REMARKS: The species is common in the Ridge area though the number of specimens is low. It is absent from the slope.

Diameter: 0.23-0.79 mm.; thickness: 0.09-0.19 mm.

Family GLABRATELLIDAE Loeblich & Tappan, 1964

Genus HERONALLENIA Cushman & Parr, 1931

HERONALLENIA PARVA Parr

Plate 5, figures 7,8

Heronallenia parva PARR, 1950, p.358, pl.14, fig.10.

REMARKS: The beaded texture, as described by Parr, is not always evident on the smaller specimens but it is readily seen on the larger ones. The raised sutures are characteristic of the species. The species is common in the Ridge area, though the number of specimens is low. It was recovered at one slope station.

Diameter: 0.11-0.21 mm.; thickness: 0.03-0.04 mm.

HERONALLENIA SP.

Characterised by strongly sigmoidal sutures on the ventral side, an aperture with radiating grooves, flush sutures on the dorsal side and a strongly beaded texture. Rare; 4 specimens recovered at 3 Ridge stations.

Diameter: 0.14-0.34 mm.; thickness: 0.04-0.06 mm.

Family SPIRILLINIDAE Reuss, 1862

Genus PATELLINA Williamson, 1858

PATELLINA CORRUGATA Williamson

Patellina corrugata WILLIAMSON, 1858, p.46, pl.3, figs.86-89. (fide Ellis & Messina, 1940, *et seq.*). - VILK, 1969, p.50, pl.3, fig.11. - BERTHOLD, 1976, pp.167-185, pls.1-8. - LAGOE, 1977, p.126, pl.4, figs.11,12.

REMARKS: The species is common though the number of specimens is low, one or two individuals were recovered at most stations.

Diameter: 0.13-0.24 mm.; thickness: 0.04-0.05 mm.

Family ELPHIDIIDAE Galloway, 1933

Genus ELPHIDIUM de Montfort, 1808

ELPHIDIUM EXCAVATUM Terquem

Plate 5, figures 4,5

Polystomella excavata TERQUEM, 1875, p.429, pl.2, fig.2. (fide Ellis & Messina, 1940, *et seq.*).

Elphidium excavatum (Terquem), FEYLING-HANSEN, 1972, pp.337-354, pls.1-6.

REMARKS: The periphery varies from rounded to subacute, some specimens are well

preserved, others are badly etched and broken. The criteria used in identifying this species are the nature of the sutures and the size and form of the plug. Initially the sutures are flush with small sutural pores near the umbilicus, then in the last formed chambers the sutures are slightly depressed with large pores extending from the umbilicus to the periphery. The apertural face is a high arch with the aperture consisting of a row of pores partly obscured by fine pustules located all along the base of the septal face. The area around the plug is partly resorbed, with a rather small, oval shaped plug in the center. Rare in the Mid Atlantic Ridge area, it is found at all but one of the slope stations. It is one of the dominant species at two stations located on the slope off Nova Scotia.

Diameter: 0.16-0.48 mm., thickness: 0.10-0.24 mm.

Family EPONIDIDAE Hofker, 1951

Genus EPONIDES de Montfort, 1808

EPONIDES POLIUS Phleger & Parker

Plate 6, figures 1-3

Eponides polius PHLEGER & PARKER, 1951, p.21, pl.11, figs.1-2.

REMARKS: Test plano-convex to biconvex, spiral side evolute, composed of three whorls. In many cases the initial chambers are yellowish-brown, becoming white in later stages. The chambers of the outer whorl have curved, oblique sutures. The umbilical side is involute, approximately 11 chambers are visible and the sutures are radial. The apertural face is high. Abundant in the Ridge area where it is present in all but one sample. It is rare in the slope area where only 5 small specimens were recovered.

Diameter: 0.13-0.20 mm.; thickness: 0.07-0.14 mm.

EPONIDES TENER (Brady)

Plate 6, figures 4-6

Truicatulina tener BRADY, 1884, p.665, pl.95, fig.11. (fide Barker, 1960).

Eponides tener (Brady), VILKS, 1969, p.50, pl.3. — LAGOE, 1977, p.127, pl.5, figs.3,7,14.

REMARKS: Test unequally biconvex with a rather high spiral side and a low dorsal side. All chambers visible on spiral side, sutures radial. Umbilical side evolute, only 7 chambers visible, sutures curved to slightly sigmoidal. Low apertural face, the aperture is a slit extending from the periphery to 1/3 of the way up. Five megalospheric specimens were

recovered. They resemble *E. umbonatus* with their large proloculus and the clear shell deposits on the spiral surface, but they are lobate like *E. tener* and are unequally biconvex with a low ventral side. This species is common and the number of specimen is abundant. Recovered at all but three stations, it was not found on the slope off the Grand Banks. Diameter: 0.14-0.38 mm.; thickness: 0.08-0.21 mm.

EPONIDES TUMIDULUS (Brady)

Plate 6, figures 7-9

Truncatulina tumidula BRADY, 1884, p.666, pl.95, fig.8. (*fide* Ellis & Messina, 1940, *et seq.*).

Eponides tumidulus (Brady). CUSHMAN, 1931, p.55, pl.11, fig.6. — PHLEGER & PARKER, 1951, p.21, pl.11, figs.7,8.

REMARKS: In 12 samples this is the most significant species in terms of numbers. It is present at all but 2 stations located on the slope off the Grand Banks. Most specimens are white in color and are identical to the type described by Brady. There is a form however, which differs in that it is reddish-brown in color. Though the number of specimens recovered is low, the species is fairly common.

Diameter: 0.09-0.34 mm.; thickness: 0.06-0.15 mm.

EPONIDES UMBONATUS (Reuss)

Rotalina umbonata REUSS, 1851, p.75, pl.5, fig.35. (*fide* Ellis & Messina, 1940, *et seq.*).
Eponides umbonatus (Reuss), PHLEGER & PARKER, 1951, p.22, pl.11, figs.10,13,14.

REMARKS: Differs from *E. tener* in the highly sigmoidal suture pattern found on the umbilical side, the large proloculus and the fact that the spiral sutures are almost completely hidden by a calcareous boss. The test is unequally biconvex with a high umbilical side and a low spiral side. Only 8 specimens recovered at 4 stations.

Diameter: 0.75 mm.; thickness: 0.14-0.44 mm.

Family CIBICIDIDAE Cushman, 1927

Genus CIBICIDES de Montfort

CIBICIDES BRADII (Tolmachoff)

Plate 7, figures 1-3

Planulina bradii TOLMACHOFF, 1934, p.333, pl.41, figs.32-34

Truncatulina wuellerstorfi BRADY, 1884, pl.93, fig.8 (non 9) (non *Anomalina wuellerstorfi* Schwager, 1866). (*fide* Barker, 1960).

REMARKS: Rare; 24 specimens recovered at 5 stations from both the Ridge and the slope areas.

Diameter: 0.30-0.76 mm.; height: 0.19-0.24 mm.

CIBICIDES CICATRICOSUS (Schwager)

Anomalina cicatricosus SCHWAGER, 1866, p.260, pl.7, fig.4. (fide Ellis & Messina, 1940, et seq.).

Cibicides cicatricosus (Schwager), CUSHMAN, TODD & POST, 1954, p.371, pl.91, figs. 25, 26. — TODD, 1965, p.52, pl.22, fig.3.

REMARKS: Not all specimens have a partly evolute dorsal side, some are completely evolute. Some specimens have a depressed umbilical area whereas in others it is filled with a plug. Rare; 25 specimens recovered at 8 stations from both the Ridge and the slope area.

Diameter: 0.26-0.68 mm.; height: 0.13-0.35 mm.

CIBICIDES LOBATULUS (Walker & Jacob)

Plate 8, figures 1-2

Nautilus lobatulus WALKER & JACOB, 1798, p.642, pl.14, fig.36. (fide Ellis & Messina, 1940, et seq.).

Cibicides lobatulus (Walker & Jacob), ROCHA & UBALDO, 1964, p.120, est.12, figs. 11 & 15.

REMARKS: Two forms that differ in their initial juvenile stage have been included here. The first one is characterized by numerous, small, regularly arranged chambers and the other type has large, loosely coiled initial chambers. In both types the adult specimens consist of loosely coiled, rapidly enlarging chambers, characterized by their very irregular shape. This very common species was recovered at all but two stations located off the slope of the Grand Banks. The number of specimens is usually high with an average of 20 specimens per station.

Diameter: 0.20-0.63 mm.; height: 0.06-0.13 mm.

CIBICIDES ROBERTSONIANUS (Brady)

Plate 7, figures 4-6

Truncatulina robertsonianus BRADY, 1881, p.65, type fig. in Brady, 1884, p.664, pl.95, fig.4. (fide Ellis & Messina, 1940, et seq.).

Cibicides robertsonianus (Brady), CUSHMAN, 1931, p.121, pl.23, fig.6. — TODD, 1965, p.54, pl.22, fig.8. — PFLUM & FRERICHs, 1976, pl.3, figs.3,4,5.

REMARKS: Common but not abundant, it was recovered from both the Ridge and the slope areas.

Diameter: 0.31-0.79 mm.; thickness: 0.15-0.31 mm.

CIBICIDES WUELLERSTORFI (Schwager)

Plate 7, figures 7-9

Anomalina wuellerstorfi SCHWAGER, 1866, p.258, pl.7, figs.105-107 (*vide* Ellis & Messina, 1940, *et seq.*).

Planulina wuellerstorfi (Schwager), ROCHA & UBALDO, 1964, p.122, ~~et~~ figs.13,16-17.
– TODD, 1965, p.51, pl.23, figs.3-5.

Cibicides wuellerstorfi (Schwager), PFLUM & FRERICHS, 1976, pl.4, figs.2,3,4.

REMARKS: Though many specimens exhibit the high spire characteristic of *Planulina bradii* Tolmachoff, they possess a subacute periphery and an aperture extending along the spiral suture. This species was recovered in every sample and is abundant at all but 5 stations.

Diameter: 0.20-0.44 mm.; height: 0.09-0.18 mm.

CIBICIDES SP.A

Test small, periphery bluntly rounded, 6 chambers visible on the umbilical side, aperture extends along the spiral suture. May be a variety of *C. lobatulus*, it resembles the specimen illustrated by Brady (1884), pl.95, fig.1 (not figs.4 and 5), except that it is much smaller and has no carina. Seven specimens recovered at 3 stations from the Ridge area.

Diameter: 0.11-0.16 mm.; height: 0.05 mm.

Family CAUCASINIDAE M.K. Bykova, 1959

Genus FRANCESITA Loeblich & Tappan, 1963

FRANCESITA ADVENA (Cushman)

Virgulina advena CUSHMAN, 1922a, p.120, pl.25, figs.1-3.

Francesita advena (Cushman), LOEBLICH & TAPPAN, 1963, p.215. – PFLUM & FRERICHS, 1976, pl.4, figs.6-7.

REMARKS: Only 6 specimens recovered at 5 Ridge stations.

Length: 0.30-0.56 mm.; breadth: 0.18-0.23 mm.

Genus FURSENKOINA Loeblich & Tappan, 1961

FURSENKOINA TESSALLATA (Phleger & Parker)

Virgulina tessallata PHLEGER & PARKER, 1951, p.19, pl.9, figs.15,16. – PHLEGER, PARKER & PEIRSON, 1953, p.35, pl.7, fig.8.

REMARKS: The 3 specimens recovered are smaller than Phleger and Parker's type,

...25 mm. - vs .4 mm. but otherwise conform to their description. The decision to assign this species to the genus *Fursenkoina* instead of *Cassidella* is based solely on external characteristics: chamber height, breadth and twisted test. Because the test is very small and fragile it is impossible to determine if the initial portion is biserial or triserial and to see the tooth plate. The aperture is comma shaped. Single specimens recovered at three Ridge stations.

Length: 0.19-0.25 mm.; breadth: 0.06-0.09 mm.

Genus CASSIDELLA Hofker, 1951

CASSIDELLA BRADYI (Cushman)

Virgulina subsquammosa BRADY (part) (not Egger), 1884, pl.52, fig.9. (fide Barker, 1960).
Virgulina bradyi CUSHMAN, 1922a, p.115, pl.24, fig.1.

REMARKS: The single specimen recovered has a more pointed initial end than either of Cushman or Brady's illustration, otherwise it is the same. The nature of the tooth plate would indicate this species belongs to the *Cassidella*.

Length: 0.44 mm.; breadth: 0.19 mm.

CASSIDELLA COMPLANATA (Egger)

Plate 5, figure 9

Virgulina schreibersiana Czjzek var. *complanata* EGGER, 1893, p.292, pl.8, figs.91-92.
 (fide Ellis & Messina, 1940, et seq.).
Cassidella complanata (Egger), VILKS, 1969, p.5, pl.3, fig.18. — LAGOE, 1977, p.127, pl.4, fig. 10.

REMARKS: Though the species is common in the Ridge area, the number of specimens is low. It is recovered at every slope station and is abundant in two samples located off Nova Scotia.

Length: 0.13-0.41 mm.; breadth: 0.05-0.13 mm.

CASSIDELLA TEXTURATA (Brady)

Virgullna texturata BRADY, 1884, p.415, pl.52, fig.6. (fide Barker, 1960).

REMARKS: This is a tentative identification as the two specimens recovered are juveniles. The tests are fragile and in both specimens the final chamber has been broken. The chambers are numerous and biserially arranged, the test is tapering with the widest portion at the apertural end. The aperture is as illustrated by Brady.

Length: 0.19-0.26 mm.; breadth: 0.09-0.11 mm.

Family LOXOSTOMIDAE Loeblich & Tappan, 1962

Genus LOXOSTOMUM Ehrenberg, 1854

LOXOSTOMUM TRUNCATUM Phleger & Parker

Plate 5, figures 3,6

Loxostomum truncatum PHLEGER & PARKER, 1951, p.17, pl.7, figs.15,16,17.

REMARKS: This is an important species of the Ridge area where approximately 1400 individuals were recovered at 15 stations. It is almost absent from the slope area where only three individuals were found.

Length: 0.13-0.29 mm.; breadth: 0.09-0.16 mm.; thickness: 0.06 mm.

Family CASSIDULINIDAE D'Orbigny, 1839

Genus CASSIDULINA d'Orbigny, 1826

CASSIDULINA CARINATA Silvestri

Plate 8, figure 3

Cassidulina laevigata d'Orbigny var. *carinata* SILVESTRI, 1896, p.104, pl.2, fig.10, (*C. laevigata* in explanation of plate). (fide Ellis & Messina, 1940, et seq.).

Cassidulina carinata Silvestri, PHLEGER & PEIRSON, 1953, p.44, pl.9, figs.32,37.

Cassidulina laevigata d'Orbigny, BELFORD, 1966, p.138, pl.24, figs.1-4.

REMARKS: This species differs from *C. neocarinata* Thalmann (*C. laevigata* d'Orbigny var. *carinata* Cushman, 1922) by its more porous test, a shorter aperture with a wider plate instead of a long aperture with a thin plate and by the shape of the final chambers which are rhomboid in *C. carinata* and ovate in *C. neocarinata*. Also, *C. neocarinata* is flatter in side view. Patchy distribution with single specimens recovered at 7 stations and more than 100 specimens found at the remaining 6 occupied stations.

Diameter: 0.18-0.40 mm.; thickness: 0.11-0.19 mm.

CASSIDULINA DELICATA Cushman

Plate 8, figure 6

Cassidulina delicata CUSHMAN, 1927c, p.168, pl.6, fig.5. — BELFORD, 1966, p.140, text fig.16-3,-4, pl.24, figs.5-10. — UBALDO, 1973, p.107, pl.12, fig.3.

REMARKS: The species is common in the Ridge area though the number of specimens is low. It is absent from the slope area.

Diameter: 0.14-0.24 mm.; thickness: 0.10-0.15 mm.

CASSIDULINA OBTUSA Williamson

Plate 8, figure 9. Plate 9, figure 1

Cassidulina obtusa WILLIAMSON, 1858, p.69, pl.6, figs.143-144. (fide Ellis & Messina, 1940, *et seq.*). - MURRAY, 1971, p.189, pl.79.

REMARKS: *C. obtusa* differs from *C. delicata* in that the latter has a wide crescentic opening with a narrow lip and faint striations on the apertural margin. The striations are absent in *C. obtusa*. Though the aperture is also crescentic it is not as wide and it is deeper. The plate is wide. Except for one station located on the slope off the Grand Banks where 170 specimens were recovered, this is a rare species with individuals recovered from both the slope and the Ridge area

Diameter: 0.15-0.25 mm.; thickness: 0.09-0.15 mm.

CASSIDULINA SP.A

Test small, periphery subacute, chambers numerous. Impossible to count because of the frosted texture of the test. The aperture appears to be cassiduline but it is hard to define because of the small size of the test. There also seems to be a plate which covers part of the aperture. Thirteen specimens were recovered from 6 Ridge stations.

Diameter: 0.11-0.18 mm.; thickness: 0.08-0.11 mm.

Genus GLOBOCASSIDULINA Voloshinova, 1960

GLOBOCASSIDULINA CRASSA (d'Orbigny) ROSSENSIS Kennett

Plate 8, figures 7-8

Globocassidulina crassa (d'Orbigny) *rossensis* KENNETT, 1967, p.134, pl.11, figs.4-6.

REMARKS: Kennett describes the type specimen as usually having 5 chambers, sometimes 4. The individuals recovered have 3 or 4 chambers. This is an abundant species in the Ridge area but it is absent from the slope.

Diameter: 0.11-0.18 mm.; thickness: 0.09-0.16 mm.

GLOBOCASSIDULINA GEMMA (Todd)

Cassidulina gemma CUSHMAN, TODD & POST, 1954, p.366, pl.90, figs.26,27.

Globocassidulina gemma (Todd), BELFORD, 1966, p.147, pl.24, figs.22-25, text fig.16:11-12.

- UBALDO, 1973, pl.12, fig.2.

REMARKS: Single specimen recovered at a Ridge station.

Diameter: 0.15 mm.; thickness: 0.13 mm.

GLOBOCASSIDULINA SUBGLOBOSA (Brady)

Plate 8, figures 4-5

Cassidulina subglobosa BRADY, 1881, p.60, type fig. Brady, 1884, pl.54, fig.17. (fide Ellis & Messina, 1940, et seq.).

Globocassidulina subglobosa (Brady), BELFORD, 1966, p.149, pl.25, figs.11-16, text figs.17-18. LOHMANN, 1978, pl.2, figs.8-9.

REMARKS: This species is easily recognized by its globular test and its re-entrant apertural face with a looped-shape aperture. *G. crassa* var. *rossensis* is flatter, with an elongate, narrow slit at the base of the chamber and a branch at right angle to this slit.

Diameter: 0.11-0.25 mm.; thickness: 0.09-0.19 mm.

Family NONIONIDAE Schultze, 1854

Genus ASTRONONION Cushman & Edwards, 1937

ASTRONONION GALLOWAYI Loeblich & Tappan

Astrononion gallowayi LOEBLICH & TAPPAN, 1953, p.90, pl.17, figs.4-7. — VILKS, 1969, p.51, pl.3, fig. 19. — FEYLING-HANSEN, 1976, p.92, fig.8:5-6.

REMARKS: The specimens from the slope area resemble Loeblich and Tappan's type specimens more closely than those from the Ridge area. The individuals recovered on the slope have depressed and curved sutures and well developed secondary chambers, whereas the Ridge specimens have less depressed sutures and the secondary chambers are hardly developed. Rare; 14 specimens recovered at 8 stations.

Diameter: 0.18-0.31 mm.; thickness: 0.09-0.16 mm.

Genus FLORILUS de Montfort, 1808

FLORILUS ASTERIZANS Fichtel & Moll

Nautilus asterizans FICHTEL & MOLL, 1798, p.37. (fide Ellis & Messina, 1940, et seq.).
Nonionina boueana d'Orbigny, BRADY, 1884, pl.109, figs.12,13. (fide Barker, 1960).
Florilus asterizans (Fichtel & Moll), LOEBLICH & TAPPAN, 1964, p.C747, Fig.612,4.

REMARKS: Single specimen was recovered at one station in the Median Valley of the Ridge.

Length: 0.30 mm.; width: 0.19 mm.; breadth: 0.14 mm.

FLORILUS ATLANTICA (Cushman)

Plate 10, figures 1-3

Nonionella atlantica CUSHMAN, 1947, p.90, pl.20, figs.4-5. — BOLTOVSKOY, 1959b, p.76, pl.10, fig.14. — UCHIO, 1960, pl.4, figs.11,12. — BELFORD, 1966, p.160, pl.31, figs.21-23. — SEN GUPTA & SCHAFER, 1973, p.359; pl.2, fig.3.

REMARKS: Belford's illustration most closely resembles the specimens recovered as the asymmetry is more pronounced than in the other references. This asymmetry is due to 14 chambers being visible on the dorsal side and only 8 on the umbilical side. This species is assigned to the genus *Florilus* as it has a flaring test, the umbilical region is slightly depressed, filled with granular skeletal material and it has no single umbilical chamber extension. The species is common in both the Ridge and slope areas but the number of specimens is low.

Height: 0.15-0.36 mm.; breadth: 0.06-0.13 mm.; width: 0.08-0.21 mm.

Genus NONIONELLINA Voloshinova, 1958

NONIONELLINA LABRADORICA Dawson

Nonionina labradorica DAWSON, 1860, p.191, fig.4. (*fide* Ellis & Messina, 1940, *et seq.*).
Nonion labradoricum (Dawson), LOEBLICH & TAPPAN, 1953, p.86, pl.17, figs.1-2.
Nonionellina labradorica (Dawson), VILKS, 1969, p.51, pl.3, fig.20.

REMARKS: This species was recovered only at two stations located on the slope off the Grand Banks. Nine of the 25 specimens are either partially or completely filled with a black material.

Height: 0.14-0.34 mm.; breadth: 0.09-0.16 mm.; thickness: 0.10-0.23 mm.

Genus PULLENIA Parker & Jones in Carpenter, Parker & Jones

PULLENIA BULLOIDES (d'Orbigny)

Plate 10, figures 7-8

Nonionina bulloides D'ORBIGNY, 1825 (1826), p.127, (293), no. 2 (nom. nud.), 1846, p.107, pl.5, figs.9-10 (*fide* Ellis & Messina, 1940, *et seq.*).
Pullenia sphaeroides (d'Orbigny), BRADY, 1884, pl.84, figs.12,13. (*fide* Barker, 1960). — CUSHMAN, 1924, p.40, pl.8, figs.3-4.
Pullenia bulloides (d'Orbigny), TODD, 1965, p.48, pl.18, fig.6. — LOHMANN, 1978, pl.1, figs.10,11.

REMARKS: Characterised by its low apertural face and compact, globular outline as seen in profile. Number of chambers 4 or 5, sutures flush. The species is common in both the Ridge and slope areas but the number of specimens is low.

Diameter: 0.19-0.51 mm.; height: 0.19-0.51 mm.; thickness: 0.15-0.46 mm.

PULLENIA SUBCARINATA (d'Orbigny)

Plate 10, figures 4-5

Nonionina subcarinata D'ORBIGNY, 1839b, p.28, pl.5, figs.23,24 (*fide* Ellis & Messina, 1940, *et seq.*).

Nonionina quinqueloba REUSS, 1851, p.71, pl.5, fig.31. (*fide* Ellis & Messina, 1940, *et seq.*).

Pullenia subcarinata (d'Orbigny), HERON-ALLEN & EARLAND, 1932, p.403, pl.63, figs.14-18.

Pullenia quinqueloba (Reuss), PARKER, 1964, p.627, pl.100, figs.1-6. — TODD, 1965, p.48, pl.18, fig.7.

REMARKS: Heron-Allen and Earland (1932) believe that *P. quinqueloba* is a deep water form of *P. subcarinata*. Most of the individuals recovered have 5 chambers but there are a few 4 and 6 chambered specimens. Recovered at all but 2 stations, it is abundant in most samples.

Diameter: 0.11-0.50 mm.; height: 0.11-0.56 mm.; thickness: 0.06-0.37 mm.

Family ALABAMINIDAE Hofker, 1951

Genus ALABAMINA Toulmin, 1941

ALABAMINA ? UMBONIFERA (Cushman)

Plate 9, figures 2-5

Pulvinulinella umbonifera CUSHMAN, 1933b, p.90, pl.9, fig.9.

Nuttalides umbonifera (Cushman), TODD, 1965, p.29, pl.11, fig.1.

Alabamina decorata (Phleger & Parker), PFLUM & FRERICHS, 1976, pl.6, figs.8,9, pl.7, fig.1.

"*Epistominella*" *umbonifera* (Cushman), LOHMANN, 1978, p.26, pl.3, figs.1-6.

REMARKS: Todd's description fits very well the specimens recovered. "The specimens exhibit considerable variation in size, thickness, abutment of the periphery, number of chambers, relative prominence of umbilical plug, degree to which an infolding of the wall extends into the apertural face, and smoothness and transparency of the wall." The fact that the apertural face is infolded and that a lip is visible in many specimens suggests that this may be an *Alabamina*. What makes this identification doubtful is that the periphery is porous in many cases and the spiral sutures are not strongly oblique. Recovered at all but 5 stations, it is abundant in 3 samples, two from the Ridge and one from the slope.

Diameter: 0.24-0.50 mm.; thickness: 0.13-0.25 mm.

Genus GYROIDINA d'Orbigny, 1826

GYROIDINA ALTIFORMIS R.E. & K.C. Stewart

Plate 10, figures 6,9

Gyroidina soldani d'Orbigny var. *altiformis* R.E. & K.C. STEWART, 1930, p.67, pl.9, fig.2. (*fide* Ellis & Messina, 1940, *et seq.*). — PHLEGER & PARKER, 1951, p.22, pl.11, figs.15-16.

Gyroidina altiformis R.E. & K.C. Stewart, UCHIO, 1960, pl.8, figs.13-15.

REMARKS: This species differs from other *Gyroidinas* in having its apertural face tilted backwards. It is the most common species of the genus. The species is common, it was recovered at 18 stations but the number of specimens is low.

Diameter: 0.19-0.43 mm.; height: 0.13-0.30 mm.

GYROIDINA LAMARCKIANA (d'Orbigny)

Rotalina lamarckiana D'ORBIGNY, 1839c, p.131, pl.2, figs.13-15. (*fide* Ellis & Messina, 1940, *et seq.*).

Gyroidina lamarckiana (d'Orbigny), TODD, 1965, p.19, pl.6, fig.3.

REMARKS: Test more compressed than other species of *Gyroidina*. Aperture usually quite extensive from the periphery to the umbilicus, but sometimes starts half way between the umbilicus and the periphery. Seven to eight chambers visible on the umbilical side. Rare; single specimens recovered at 8 stations from both the Ridge and the slope areas.

Diameter: 0.25-0.54 mm.; height: 0.13-0.28 mm.

GYROIDINA NEOSOLDANII Brotzen

Rotalia (Gyroidina) soldanii d'Orbigny, BRADY, 1884, pl.107, figs.6-7. (*fide* Ellis & Messina, 1940, *et seq.*).

Gyroidina neosoldanii BROTZEN, 1936, p.158, type fig. in Brady, op. cit., pl.107, figs.6-7. (*fide* Ellis & Messina, 1940, *et seq.*) — UBALDO, 1973, p.172, pl.13, fig.1. — LOHMANN, 1978, pl.1, figs.7-8 (not figs.4,5-6).

REMARKS: *G. neosoldanii* differs from *G. soldanii* in having a rounded periphery instead of subacute-subrounded. D'Orbigny's species has bulging dorsal chambers with depressed sutures whereas *neosoldanii* has flat dorsal chambers with sutures nearly flush. It is less enrolled than *soldanii* and has a rather bulging dorsal side as opposed to *soldanii*'s almost flat one. Rare; 10 specimens recovered at 6 stations from both the slope and the Ridge areas.

Diameter: 0.45-0.98 mm.; height: 0.35-0.65 mm.

GYROIDINA ORBICULARIS d'Orbigny

Gyroidina orbicularis D'ORBIGNY, 1826, p.278, type fig. in Parker, Jones & Brady, 1865, pl.3, fig.85. (*fide* Ellis & Messina, 1940, *et seq.*). — BELFORD, 1966, p.164, pl.27, figs.7-14, text fig.19:1-2, 21:1-5. — PFLUM & FRERICHs, 1976, pl.5, figs.5,6,7.

REMARKS: A highly variable species, it has a small to closed umbilicus. Umbilical side flat with 9-10 chambers visible, all chambers visible on the spiral side. Spiral sutures flush, radial to slightly oblique. Aperture a slit extending from the periphery to the umbilicus.

Rare: single specimens recovered at 3 stations, 2 specimens recovered at a station.

Diameter: 0.31-0.70 mm.; height: 0.20-0.31 mm.

GYROIDINA SOLDANII d'Orbigny

Gyroidina soldanii D'ORBIGNY, 1826, p.278, type fig. in Parker, Jones & Brady, 1871, pl.12, fig.151. (*fide* Ellis & Messina, 1940, *et seq.*). — SAIDOVA, 1961, pl.18, fig.128. — TODD, 1965, p.19, pl.6, fig.4.

REMARKS: Rare, 9 specimens recovered at 6 stations from both areas.

Diameter: 0.58-0.95 mm.; height: 0.33-0.78 mm.

Family ANOMALINIDAE Cushman, 1927

Genus ANOMALINA d'Orbigny, 1826

ANOMALINA BASSENSIS Parr

Plate 9, figures 6-7

Anomalina bassensis PARR, 1950, p.363, pl.15, fig.5.

REMARKS: Some specimens, especially those from the slope area, are very similar to Parr's type, but the fauna of the Ridge area differs in that the sutures are less depressed, giving the test a smoother, less lobate appearance. Also, they are more tightly coiled, the initial chambers sometimes being completely hidden. The color is variable with some individuals being entirely white, others have brown initial chambers. The later chambers are clear and some specimens are entirely reddish brown. The species is common, it was recovered at 17 stations, but the number of specimens is low.

Diameter: 0.11-0.21 mm.; thickness: 0.06-0.11 mm.

ANOMALINA SP.

Plate 11, figures 1-3

Test free, low trochospiral, periphery rounded. Spiral side nearly flat, evolute, 2-1/2 whorls, sutures radial, no boss. Umbilical side low, involute, 6-8 chambers, sutures slightly depressed,

aperture an interior marginal equatorial slit, extending slightly to the umbilical side. Though the number of specimens recovered is low, the species is common, occurring at all but 5 stations. Diameter: 0.11-0.29 mm.; thickness: 0.06-0.13 mm.

Genus MELONIS de Montfort, 1808

MELONIS POMPILIOIDES (Fichtel & Moll)

Plate 11, figures 4-5

Nautilus melo SOLDANI, 1780, p.100, tab.2, fig.16, tt. TT.vv.xx: 1789, p.59, tab.46, fig.qq. ? (fide Ellis & Messina, 1940, et seq.).

Nautilus pompilioides FICHTEL & MOLL, 1798, p.31, pl.2, figs.a-c. (fide Ellis & Messina, 1940, et seq.).

Melonis pompilioides (Fichtel & Moll), BELFORD, 1966, p.183, pl.30, figs.17-20. - LOHMANN, 1978, pl.1, figs.12-13.

REMARKS: In most cases the species is common but the number of specimens is low. It was recovered from both the slope and the Ridge areas. At only 3 stations were the number of individuals considered significant (10-20 specimens).

Diameter: 0.19-0.48 mm.; thickness: 0.13-0.39 mm.

MELONIS ZAANDAMI (van Voorthuysen)

Plate 11, figures 7-8

Nonion barleeaanum (Williamson) var. *inflatum* VAN VOORTHUYSEN, 1952, p.41, pl.3, fig.6, t.f.7. (fide Ellis & Messina, 1940, et seq.).

Anomalinoidea barleeaanum (Williamson) var. *inflatum* (van Voorthuysen), 1950, p.66. (fide Ellis & Messina, 1940, et seq.).

Anomalinoidea barleeaanum (Williamson) var. *zaandamae* (van Voorthuysen), THALMAN, 1952, p.265. Type fig. see van Voorthuysen, 1950. (fide Ellis & Messina, 1940, et seq.).

Melonis zaandami (van Voorthuysen), VILKS, 1969, p.51, pl.3, fig.21.

REMARKS: Differs from *M. pompilioides* in having finer, less numerous pores, curved sutures which are also slightly depressed and a higher apertural face. The test is more compressed and the umbilicus is often though not always, plugged with calcareous material. Slightly more abundant than *M. pompilioides*, it is still not a very significant species in terms of numbers.

Diameter: 0.15-0.56 mm.; width: 0.08-0.31 mm.

Family CERATOBULIMINIDAE Cushman, 1927

Genus CERATOBULIMINA Toulou, 1915

CERATOBULIMINA ARCTICA Green

Ceratobulimina arctica GREEN, 1960, p.71, pl.1, fig.1.

REMARKS: Rare, 6 specimens recovered at 3 Ridge stations.

Length: 0.14-0.20 mm.; width: 0.08-0.11 mm.; thickness: 0.06-0.08 mm.

Genus HOEGLUNDINA Brotzen, 1948

HOEGLUNDINA ELEGANS (d'Orbigny)

Plate 11, figure 6

Hammoniformis trochiformis SOLDANI, 1788-1799, tab.2, fig.R (not available). (fide Ellis & Messina, 1940, et seq.).

Rotalia (Turbinulina) elegans D'ORBIGNY, 1826, p.276, type fig. in Parker, Jones & Brady, 1871, pl.12, fig.142 - fig.R, after Soldani. (fide Ellis & Messina, 1940, et seq.).

Hoeglundina elegans (d'Orbigny), TODD, 1965, p.56, pl.23, fig.2. - BELFORD, 1966, p.190, pl.36, figs.8-13.

REMARKS: A very common species in the Ridge area though the number of specimens is low. It was not recovered on the slope off the Grand Banks, but it is abundant in one of the Nova Scotian slope samples.

Diameter: 0.41-1.15 mm.; thickness: 0.24-0.60 mm.

Family ROBERTINIDAE Reuss, 1850

Genus ROBERTINA d'Orbigny, 1846

ROBERTINOIDES BRADYI (Cushman & Parker)

Bulimina subteres BRADY, 1884, pl.50, fig.18. (fide Barker, 1960).

Robertina bradyi CUSHMAN & PARKER, 1936, p.99, pl.6, fig.9.

REMARKS: Differs from *R. charlottensis* in being a shorter, stouter form, with fewer, larger chambers. It also has a longer, broader aperture. Rare; 8 specimens recovered at 4 Ridge stations.

Length 0.25-0.34 mm.; width: 0.19-0.21 mm.

ROBERTINOIDES CHARLOTTENSIS (Cushman)

Plate 11, figure 9

Cassidulina charlottensis CUSHMAN, 1925, p.41, pl.6, figs.6-7.

Robertinoides charlottensis (Cushman), UCHIO, 1960, p.62, pl.4, fig.29. - VILKS, 1969, p.51, pl.3, fig.22.

REMARKS: The species is absent from the slope. It is common in the Ridge area, though the number of specimens is low.

Length: 0.15-0.49 mm.; width: 0.09-0.23 mm.

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APPENDIX I

SAMPLE PROCESSING TECHNIQUE

All twenty-one samples were soft and friable and consequently quite simple to process. Because they were recovered at different times these samples contain variable amounts of water. They were not dried before weighing as the purpose of this thesis is to identify benthonic species present in various environments and compare their relative abundance, not to compare the absolute standing crops. Approximately 5 gms. of sediment was weighed whether the sample was completely dry, as is the case with the 66-19 and 68-22 series, or only partly so, as is the case in the grab samples from box cores obtained in the 74-021 series. In both cases this was sufficient to insure that at least three hundred specimens were present in each sample. The weighed samples were placed in a clean 250 ml. beaker. Tap water was added to fill half the beaker and a small amount of weak dish washing detergent was used to act as a disaggregating agent. The beaker containing the sample and the solution was placed on a hot plate and allowed to simmer for about half an hour. It was then placed in an ultrasonic vibrator for thirty seconds. The residue was washed in a nest of sieves, the mesh size in order from top to bottom being 35, 60, 120 and 230. Originally the author intended to pick the first two size fractions entirely and only parts of the smaller fractions. It was soon realized that the more abundant species were mostly confined to these smaller mesh sizes. Consequently it was decided to pick the entire sample and only the 230 mesh size sieve was used. The wet sieved samples were washed into a labelled evaporating dish and placed in a low oven to evaporate and dry. The dry sample was weighed and placed in a labelled container: a folded piece of paper stored in a labelled plastic envelope.

DISTRIBUTION OF BENTHONIC FORAMINIFERA SPECIES

STATION NUMBER	(NO. OF SPECIMENS)															
	66-19-12	66-19-15	66-19-18	66-19-20	66-19-26	66-19-27	66-19-50	68-22-145	68-22-154	68-22-158	68-22-160	68-22-163	68-22-181	68-22-191	68-22-195	74-021-4C
<i>Alabammina ? umbonifera</i>																
<i>Alveolophragmium wiesneri</i>																
<i>Aminobaculites agglutinans</i>																
<i>Ammodiscus incertus</i>																
<i>Ammonia marginifera</i>																
<i>Anomalina bassensis</i>																
<i>Anomalina sp. A.</i>																
<i>Astrononion gallowayl</i>																
<i>Bolivina earlandi</i>																
<i>B. inflata</i>																
<i>B. ordinaria</i>																
<i>B. pusilla</i>																
<i>B. seminuda</i>																
<i>B. subspinescens</i>																
<i>B. sp. A.</i>																
<i>Bolivina quadrilatera</i>																
<i>Bucella frigida</i>																
<i>Bulimina aculeata</i>																
<i>Bulimina formosa A.</i>																
<i>B. costata</i>																
<i>B. elongata</i>																
<i>B. gibba</i>																
<i>Buliminella sp. A.</i>																
<i>Cassidella bradyi</i>																
<i>C. coniplanata</i>																
<i>C. texturata</i>																
<i>Cassidulina carinata</i>																
<i>C. delicata</i>																
<i>C. obtusa</i>																

APPENDIX IIA

APPENDIX IIA (continued)

STATION NUMBER

<i>C. sp. A</i>	1	1	1	3	4	5	6	66-19-50	68-22-145	68-22-154	68-22-158	68-22-160	68-22-163	68-22-181	68-22-191	68-22-195	74-021-4C	74-021-06	74-021-7C	74-021-08	74-021-25	74-021-26
<i>Cassidinoides tenuis</i>																						
<i>Ceratobulimina arctica</i>																						
<i>Cibicides bradli</i>																						
<i>C. cicatricosus</i>																						
<i>C. lobatulus</i>	1	1	4	3	2	1	1															
<i>C. robertsonianus</i>	42	18	13	29	31	44	8	19	19	48	18	21	1	13	38	11						
<i>C. wuellerstorfi</i>	33	19	33	24	61	31	4	43	14	50	17	23	1	26	61	2						
<i>C. sp. A</i>																						
<i>Cornuloculina inconstans</i>																						
<i>Cyclammina trullissata</i>																						
<i>Dentalina inornata bradyensis</i>																						
<i>Dicorbis biperturata</i>	10	4	5	4	5	6	3		2	4	7	2			2	1						
<i>Dorothia exilis</i>																						
<i>D. scabra</i>	4	1	9	4	6	10	1	14	1	12					3	21						
<i>Eggerella bradyi</i>																						
<i>E. scabra</i>																						
<i>Elphidium excavatum</i>	99	94	86	102	102	190	94	19	126	107	109	1	1	3	3	3	137	84				
<i>Epistominella exigua</i>	52	20	30	40	36	46	17	10	16	36	16	33	70	4	47	155	4	15	67	41	6	1
<i>Eponides politus</i>	32	16	27	31	30	44	8	16	28	29	16	34	34		9	59	1	59	129	15		
<i>E. tener</i>																						
<i>E. tumidulus</i>	341	189	208	337	178	568	414	1	138	140	129	125	4	143	75	13	13	78	161	60		
<i>E. rhombonatus</i>																						
<i>Fissurina alveolata</i>																						
<i>F. annectens</i>	1							2														
<i>F. auriculata</i>	1																					
<i>F. blancei</i>	1																					
<i>F. bradli</i>	1																					
<i>F. crebra</i>	1																					

APPENDIX IIIA (continued)

STATION NUMBER	66-19-12	66-19-15	66-19-18	66-19-20	66-19-26	66-19-27	66-19-50	68-22-145	68-22-154	68-22-158	68-22-160	68-22-163	68-22-181	68-22-191	68-22-195	74-021-4G	74-021-06	74-021-7C	74-021-08	74-021-25	74-021-26
<i>P. depressa</i>	2			1	1	10	2	1			1	6									
<i>P. murrhina</i>	4	1	2	6	3	3		2	2	3		7			8		9		2		
<i>Pyralina angusta</i>	2			2		2						3						2		1	
<i>P. fusiformis</i>	1	1				2					1										
<i>Quinquelaeculina amygdaloides</i>	9	2	2			17	2	2	2	2	4			2	13	3	3	1			1
<i>Q. lamarchiana</i>	6	2	4		3	6	2	10	3	10	3	9		4	3						
<i>Q. seminulum</i>	5	3	8	6	5	2	2	4	4	7	10	5		2	3						
<i>Q. venusta</i>	12	9	9	16	12	24	11	3	1	12	1	9		3	8		1				
<i>Q. vulgaris</i>						9		4		16	4	16		3							
<i>Reophax agglutinator</i>	1							1		1		1									
<i>R. bacillaris</i>																	2	3			
<i>R. distans</i>						3				6	4	4						2			
<i>Rhizammima indivisa</i>					5	2				6	3	3									
<i>Robertinoides bradyi</i>				2	4			1						1							
<i>R. charlottensis</i>	4				4	1		2	2	2	2	2		2							
<i>Saracenaria italica</i>								1													
<i>S. latifrons</i>								1													
<i>Sigmoilopsis schumbergeri</i>	4	3	3	3		3		2	5	1	1	1		1		1	34	3			
<i>Siphonodosaria consobrina</i>				1		2															
<i>Siphonotextularia affinis</i>	6	5	7	9	7	10	1	6	1	4		4	4		2						
<i>S. aff. affinis</i>							13														
<i>Spiroloculina rotunda</i>											1										
Subfamily Glandulininae																					
<i>Textularia candelana</i>							1														
<i>T. pseudogramen</i>							17														
<i>Trifarina albatrossi</i>		1					3														
<i>Trochammima antarctica</i>		2	1									2				15		1		2	

APPENDIX IIA (continued)

STATION NUMBER

<i>T. globigeriniformis</i>	66-19-12	66-19-15	66-19-18	66-19-20	66-19-26	66-19-27	66-19-50	68-22-145	68-22-154	68-22-158	68-22-160	68-22-163	68-22-181	68-22-191	68-22-195	74-021-4G	74-021-06	74-021-7C	74-021-08	74-021-25	74-021-26
<i>T. pauciloculata</i>	2		2	1	4	9	5	1	1	2	1	4			4				4		
<i>T. rotaliformis</i>			2	1		3		1	1									1			
<i>T. sorosa</i>						3						1									
<i>Uvigerina auberiana</i>		5	2	5	4	1	1	15		18	4	1		5	1						
<i>U. canariensis</i>															5						
<i>U. hollicki</i>			2					7							26		2		28		1

APPENDIX IIB (continued)

STATION NUMBER

<i>C. sp. A</i>	66-19-12	66-19-15	66-19-18	66-19-20	66-19-26	66-19-27	66-19-50	68-22-145	68-22-154	68-22-158	68-22-160	68-22-163	68-22-181	68-22-191	68-22-195	74-021-40	74-021-06	74-021-70	74-021-08	74-021-25	74-021-26
<i>Ossidulnoides tenuis</i>	.10		.14	.11	.37	.28	.82			.36				.19	.26			.32		4.89	
<i>Ceratobullina arctica</i>																					
<i>Cibicides bradleyi</i>																					
<i>C. cinctus</i>			.42	.11	.26	.84		.28	.12	.12	.30				1.43		.90	.32			
<i>C. lobatulus</i>	.10	.13	.56	.32	.26										4.56	.30	.16	.32			
<i>C. robertsonianus</i>	4.16	2.28	1.83	3.08	3.73	3.08	.83	4.62	2.66	5.61	2.80	3.11	3.57	2.43	.38	.37	.263	6.24	6.14		
<i>C. wuellerstorfi</i>	.26	.56	.21	.07		.73		.73		.47	.82	.16			7.23	.60	.272	2.47			
<i>C. sp. A</i>	3.17	2.03	4.23	2.34	6.14	2.76	.40	8.27	1.96	6.00	2.73	3.41	3.57	4.76		.80	.32	8.02	5.14	3.23	3.46
<i>Cornuloculina inconstans</i>					.12	.82								.38						.29	
<i>Cyclaminina trullissata</i>			.28		.26					.12	.47			.19	.13						
<i>Dentalina inornata bradyensis</i>				.11			.10			.12	.16			.19							
<i>Discorbis biapertura</i>	.96	.51	.70	.43	.62	.42	.31		.28	.47	1.09	.30			.26	.30	.16	.48		1.76	
<i>Dorothia exilis</i>																		.32			
<i>D. scabra</i>															.13						
<i>Eggerella bradyi</i>	.40	.13	1.27	.43	.74	.70	.10	3.41	.14	1.40		.74		.56	2.62	1.21	1.48	.64			3.46
<i>E. scabra</i>																			.30		
<i>Elphidium excavatum</i>	9.80	11.93	11.97	10.84	12.28	13.23	9.79	4.82	17.62	12.52	16.93	10.37	14.29	8.80	19.33	1.21	2.47	9.12	12.39	.91	3.46
<i>Epistominella exigua</i>	6.16	2.64	4.23	4.26	4.22	3.20	1.77	2.43	3.24	4.21	2.48	4.89		3.56	2.00		.16	.80			
<i>Eponides palisus</i>	3.17	2.03	3.80	3.29	3.62	3.06	.83	3.89	3.92	3.39	2.48	5.04		1.68	6.98	.30	9.70	4.48	4.23		
<i>E. tener</i>	33.76	23.99	38.30	36.81	21.45	39.55	43.13	.24	19.30	16.37	20.03	18.52	14.29	26.78	9.36	3.93	12.83	26.78	18.13		
<i>E. umbonatus</i>										.23	.62	.30				.30					
<i>Fissurina alveolata</i>										.12									.30		
<i>F. annectens</i>				.11		.07	.10	.48							.13		.32				
<i>F. auriculata</i>	.10	.13								.12	.16			.38	.13			.48			
<i>F. biancae</i>								.14						.19							
<i>F. bradyi</i>	.10	.28	.28	.21	.12	.14	.10			.24	.16	.16			.13			.16			3.46

APPENDIX IIB (continued)

APPENDIX IIB (continued)																				
STATION NUMBER																				
<i>F. crebra</i>	.10				.37	.07											.16	.32		
<i>F. earlandi</i>			.14														.13			
<i>F. fasciata spinosa</i>	.10	.13		.11	.21	.07		.48	.28	.72		.16					.13			
<i>F. fimbriata</i>	.10			.21	.26	.07				.12							.13			
<i>F. aff. formosa</i>	.10			.21	.12	.14		.48												
<i>F. gratiosa</i>	.10		.14	.21	.12	.14					.16	.30		.19				.32		
<i>F. kerguelensis</i>	.10		.14	.11	.12															
<i>F. lagenoides</i>			.14						.14					.19						
<i>F. lagenoides tenuistriata</i>		.13							.48	.12	.47			.19						
<i>F. lagenoides forma A</i>										.12				.19	.13		.16			
<i>F. marginata</i>		.26	.14	.43	.26	.07	.40			.12	.16	.30		.96	.26				.30	.38
<i>F. marginata spinosa</i>	.10	.86			.12	.21				.12					.26					
<i>F. sp. cf. F. marginata</i>	.10				.12	.07				.12					.26					
<i>F. obtusa</i>	.10		.14		.12	.14		.24	.14	.12		.15						.48	.50	
<i>F. orbignyana</i>	.10	.13	.14		.12					.12					.13					
<i>F. pacifica forma A</i>																				
<i>F. quadrata</i>																				
<i>F. radiata</i>	.10				.12						.16			.19						
<i>F. reniformis</i>	.10				.12	.07				.12										
<i>F. seguenziana</i>			.14	.11	.37	.14								.56	.13					
<i>F. semimarginata</i>	.10		.14	.11	.14		.24		.14	.12				.19	.13					
<i>F. submarginata</i>	.30		.14	.11	.14			.24	.28	.12	.16	.15								
<i>F. wiesneri</i>																				
<i>F. sp. 1</i>	.10			.11	.26	.07										.16				
<i>F. sp. 2</i>																				
<i>F. sp. 3</i>										.12										
<i>F. sp. 4</i>																				
<i>F. sp. 5</i>																				
<i>F. sp. 6</i>								.24		.12	.16									

APPENDIX IIB (continued)

STATION NUMBER	66-19-12	66-19-15	66-19-18	66-19-20	66-19-26	66-19-27	66-19-50	68-22-145	68-22-154	68-22-158	68-22-160	68-22-163	68-22-181	68-22-191	68-22-195	74-021-4C	74-021-06	74-021-7C	74-021-08	74-021-25	74-021-26
<i>F. sp. 7</i>																					
<i>Florilus atlantica</i>		.13	.28	.21	.48	.14	.24	.24	.42	.12		.74		.19	.13	1.21	1.65	.32		.88	
<i>F. asterizans</i>					.12		.10	.48		.12	.16										
<i>Francesita advena</i>		.13																			
<i>Fursenkoiina tessellata</i>	.10	.13																			
<i>Gavelinopsis lobatulus</i>		.13												.19			1.12	.48			
<i>Globobulimina affinis</i>																	.64				
<i>G. pacifica</i>																					
<i>Globocassidulina crassa rossensis</i>	8.12	13.07	4.37	7.08	5.90	8.27	10.31	1.48	15.94	1.29	9.16	6.81		8.06	5.81						
<i>G. gemma</i>														.19							
<i>G. subglobosa</i>	.89	.51	.86	1.17	3.37	1.08	3.02	.97	5.03	4.33	2.33	2.22		1.89	2.12		.16				
<i>Glomospira charoides</i>	.10	.13	.14	.32					.28		.47	.89						.64			
<i>G. gordialis</i>	.20	.13	.32	.32	.62	.49	.21			.23	.62	.44						.80			
<i>Gyrodina altiformis</i>	.60	.26	1.13	.32	.26	.36	.42	.97		.68	.62	1.48		1.50	1.26		.64	1.28	.60		
<i>G. lamarkiana</i>	.10		.14			.07		.24		.12	.16	.15		.38	.13		.30	.30			
<i>G. neosoldanii</i>	.10							.24		.24							.64			.30	
<i>G. orbicularis</i>														.19			.32	.16			
<i>G. soldanii</i>	.10		.14	.21		.07		.24									.32	.32			
<i>Haplophragmoides rotatum</i>										.12									.96	.30	
<i>H. sphaeriloculum</i>	.70	.26	.14	.77	.98	.36				.47	.47	1.48						.16	.30		
<i>H. subglobosum</i>				.21		.49						.15						1.12			
<i>Heronallenia parva</i>	.40	.51	.28	.43	.12	.28			.42			.30		.19				.48			
<i>H. sp. A</i>																					
<i>Hoeglundina elegans</i>	.59	.76	1.97	.43	.62	.83	2.68	.24	.84	1.17	.93	.59	10.71	1.12	.26	.60	7.57	.96			
<i>Hyperammina elongata</i>				.11	.12	.07	.24			.23		.30					.33	1.80	1.51		
<i>Islandiella helenae</i>																				2.06	13.79
<i>I. norcrossi</i>							.10													2.64	
<i>Karreriella bradyi</i>	.20		.28	.11	.49	.28	.97											.16			
<i>Lagena advena</i>	.10		.14	.11		.07	.10		.14								.33				

STATION NUMBER

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APPENDIX IIB (continued)

STATION NUMBER	74-021-26	74-021-25	74-021-08	74-021-7C	74-021-06	74-021-4C	68-22-195	68-22-191	68-22-181	68-22-163	68-22-160	68-22-158	68-22-154	68-22-145	66-19-50	66-19-27	66-19-26	66-19-20	66-19-18	66-19-15	66-19-12
<i>Pyrgo bulloides</i>											.16			.49	1.81	.12		.11			
<i>P. depressa</i>					.16					.16	.74			.24	.70	.37		.84	.28	.13	.20
<i>P. murrillina</i>			.80	.96	.99		1.00			1.04		.36	.28	1.96	.21	.70	.37	.84	.28	.13	.40
<i>Pyrrulina angusta</i>		.29		.32						.44				.14	.14	.14		.21			.20
<i>P. fusiformis</i>											.16			.14	.14				.13	.10	.10
<i>Quinqueloculina amygdaloides</i>								.38			.82	.23	.28	.49	1.18	1.18			.26	.26	.90
<i>Q. lanarkiana</i>						.91	1.62	.76			.47	1.17	.42	2.43	.42	.37			.26	.26	.80
<i>Q. seminulum</i>				.16	.49		.37	.38			1.55	.82	.56	.56	.21	.82	.82	.84	1.13	.38	.60
<i>Q. venusta</i>							1.00	.56			.16	1.40	.14	.73	1.15	1.87	1.48	1.70	1.27	1.17	1.20
<i>Q. vulgaris</i>					.16			.56			.82	1.87	.14	.97	.83						
<i>Reophax agglutinatus</i>											.12	.12		.24							
<i>R. bacillaris</i>				.48	.33																
<i>R. distans</i>				.32						.59		.70			.21	.21					
<i>Rhizaminina indivisa</i>										.44		.70			.14	.82					
<i>Robertinoides bradyi</i>								.19										.21			.40
<i>R. charlottensis</i>								.38						.24	.49	.49	.49				
<i>Saracenaria italica</i>								.38						.24	.24						
<i>S. latifrons</i>			.30					.19													
<i>Sigmillopsis schumbergeri</i>												.12	.70	.49	.21	.21		.32	.42	.26	.40
<i>Siphonodossaria consobrina</i>															.14	.14		.11			
<i>Siphonotextularia affinis</i>												.47	.14	1.46	.70	.96	.96	.96	.96	.64	.80
<i>S. aff. affinis</i>						.30								1.36							
<i>Spiroloculina rotunda</i>							.26							.24	.10					.13	
<i>Subfamily Glandulininae</i>								.38			.16				.10						
<i>Textularia candellana</i>															1.77					.26	
<i>T. pseudogramen</i>								.10							.31						
<i>Trifarina albatrossi</i>			.59	.16	4.53																

DISTRIBUTION OF MOST ABUNDANT BENTHONIC FORAMINIFERAL SPECIES

APPENDIX IIC	STATION NUMBER	(PERCENTAGE)
<i>Alabamina ? umbonifera</i>	66-19-12	
<i>Bulimina costata</i>	66-19-15	
<i>Bulimina elongata</i>	66-19-18	
<i>Cassidulina carinata</i>	66-19-20	
<i>Cassidulina obtusa</i>	66-19-26	
<i>Cibicides lobatulus</i>	66-19-27	
<i>Cibicides wuellerstorfi</i>	66-19-50	
<i>Elphidium excavatum</i>	68-22-145	
<i>Epistominella exigua</i>	68-22-154	
<i>Eponides politus</i>	68-22-160	
<i>Eponides tener</i>	68-22-181	
<i>Eponides tumidulus</i>	68-22-191	
<i>Globocassidulina crassa rossensis</i>	68-22-195	
<i>Hoeglundina elegans</i>	68-22-2163	
<i>Islandiella helenae</i>	68-22-225	
<i>Loxostomum truncatum</i>	68-22-25	
<i>Melonis zaandami</i>	68-22-7C	
<i>Nonionellina labradorica</i>	68-22-7G	
<i>Pullenia subcarinata</i>	68-22-7H	
<i>Signillopsis schumbergeri</i>	68-22-7I	
<i>Siphonotextularia affinis</i>	68-22-7J	
<i>Uvigerina hollicki</i>	68-22-7K	
Total	68-22-7L	

SUMMARY OF CORE STATIONS DATA & FAUNAL RESULTS

APPENDIX IIIA

Sample No.	Sample Location		Depth in Metres	Temperature in Degrees Celsius		Salinity in P.P.T.		Weight of Sed. in Grams		% Sed. Out	No. of Specimens per Gram	No. of Species per Sample	Coring Apparatus & Sample Depth
	Latitude	Longitude		Min.	Max.	Min.	Max.	In*	Out				
66-19-12	45-15.6 N	28-11.4 W	3085	2.8	3.0	34.95	34.96	1.26	22	17.85	804.78	78	2-5 cm. of piston core
66-19-15	45-22.2 N	28-52.5 W	2985	2.8	3.0	34.95	34.96	1.27	16	12.64	622.43	65	0-3 cm. of piston core
66-19-18	45-23.6 N	29-00.2 W	2950	2.8	3.0	34.95	34.96	1.24	22	18.09	573.51	69	4-5 cm. of piston core
66-19-20	45-13.25 N	19-12.4 W	3100	2.8	3.0	34.95	34.96	1.28	23	17.51	732.30	73	0-3 cm. of trigger core
66-19-26	45-14.25 N	28-54.5 W	2810	2.8	3.0	34.95	34.96	1.28	23	17.98	630.35	74	0-3 cm. of trigger core
66-19-27	45-27.8 N	29-17.5 W	3130	2.8	3.0	34.95	34.96	1.21	42	35.10	1188.74	88	2-5 cm. of piston core
66-19-50	45-40.4 N	27-46.0 W	3560	3.55	3.55	34.96	34.98	5.30	16	3.02	181.06	61	0-5 cm. of piston core
68-22-145	45-32.7 N	28-39.0 W	2670	3.0	3.2	34.94	34.95	2.70	92	34.20	152.28	66	powder from top of piston core
68-22-154	45-50.7 N	29-56.3 W	3120	2.6	2.8	34.94	34.95	1.43	54	37.80	498.61	63	0-3 cm. of piston core
68-22-158	45-54.9 N	29-03.9 W	2770	3.20	3.20	34.94	34.96	1.37	35	25.57	624.54	86	0-3 cm. of piston core
68-22-160	45-34.2 N	29-18.2 W	2634	2.8	3.0	34.95	34.96	1.42	34	24.10	453.84	70	0-3 cm. of piston core
68-22-163	45-19.5 N	29-51.0 W	2960	2.6	2.8	34.94	34.95	82	25	30.44	778.73	67	0-3 cm. of piston core
68-22-181	45-27.9 N	26-40.0 W	2940	3.15	3.15	34.94	34.95	1.30	25	19.37	21.60	10	0-3 cm. of piston core
68-22-191	45-9.7 N	27-25.8 W	2180	3.50	3.55	34.96	34.98	1.29	35	27.28	412.87	71	1-4 cm. of piston core
68-22-195	45-37.5 N	26-53.4 W	2760	3.00	3.20	34.94	34.95	1.34	91	68.03	597.62	66	powder from top of core
74-021-4G	42-25.6 N	63-21.9 W	1745	3.50	3.70	34.94	34.96	4.93	07	1.40	67.15	35	10-12 cm. of trigger core
74-021-46	42-04.0 N	63-11.0 W	2590	2.80	3.00	34.95	34.96	5.61	22	3.85	108.36	68	4-6 cm. of trigger core
74-021-7G	41-36.0 N	63-00.0 W	3436	2.00	2.20	34.91	34.93	5.63	32	5.77	111.05	54	4-6 cm. of trigger core
74-021-08	41-17.5 N	62-51.8 W	3851	1.90	2.00	34.89	34.90	5.00	12	2.36	66.20	33	4-6 cm. of trigger core
74-021-25	42-59.4 N	51-39.6 W	1400	3.6	3.80	34.94	34.96	5.24	29	5.46	65.13	28	grab from box core
74-021-26	43-06.9 N	51-42.0 W	1847	3.50	3.70	34.94	34.96	6.08	03	4.3	4.77	15	grab from box core

* Because of the abundant fauna contained in certain samples the processed sediments were split. Where this has occurred the weight of the unprocessed was divided by the corresponding fraction.

** From indicated depth in gravity cores.

APPENDIX IIIB

Notes on sample lithology and composition of washed residues

Sample 66-19-12

Lithology: Pale yellow to tan colored slightly indurated silt with visible pteropod fragments.

Residue: The residue is predominantly biogenic, consisting mainly of foraminifera (90%), radiolarians and ostracodes are present. There are also some rare pteropod fragments and broken echinoderm spines. The mineral fraction consists almost entirely of quartz grains. A few grains of glauconite, volcanic glass and ferruginous material were observed.

Sample 66-19-15

Lithology: Pale yellow to tan colored silty powder with a few slightly indurated fragments.

Residue: The residue is composed almost exclusively of foraminifera, with some rare radiolarians and ostracodes. Quartz grains account for no more than 3% of the material; rare mica flakes were observed along with a few pieces of volcanic glass.

Sample 66-19-18

Lithology: Pale yellow to tan colored slightly indurated silt.

Residue: The biogenic fraction comprises about 90% of the residue; it consists mainly of foraminifera with rare ostracodes, echinoderm spines and radiolarians. Volcanic glass and quartz are the dominant mineral components; glauconite is present and a few rock fragments were observed along with some pyrite grains.

Sample 66-19-20

Lithology: Pale yellow to tan colored indurated silt.

Residue: The residue is predominantly biogenic, consisting mainly of foraminifera (95%); radiolarians and pteropod fragments are present along with some rare ostracodes and sponge spicules. The mineral fraction consists of rare grains of quartz, glauconite and flakes of mica.

Sample 66-19-26

Lithology: Pale yellow to tan colored indurated silty mud

Residue: Foraminifera make up 80% of the residue, pteropod fragments and radiolarians are present along with some rare ostracodes. The mineral fraction is composed of 1-2% quartz and some rare grains of glauconite.

Sample 66-19-27

Lithology: Pale yellow to tan colored powdered silt with small indurated fragments.

Residue: Foraminifera make up 90% of the material; radiolarians are present along with some rare ostracodes. The mineral fraction consists of quartz, volcanic glass, rare glauconite grains and pumice.

Sample 66-19-50

Lithology: Pale yellow to buff colored slightly indurated mud.

Residue: The residue is predominantly biogenic, consisting mainly of foraminifera (90%) with rare radiolarians and echinoderm spines. The mineral fraction is composed of quartz and volcanic glass (5%) with a few grains of glauconite, some mica and some pumice.

Sample 68-22-145

Lithology: Pale yellow to tan colored silt size powder with some indurated fragments.

Silt size rock fragments visible.

Residue: The biogenic fraction makes up 50% of the residue; it is composed almost exclusively of foraminifera with rare ostracodes, sponge spicules and echinoderm spines. The mineral fraction consists mainly of quartz grains (40%), also present are rock fragments, ferruginous material, volcanic glass and glauconite.

Sample 68-22-154

Lithology: Pale yellow to tan colored indurated silt with visible sand size rock fragments.

Residue: The biogenic fraction makes up 50% of the residue; it is composed almost exclusively of foraminifera with some rare echinoderm spines, ostracodes, radiolarians and pteropod fragments. The mineral fraction consists mostly of quartz (40%) which exhibits

a wide range of size and shape. The remainder of the residue consists of mica, hornblende, glauconite, volcanic glass, pumice, rock fragments and ferruginous material.

Sample 68-22-158

Lithology: Pale yellow to tan colored indurated silt.

Residue: The biogenic fraction makes up 95% of the residue. Foraminifera account for 90% of the material while ostracodes and pteropod fragments make up the other 5%. There are also some rare radiolarians and echinoderm spines. The most abundant mineral is quartz; there are also a few grains of hornblende and glauconite, some rare rock fragments, volcanic glass and ferruginous material.

Sample 68-22-160

Lithology: Pale yellow to tan colored indurated silt with numerous visible pteropod fragments.

Residue: The residue consists mainly of foraminifera (80%); pteropod fragments and ostracodes are present along with some rare radiolarians and echinoderm spines. The mineral fraction consists of quartz (5%), rock fragments, mica flakes, volcanic glass and ferruginous material.

Sample 68-22-163

Lithology: Pale yellow to tan colored indurated silt with some pteropod fragments.

Residue: The residue consists almost exclusively of biogenic material. Foraminifera account for 80% of the material, broken pteropod fragments for 10% and the rest consists of radiolarians, ostracodes and echinoderm spines. There are rare grains of quartz, glauconite, ferruginous material and mica flakes.

Sample 68-22-181

Lithology: A well indurated grey colored silt with visible sand size quartz grains.

Residue: This residue consists almost entirely of non biogenic material. Quartz and volcanic glass are the main components; there is also some pyrite, hornblende, glauconite, micas, rock fragments and ferruginous material. The biogenic fraction (apx. 1%)

is made up of foraminifera.

Samples 68-22-191

Lithology. Pale yellow to tan colored indurated silt with one small pocket of ferruginous material visible.

Residue: The biogenic fraction makes up 95% of the residue, it consists almost entirely of foraminifera. Ostracodes are present along with some rare pteropod fragments, echinoderm spines and radiolarians. The mineral fraction is composed mainly of quartz. A few grains of glauconite and ferruginous material were also observed, along with some rock fragments.

Sample 68-22-195

Lithology A pale yellow to tan colored silt size powder

Residue. Foraminifera make up 90% of the residue; the remainder of the biogenic fraction consists of rare ostracodes, sponge spicules and echinoderm spines. The mineral fraction consists mainly of quartz and volcanic glass, and some rare grains of glauconite, hornblende, rock fragments, ferruginous material and mica flakes.

Sample 74-021-4G

Lithology: Grey colored well indurated mud.

Residue: The biogenic portion is dominant, comprising about 95% of the material. It consists mostly of foraminifera, many of them broken, with some rare echinoderm spines, radiolarians, and a few broken ostracodes shells. The mineral fraction consists mainly of quartz; glauconite is present along with a few grains of hornblende.

Sample 74-021-06

Lithology: Grey colored mud.

Residue: The residue consists mostly of foraminifera (95%) with abundant echinoderm spines; radiolarians are present along with a few ostracodes. The mineral fraction consists mainly of quartz grains. Rare mica flakes, hornblende and ferruginous material were also observed.

Sample 74-021-7G

Lithology Grey colored mud.

Residue: This residue consists almost exclusively of biogenic material, most of it broken. Foraminifera comprise 99% of the material, agglutinated foraminifera are abundant. There are also rare echinoderm spines. As quartz grains are rare, it is assumed that many were incorporated in the agglutinated tests. There are rare flakes of mica and some volcanic glass.

Sample 74-021-08

Lithology: Grey colored indurated mud with visible pteropods and foraminifera.

Residue The biogenic fraction makes up 75% of the residue. It consists almost exclusively of broken foraminiferal tests with some rare radiolarians. The mineral fraction is mostly quartz and volcanic glass with some glauconite, hornblende, mica flakes and rock fragments.

Sample 74-021-25

Lithology: Dark olive green mud.

Residue: The residue is composed mostly of quartz (80%) with some volcanic glass. Hornblende, pyrite and rock fragments are present as minor constituents. The biogenic fraction consists of foraminifera (10%) with some rare echinoderm spines.

Sample 74-021-26

Lithology: Dark olive green mud.

Residue: The residue consists mainly of quartz grains (70%). Pyrite grains and concretions are common, infilling some foraminifera. There are also mica flakes and glauconite grains. Foraminifera are rare (3%), most of the biogenic fraction being represented by fecal pellets (20%) and by diatoms (5%), some of them filled with pyrite.

EXPLANATION OF PLATE I

FAMILIES AMMODISCIDAE, LITUOLIDAE, TEXTULARIIDAE, TROCHAMMINIDAE

Figs.		Page
1	<i>Glomospira charoides</i> (Jones & Parker) CUCL 1, sample 68-22-163, X591	48
2	<i>Glomospira gordialis</i> (Jones & Parker) CUCL 2, sample 68-22-163, X291	48
3,6	<i>Textularia candeiana</i> d'Orbigny Fig. 3, CUCL 3, sample 66-19-50, X216 Fig. 6, CUCL 4, sample 66-19-50, X280	51
4,5	<i>Haplophragmoides sphaeriloculum</i> Cushman Fig. 4, CUCL 5, sample 68-22-163, X162 Fig. 5, CUCL 6, sample 68-22-163, X173	50
7,8	<i>Siphotextularia affinis</i> (Fornasini) Fig. 7, CUCL 7, sample 68-22-160, X212 Fig. 8, CUCL 8, sample 68-22-160, X208	52
9	<i>Trochammina globigeriniformis</i> (Parker & Jones) CUCL 9, sample 74-021-7G X214	52

EXPLANATION OF PLATE 2

FAMILIES TROCHAMMINIDAE, ATAXOPHRAGMIIDAE, MILIOLIDAE

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1	<i>Trochammina globigeriniformis</i> (Parker & Jones) CUCL 10, sample 74-021-7G, X122	52
2,3	<i>Trochammina pauciloculata</i> Brady Fig. 2, CUCL 11, sample 68-22-163, X126 Fig. 3, CUCL 12, sample 68-22-163, X114	53
4,5	<i>Sigmouloopsis schlumbergeri</i> (Silvestri) Fig. 4, CUCL 13, sample 74-021-06, X90 Fig. 5, CUCL 14, sample 74-021-06, X240	59
6,9	<i>Miliolinella circularis</i> (Bornemann) Fig. 6, CUCL 15, sample 68-22-158, X420 Fig. 9, CUCL 16, sample 68-22-158, X265	59
7,8	<i>Eggerella bradyi</i> (Cushman) Fig. 7, CUCL 17, sample 68-22-145, X180 Fig. 8, CUCL 18, sample 68-22-145, X172	54

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1,2	<i>Quinqueloculina lamarckiana</i> d'Orbigny Fig. 1, CUCL 19, sample 68-22-163, X125 Fig. 2, CUCL 20, sample 68-22-145, X275	57
3	<i>Bulimina aculeata</i> d'Orbigny CUCL 21, sample 68-22-145, X138	85
4,5	<i>Quinqueloculina venusta</i> Karrer Fig. 4, CUCL 22, sample 68-22-158, X86 Fig. 5, CUCL 23, sample 68-22-158, X135	57
6	<i>Bulimina elongata</i> d'Orbigny CUCL 24, sample 74-021-G, X208	86
7,8	<i>Quinqueloculina vulgaris</i> d'Orbigny Fig. 7, CUCL 25, sample 68-22-158, X141 Fig. 8, CUCL 26, sample 68-22-158, X129	58
9	<i>Uvigerina auferiana</i> d'Orbigny CUCL 27, sample 68-22-145, X135	87

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2,4	<i>Islandiella nörcrossi</i> (Cushman) Fig. 2, CUCL 29, apertural view, sample 74-021-25, X720 Fig. 4, CUCL 29, sample 74-021-25, X180	84
5,6,7	<i>Uvigerina hollicki</i> Thalmann Fig. 5, CUCL 30, sample 68-22-195, X66 Fig. 6, CUCL 31, sample 68-22-195, X73 Fig. 7, CUCL 32, sample 68-22-195, X77	87

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FAMILIES DISCORBIDAE, LOXOSTOMIDAE,
GLABRATELLIDAE, ELPHIDIIDAE, CAUCASINIDAE

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3,6	<i>Loxostomum truncatum</i> Phleger & Parker Fig. 3, CUCL 35, sample 68-22-158, X149 Fig. 6, CUCL 36, sample 68-22-158, X147	96
4,5	<i>Elphidium excavatum</i> Terquem Fig. 4, CUCL 37, sample 74-021-06, X157 Fig. 5, CUCL 38, sample 74-021-06, X178	90
7,8	<i>Heronallenia parva</i> Parr Fig. 7, CUCL 39, sample 68-22-154, X227 Fig. 8, CUCL 40, sample 68-22-154, X309	90
9	<i>Cassidella complanata</i> (Egger) CUCL 41, sample 74-021-06, X147	95

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FAMILY EPONIDIDAE

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4,5,6	<i>Eponides tener</i> (Brady) Fig. 4, CUCL 45, sample 68-22-158, X173 Fig. 5, CUCL 46, sample 68-22-158, X265 Fig. 6, CUCL 47, sample 68-22-158, X210	91
7,8,9	<i>Eponides tumidulus</i> (Brady) Fig. 7, CUCL 48, sample 68-22-158, X353 Fig. 8, CUCL 49, sample 68-22-158, X353 Fig. 9, CUCL 50, sample 68-22-158, X353	92

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7,8,9	<i>Cibicides wuellerstorfi</i> (Schwager)	94
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EXPLANATION OF PLATE 8

FAMILIES CIBICIDIDAE, CASSIDULINIDAE

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1,2	<i>Cibicides lobatulus</i> (Walker & Jacob) Fig. 1, CUCL 60, 68-22-158, X160 Fig. 2, CUCL 61, 68-22-158, X166	93
3	<i>Cassidulina carinata</i> Silvestri CUCL 62, 68-22-195, X110	96
4,5	<i>Globocassidulina subglobosa</i> (Brady) Fig. 4, CUCL 63, 68-22-158, X220 Fig. 5, CUCL 64, 68-22-158, X216	98
6	<i>Cassidulina delicata</i> Cushman CUCL 65, 68-22-154, X297	96
7,8	<i>Globocassidulina crassa rossensis</i> Kennett Fig. 7, CUCL 66, 68-22-145, X185 Fig. 8, CUCL 67, 74-021-25, X278	97
9	<i>Cassidulina obtusa</i> Williamson CUCL 68, 74-021-25, X263	96

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ANOMALININAE, DISCORBIDAE

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1	<i>Cassidulina obtusa</i> Williamson CUCL 68, apertural view, sample 74-021-25, X740	96
2,3,4,5	<i>Alabamina ? umbonifera</i> (Cushman) Fig. 2, CUCL 69, apertural view 68-22-158, X450 Fig. 3, CUCL 70, sample 68-22-158, X157 Fig. 4, CUCL 71, sample 68-22-158, X177 Fig. 5, CUCL 72, sample 68-22-158, X146	100
6, 7	<i>Anomalina bassensis</i> Parr Fig. 6, CUCL 73, sample 74-021-7G, X217 Fig. 7, CUCL 74, sample 74-021-7G, X297	102
8	<i>Discorbis biaperturata</i> (Pokorny) Fig. 8, CUCL 75, sample 68-22-160, X291	88

EXPLANATION OF PLATE 10
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6,9	<i>Gyroidina altiformis</i> R.E. & K.C. Stewart Fig. 6, CUCL 81, sample 68-22-158, X122 Fig. 9, CUCL 82, sample 68-22-158, X130	100
7,8	<i>Pullenia bulloides</i> (d'Orbigny) Fig. 7, CUCL 83, sample 68-22-145, X166 Fig. 8, CUCL 84, sample 68-22-145, X169	99

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FAMILIES ANOMALINIDAE, CERATOBULIMINIDAE, ROBERTINIDAE

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4,5	<i>Melonis pompilioides</i> (Fichtel & Moll) Fig. 4, CUCL 88, sample 68-22-195, X129 Fig. 5, CUCL 89, sample 68-22-195, X108	103
6	<i>Hoeglundina elegans</i> (d'Orbigny) CUCL 90, sample 68-22-158, X82	104
7,8	<i>Melonis zaandami</i> (van Voorthuysen) Fig. 7, CUCL 91, sample 68-22-195, X93 Fig. 8, CUCL 92, sample 68-22-195, X98	103
9	<i>Robertinoides charlottensis</i> (Cushman) CUCL 93, sample 68-22-145, X216	104

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