Foraminifera on the Continental Shelf and Slope off Southern Hawke’s Bay, New Zealand

by

K. B. LEWIS

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K. B. Lewis

New Zealand Oceanographic Institute,
Department of Scientific and Industrial Research,
Wellington.

ABSTRACT

Foraminiferal populations are described from a continental shelf and slope devoid of strong currents on the eastern side of North Island, New Zealand.

The large numbers of living specimens per unit area suggest that productivity is high. Except on the turbulent inner shelf, the ratio of living to dead specimens correlates well with estimated rates of deposition. A method is evolved of estimating the contribution of each species to sediment accumulation at each site.

Six, depth-controlled biofacies are described and compared with Tertiary foraminiferal biofacies. It appears that the estimated depth of deposition of some Tertiary natic and bathyal faunas may have been somewhat underestimated.

INTRODUCTION

Despite the potential value of foraminifera for closely defining the environments of deposition of ancient sediments in New Zealand, the environment in which many species of benthonic foraminifera now live and are incorporated into the sediment is known in only general terms.

Eade (1967) briefly reviewed studies of Recent foraminifera from the seabed around New Zealand and compiled a checklist of Recent New Zealand species. Most studies are either systematic descriptions or lists of species, either from a single sample or from a few closely spaced samples: distribution studies are rare. Kustanowich (1963) described the distribution of planktonic foraminifera in deep-sea sediments and Hulme (1964) gave a detailed account of the variation of shallow water benthonic species in Manukau Harbour. The only distribution study of benthonic species in the open ocean is by Vella (1957), who described the foraminifera of dried dredge samples from Cook Strait and concluded that strong bottom currents had mixed faunas from different depths so that biofacies could not be recognised.

The following investigation is an attempt to quantitatively define the distribution of foraminifera in an area devoid of strong currents and thereby to provide criteria useful for the recognition of specific environments in ancient, indurated sediments.
COLLECTION AND PROCESSING OF SAMPLES

Sixteen samples (Table 1; Fig 1) were collected for detailed quantitative analysis. The two shallowest samples were collected with an orange-peel grab, the remainder with a short gravity corer of 47 mm internal diameter, care being taken with both grab and core samples to prevent washing of the surface sediment. For a more detailed description of techniques see Lewis (1970). The area sampled by the corer was about 1700 mm$^2$ and a similar area was sampled at the two shallowest stations by pressing a piece of core liner into the surface of each grab sample. The same volume of sediment, 17 ml, representing a layer about 10 mm thick, was removed from the surface of each core and grab sample and preserved with 90% ethyl alcohol.

In the laboratory each sample was washed on a sieve with a mesh aperture of 0.06 mm, thereby removing alcohol and all material of silt and clay grade, including some juvenile and small foraminifera. The washed sample was steeped for 12-24 hours in Rose Bengal in order to stain protoplasm (Walton 1952), thereby showing which specimens were alive when collected. The stained sample was washed again on the 0.06 mm sieve and soaked in water for 12-24 hours to remove excess stain from the surface of foraminiferal tests. The sample was then washed through a nest of seven sieves with mesh apertures of 0.17 mm, 0.12 mm, 0.08 mm and 0.06 mm. The sieves sort grains, including foraminifera, according to their width, so that foraminifera on the bottom sieve have widths ranging from 0.08 mm to 0.06 mm.

Each sieve fraction was examined on a water-filled counting tray because many fragile specimens are destroyed by drying. Further, many foraminifera are translucent when wet so that stained protoplasm is easily visible. All benthonic foraminifera on randomly selected squares on the tray were identified and counted until between 100 and 200 specimens had been counted. The total number of specimens and percentage of planktonic specimens in the fraction was then calculated. Each living specimen in the whole fraction was identified and counted. Thus, in each fraction, the number of living and dead specimens of each benthonic species is known. The number in the whole sample was found by adding the numbers in each fraction.

Thirteen subsidiary samples (Table 2; Fig 1) were collected by similar techniques but the volume of each sample was not accurately measured and stained fractions were examined dry. The presence of living and dead specimens of each benthonic species was noted.

### Table 1. Position and depth of 17 ml samples.

<table>
<thead>
<tr>
<th>Sample</th>
<th>NZOI Stn</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Depth</th>
<th>Zone</th>
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<tbody>
<tr>
<td>1</td>
<td>F662</td>
<td>39° 49'</td>
<td>177° 08'</td>
<td>18 m</td>
<td>inner</td>
</tr>
<tr>
<td>2</td>
<td>F630</td>
<td>40° 37'</td>
<td>176° 26.3'</td>
<td>18 m</td>
<td>shelf</td>
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<tr>
<td>3</td>
<td>F661</td>
<td>39° 50'</td>
<td>177° 02.5'</td>
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<td></td>
</tr>
<tr>
<td>4</td>
<td>F636</td>
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</tr>
<tr>
<td>5</td>
<td>F660</td>
<td>39° 50'</td>
<td>177° 05'</td>
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<td>6</td>
<td>F659</td>
<td>39° 50'</td>
<td>177° 08'</td>
<td>130 m</td>
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<tr>
<td>7</td>
<td>F861</td>
<td>40° 01.5'</td>
<td>177° 22'</td>
<td>329 m</td>
<td>bank</td>
</tr>
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<td>8</td>
<td>F609</td>
<td>40° 45'</td>
<td>176° 40'</td>
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</tr>
<tr>
<td>9</td>
<td>F601</td>
<td>40° 50'</td>
<td>176° 44'</td>
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<tr>
<td>10</td>
<td>F863</td>
<td>40° 02'</td>
<td>177° 16.5'</td>
<td>479 m</td>
<td>slope</td>
</tr>
<tr>
<td>11</td>
<td>F999</td>
<td>40° 52'</td>
<td>176° 58'</td>
<td>1,240 m</td>
<td>mid</td>
</tr>
<tr>
<td>12</td>
<td>F673</td>
<td>40° 11'</td>
<td>177° 51'</td>
<td>1,419 m</td>
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<td>13</td>
<td>F683</td>
<td>40° 08'</td>
<td>177° 32'</td>
<td>1,646 m</td>
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</tr>
<tr>
<td>14</td>
<td>F679</td>
<td>40° 22'</td>
<td>177° 55.3'</td>
<td>2,329 m</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>F592</td>
<td>40° 50'</td>
<td>177° 42'</td>
<td>2,432 m</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>F590</td>
<td>40° 59'</td>
<td>177° 59'</td>
<td>2,469 m</td>
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</tr>
</tbody>
</table>

### Table 2. Position and depth of subsidiary samples.

<table>
<thead>
<tr>
<th>Sample</th>
<th>NZOI Stn</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Depth</th>
<th>Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B865</td>
<td>40° 13.8'</td>
<td>176° 48.8'</td>
<td>40 m</td>
<td>inner</td>
</tr>
<tr>
<td>B</td>
<td>B863</td>
<td>40° 31.6'</td>
<td>176° 39.5'</td>
<td>42 m</td>
<td>shelf</td>
</tr>
<tr>
<td>C</td>
<td>B866</td>
<td>40° 15.5'</td>
<td>176° 54.2'</td>
<td>113 m</td>
<td>outer</td>
</tr>
<tr>
<td>D</td>
<td>B867</td>
<td>40° 16.6'</td>
<td>176° 58.2'</td>
<td>186 m</td>
<td>shelf</td>
</tr>
<tr>
<td>E</td>
<td>B154</td>
<td>40° 21'</td>
<td>177° 12'</td>
<td>142 m</td>
<td>Madden</td>
</tr>
<tr>
<td>F</td>
<td>B153</td>
<td>40° 37'</td>
<td>177° 02'</td>
<td>183 m</td>
<td>Banks</td>
</tr>
<tr>
<td>G</td>
<td>B868</td>
<td>40° 17.8'</td>
<td>177° 01.8'</td>
<td>276 m</td>
<td>upper</td>
</tr>
<tr>
<td>H</td>
<td>B881</td>
<td>40° 22.0'</td>
<td>176° 50.2'</td>
<td>427 m</td>
<td>slope</td>
</tr>
<tr>
<td>I</td>
<td>B869</td>
<td>40° 19.0'</td>
<td>177° 05.6'</td>
<td>625 m</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>B884</td>
<td>40° 27.8'</td>
<td>177° 03.8'</td>
<td>1,439 m</td>
<td>mid slope</td>
</tr>
<tr>
<td>K</td>
<td>B885</td>
<td>40° 35'</td>
<td>177° 16'</td>
<td>2,028 m</td>
<td>lower</td>
</tr>
<tr>
<td>L</td>
<td>F594</td>
<td>40° 56.5'</td>
<td>177° 14'</td>
<td>2,063 m</td>
<td>lower</td>
</tr>
<tr>
<td>M</td>
<td>F862</td>
<td>40° 13'</td>
<td>177° 45'</td>
<td>2,127 m</td>
<td>slope</td>
</tr>
</tbody>
</table>
Fig. 1. Map of the continental shelf and slope off Hawke's Bay Land District showing positions of 16 samples used for quantitative analysis (numbers) and 13 subsidiary samples (letters). Depths are in metres.
THE ENVIRONMENT

The sixteen samples for quantitative analysis consist of three samples from each of five depth zones plus a sample from a bank on the upper continental slope (Table 1). The five depth zones are the inner (continental) shelf at depths of less than 50 m, the outer shelf ranging from 50–200 m deep, the upper slope ranging from 200–1000 m deep, the mid slope ranging from 1000–2000 m deep, and the lower slope at depths of more than 2000 m.

Previous authors have correlated the distribution of foraminiferal species with such environmental factors as hydrostatic pressure, temperature, composition of substrate, turbulence, light intensity, seawater chemistry, availability of food, and effects of predators (Phleger 1960). Many of these factors are either directly or indirectly related to depth. Hydrostatic pressure increases directly with increase in depth and it is known that the distribution of some marine bacteria is limited by hydrostatic pressure (Oppenheimer and Zobell 1952). The depth of each sample was measured with an echo sounder and depths of more than 700 m were corrected with Matthew’s (1939) tables (Fig. 2a).

Temperature, at least in a local context, is depth dependent. It was measured on the continental shelf in spring and late summer using a bathythermograph which was allowed to rest briefly on the seabed. Data from the bathythermograph was supplemented by reversing bottle measurements above the continental shelf (Heath 1970) and reversing bottle measurements above the continental slope to the south of the study area (Garner 1961). On the inner shelf the mean annual temperature is about 15°C and the seasonal variation is about 4.5°C (Fig 2b). Mean annual temperature and seasonal variation decrease with increasing depth so that on the mid and lower slope the temperature is less than 5°C and there is virtually no seasonal variation.

Foraminifera live in and on the surface layer of sediment, the composition of which is critical for at least some species. Many fragile species could not survive on sand that is subject to continuous movement. Sediment composition in turn affects food supply; muds, at least those that are well oxygenated, might be expected to harbour a richer supply of food than clean sand. The surface 5–10 mm of all mud cores was yellow-brown and presumably well oxygenated, whereas the underlying mud was greenish-grey and presumably a reducing environment. The grain size of the sediment immediately beneath the layer used for foraminiferal analysis was analysed by normal sieving and pipetting techniques (Fig. 2c). The three samples from the inner shelf are predominantly detrital sand; all other samples contain less than 10% detrital sand. In general the sediment becomes finer offshore but samples from banks and local highs on the continental slope contain as much as 70% sand-sized grains, which include foraminifera, glauconite and volcanic ash. Nearshore sands are generally more dense than porous offshore sediments, the dry weight of the nearshore sand being about three times greater than that of the same volume (17 ml) of mud, and twice as great as that of the same volume of bank sediment rich in low density, non-detrital, sand grains (Fig. 2d).

The non-detrital component of the sediment consists of air-fall ash, authigenic minerals, and skeletons of animals, including foraminifera. It accumulates relatively slowly on the seabed at most places in the study area. Everywhere except on the slope banks and highs, the non-detrital component is greatly diluted by mixing with relatively rapidly deposited detrital sediment (Lewis 1973a). The rate of deposition is most rapid on the middle part of the continental shelf, where mud is deposited at rates of 1–4 m/thousand years (Lewis 1973b) (Fig. 2e). In continental slope depressions, measured rates of deposition range from 0.02–0.35 m/thousand years (Lewis and Kohn 1973), but rates may be greater in some relatively shallow depressions from which piston cores were not obtained. On continental slope banks rates are less than 0.02 m/thousand years. (Lewis 1974a).

DISTRIBUTION OF BENTHONIC SPECIES

The foraminiferal censuses gave the abundance of each species of benthonic foraminifera in the same volume of wet sediment for each station. Walton (1955) pointed out that it is artificial to refer the population to any base other than available living space, and that wet volume is the only natural base for comparison of living marine populations. To compare the results with populations in ancient marine sediments it may be necessary to calculate the number of each species in the same dry weight of sediment using the data in Fig. 2d. The number of specimens in 10 g of dry sediment is the “foraminiferal number” (Schott 1935; Said 1950).
Fig. 2. Frequency polygons showing environmental character at 16 stations. A. Depth in metres. B. Late summer (top) and late winter (lower) temperature on the seabed in degrees centigrade. C. Percentage by weight of sediment coarser than 0.064 mm. D. Dry weight of 17 ml of sediment in grams. E. Estimated rate of sediment deposition in metres per thousand years (from Lewis 1971, 1973b).
As the foraminifera were sieved into classes of similar width, the mean width of each species may be estimated from the numbers in each class.

Both the abundance and the mean width may be noted conveniently on logarithmic scales (Table 3). The notations for abundance are the log₂, rounded downwards, of the number of foraminifera in 17 ml of wet sediment. The notations for mean width represent classes on log₂ (phi) scale (Krumbein 1936), the class boundaries being at 0.5 φ intervals, the same as the mesh diameters of the sieves.

To assess the relative importance of each species to the rate of deposition of sediment, the mean weight of foraminifera in each class was measured using an electrobalance. The mean was calculated using weights from several different stations, with 10 to 100 specimens being weighed from each station. Table 4 shows weights for various sizes and abundances, the mean weight of a single specimen being shown in the left-hand column. Other columns show the mean weight in each abundance class; the second column being the weight of three specimens, the third the weight of six specimens, the fourth the weight of 12 specimens and so on. It is interesting to note that 300-400 small specimens (8a) weigh about as much as a single large specimen (-g).

Table 5 shows the abundance and mean width of each species at each station and by reference to Table 4, the contribution of each species to the sediment. Abundances range from a single specimen (-) to 80,000 specimens (16). There are about 80,000 specimens of Bolivina robusta at Station 7, and these 80,000 specimens represent about 100 mg of a sample that weighs 13 g. The depth range and abundance of each species are summarised in the following section. The presence of living specimens is shown in Table 5 by underlining. Actual numbers of living specimens are not shown because the distribution of living populations is patchy (J. V. Eade, pers. comm).

Table 3: Notations for foraminiferal abundance and size

<table>
<thead>
<tr>
<th>Notation</th>
<th>Number of foraminifera in 17 ml of wet sediment</th>
<th>Notation</th>
<th>Mean width from abundance on sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2-3</td>
<td>g</td>
<td>&gt;0.50 mm</td>
</tr>
<tr>
<td>2</td>
<td>4-7</td>
<td>f</td>
<td>0.33-0.50 mm</td>
</tr>
<tr>
<td>3</td>
<td>8-15</td>
<td>e</td>
<td>0.25-0.33 mm</td>
</tr>
<tr>
<td>4</td>
<td>16-31</td>
<td>d</td>
<td>0.17-0.25 mm</td>
</tr>
<tr>
<td>5</td>
<td>32-63</td>
<td>c</td>
<td>0.12-0.17 mm</td>
</tr>
<tr>
<td>6</td>
<td>64-127</td>
<td>b</td>
<td>0.08-0.12 mm</td>
</tr>
<tr>
<td>7</td>
<td>128-255</td>
<td>a</td>
<td>0.06-0.08 mm</td>
</tr>
</tbody>
</table>

Underlining indicates presence of living specimens.

Table 4: Weight of foraminifera as a function of size and abundance: letters for size and numbers for abundance as in Table 3. Weights at bottom are in micrograms, weights in centre are in milligrams, weights at top right are in grams.

| g: 140 | 420 | 840 | 1.6 | 3.4 | 6.7 | 13 | 27 | 54 | 108 | 215 | 430 | 860 | 1.7 | 3.6 | 6.9 | 14 |
| f: 51  | 153 | 306 | 612 | 1.2 | 2.4 | 4.9 | 10 | 20 | 39 | 78  | 157 | 313 | 627 | 1.3 | 2.5 | 5.0 |
| e: 20  | 60  | 120 | 240 | 480 | 960 | 1.9 | 3.8 | 7.7 | 15 | 31 | 61 | 123 | 256 | 492 | 984 | 1.9 |
| d: 7.5 | 22  | 45  | 90  | 180 | 360 | 720 | 1.4 | 2.8 | 5.7 | 12 | 23 | 46 | 92  | 192 | 369 | 738 |
| c: 2.8 | 8.4 | 17  | 34  | 67  | 134 | 269 | 538 | 1.1 | 2.2 | 4.3 | 8.6 | 17  | 34  | 72  | 138 | 276 |
| b: 1.0 | 3.0 | 6.0 | 12  | 24  | 48  | 96  | 192 | 384 | 768 | 1.5 | 3.1 | 6.1 | 12  | 26  | 49  | 98  |
| a: 0.4 | 1.1 | 2.3 | 4.6 | 9.1 | 18  | 36  | 73  | 146 | 292 | 584 | 1.2 | 2.3 | 4.7 | 9.7 | 19  | 37  |

Table 5: Foraminiferal distribution data. Main part shows abundance and mean width of foraminifera at 16 stations, subsidiary part is a list of stations at which each foraminifera occurs. Underlining indicates presence of living specimens, double underlining indicates presence of more than 20 living specimens.

| Adercotryma | 4a  | 6a | 3b | 3a | 1b | 2b |
| Alveolarphragmium | g | g | EGH |

zealandicum
<table>
<thead>
<tr>
<th>Subsidiary</th>
<th>Inner Shelf 1</th>
<th>Outer Shelf 2</th>
<th>Mid Shelf 3</th>
<th>Lower Shelf 4</th>
<th>Bank 5</th>
<th>Upper Slope 6</th>
<th>Mid Slope 7</th>
<th>Lower Slope 8</th>
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<td></td>
<td></td>
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<td>aff. filiformis</td>
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<td></td>
<td></td>
<td></td>
<td>3b</td>
<td>5c</td>
<td>3b</td>
<td>3b</td>
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<td></td>
<td></td>
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<td>-a</td>
<td>3d</td>
<td>-c</td>
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<td></td>
<td></td>
<td></td>
<td>1d</td>
<td>-d</td>
<td>2f</td>
<td>-g</td>
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<td>planorbis</td>
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<td></td>
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<td>-b</td>
<td>8b</td>
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<td></td>
<td></td>
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<td>1e</td>
<td>4c</td>
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<td>2f</td>
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<td>-c</td>
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<td></td>
<td></td>
<td>1g</td>
<td>1f</td>
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<td>-g</td>
<td>2f</td>
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<td>1e</td>
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<td></td>
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**Glabratella**
- radiata 3d 4d 1d
- zealandica 5c 4c 3d -d

**Globobulimina**
- turgida 1e 3d 2e
- hoeglundina 1d 2e 2c 2d 1e 5e 1f 2e 4d 4e
- notovata -d 2d 1e 3c
- cf. pacifica

**Globocassidulina**
- canalisaturata 10d 1e
- aff. inflata a 4a 3a 9a
- minuta 8a
- producta 1b 2a 4c
- sphaerica -a 2d -c

**Glomospira**
- charoides -c
- cf. elongata -c
- gordialis -c

**Gyroidina**
- orbicularis 2c 1b 3d 2b 7a 3a 4c 3b 4c 5c 3b 3b
- neosoldanii
- neoterebratulata

**Haplophragmoides**
- canariensis 2c 1c 2d -c
- cf. arca 3b
- sphaeroides -c b
- subnuttiana 3c 2g 1c
- turrillus 1c

**Heterolepa**
- aff. dutemplei 9g 1f
- Hoeglundina
- elegans 1e 1d 1a -g 1e
- Oplincl Interstate

**Hopkinsina**
- pacifica 4a 3a 3a 4a 5b 1b 4a

**Hormosina**
- globulifera 5f 3e 2e 3b 2d 5c 4c
- Hyperammina -g 1f

**Karreriella**
- apicularis 3c 6d 3b 1d 1c 4d
- bradyi

**Lagena**
- spp. 1c 5c 2c 2c 6d 4c 2c 2c 3d 5d 3d 2b 4b 3b

**Laginammina**
- bulbosa
- diffugiformis
- sp.

**Laryngosigma**
- hyalascidia

**Laticarinina**
- altocamerata
- pauperata
- Lenticulina

**Marginulina**
- glabra 2e 6d
- tenuis

**Marginulinopsis**
- bradyi 1a

**Marsipella**
- elongata

**Martinottiella**
- cf. communis

**Massilina**
- brodiei 1b

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SYSTEMATIC NOTES ON BENTHONIC SPECIES

NOTE: For synonyms see Eade (1967). Where a reference is given it indicates a figure which is not the original for the species but is considered to represent the same species as the specimens from the study area. Many species are illustrated in Brady’s (1884) plates, which have been reprinted by Barker (1960).

Order FORAMINIFERIDA
Suborder TEXTULARIINA
Superfamily AMMODISCACEA
Family ASTRORHIZIDAE
Subfamily ASTRORHIZINAE

Rhizammina algaeformis Brady
Brady 1884, pl. 28, figs 2, 6.
REMARKS: Branching tubes of fine sand and coarse silt.
EXTERNAL TUBE DIAMETER: 0.25-0.30 mm.
DEPTH RANGE: 1419-2432 m, living: 1419-2432 m.
OCCURRENCE: Common on mid and lower slope.

Rhizammina sp.
REMARKS: Similar to R. algaeformis, but tubes relatively narrow and wall composed of relatively fine grains; tubes repeatedly branching; tectinous lining collapses when dried to form flat ribbon. More coarsely grained and rougher walls than Psammatodendron arborescens.
EXTERNAL TUBE DIAMETER: 0.10-0.15 mm.
DEPTH RANGE: 1240-2469 m, living: 1240-2469 m.
OCCURRENCE: Abundant on mid and lower slope, many specimens living.

Bathysiphon aff. argenteus Heron-Allen and Earland
REMARKS: Rigid, pale orange-brown tubes, paler at extremities; wall moderately smooth; test straight or gently curved, occasionally twisted. More robust than B. argenteus.
EXTERNAL TUBE DIAMETER: Generally 0.05-0.08 mm, rarely 0.10 mm.
DEPTH RANGE: 1240-2432 m, living: 2432 m.
OCCURRENCE: Rare, on mid and lower slope.

Bathysiphon globigeriniformis Hofker
REMARKS: Pale orange-brown tube with many tests of foraminifera attached, attached foraminifera as much as 0.4 mm in length.
EXTERNAL DIAMETER OF ORANGE-BROWN TUBE: About 0.10 mm.
DEPTH RANGE: 19-2469 m, living: 1419-2469 m.
OCCURRENCE: Common on mid and lower slope, rare elsewhere.

Bathysiphon spp.
REMARKS: Several large diameter forms with walls of coarse silt or very fine sand grains, most specimens having rough finish, some specimens tapered.
EXTERNAL TUBE DIAMETER: 0.12-0.25 mm.
DEPTH RANGE: 1419-2469 m, living: 2028-2329 m.
OCCURRENCE: Common on lower slope, rare on mid slope.

Marsipella elongata Norman
Brady 1884, pl. 24, figs 10, 11, 16, 17.
REMARKS: Wall of coarse silt grains without sponge spicules. Broken specimens resemble Saculella acuta.
LENGTH: About 0.5 mm, maximum width about 0.12 mm.
DEPTH RANGE: 2432 m, no living specimens.
OCCURRENCE: Rare, on lower slope only.

Subfamily HIPPOCREPININAE

Hyperammina friabilis Brady
REMARKS: Consistent in shape and texture with type specimens, but varying greatly in size.
LENGTH: 1.1-7.5 mm, maximum external diameter: 0.3-1.7 mm.
DEPTH RANGE: 1419-2432 m, no living specimens.
OCCURRENCE: Rare, on mid and lower slope.

Family SACCAMMINIDAE
Subfamily PSAMMOSPHAERINAE

Psammospheara fusca Schulze
Brady 1884, pl. 18, fig. 1.
LENGTH: 0.2-0.4 mm.
DEPTH RANGE: 40-2469 m, living: 40-2432 m.
OCCURRENCE: A few specimens at most stations.

Psammospheara parva Flint
Brady 1884, pl. 18, fig. 4.
LENGTH (excluding spicule): About 0.4 mm.
DEPTH RANGE: 1240-2028 m, living: 2028 m.
OCCURRENCE: Single specimens at two stations on mid and lower slope.
Subfamily SACCAMMININAE

**Saccammina cushmani** (Collins)

**Remarks:** Originally described as *Proteonina*; test tapering to small aperture.

**Length:** 0.1–0.3 mm.

**Depth range:** 329–2469 m, living: 329–2432 m.

**Occurrence:** Common at most places on the continental slope.

**Saccammina sphaerica** Sars

*Brady 1884, pl. 18, fig. 15.*

**Remarks:** Test spherical with slightly protruding aperture.

**Length:** 0.3–1.0 mm.

**Depth range:** 329–2469 m, living: 329–1419 m.

**Occurrence:** A few specimens at most stations on slope.

**Brachysiphon corbuliniformis** Chapman

*Lewis 1970, frontispiece.*

**Length:** 0.5–1.0 mm.

**Depth range:** 2432–2469 m, no living specimens.

**Occurrence:** Rare, only at two deepest stations.

**Lagenammina bulbosa** (Chapman and Parr)

**Remarks:** Originally described as *Proteonina*; tiny with fine grained neck; large specimens of similar shape but with coarse grained neck are referred to *Hormosina globulifera*.

**Length:** About 0.15 mm.

**Depth range:** 2063–2469 m, living: 2063–2432 m.

**Occurrence:** Rare, on lower slope only.

**Lagenammina diffugiformis** (Brady)

*Brady 1884, pl. 30, fig. 3, see also original figure.*

**Remarks:** Some specimens more elongate than Brady’s figure, and some have delicate phialine lip (see original figure).

**Length:** 0.28–0.65 mm.

**Depth range:** 1240–2469 m, living: 1240–2469 m.

**Occurrence:** Abundant on lower slope, common on mid slope.

**Lagenammina** sp.

**Remarks:** Test small, delicate, fusiform, pale orange; wall fine grained; little variation.

**Length:** About 0.20 mm; width: about 0.09 mm.

**Depth range:** 1649–2469 m, living: 1649 m.

**Occurrence:** Rare, mid and lower slope.

**Pelosina didera** (Loeblich and Tappan)

**Remarks:** Originally described as *Pelosinella*.

**External diameter of central chamber:** 0.35 mm.

**Depth range:** 1649–2329 m, no living specimens.

**Occurrence:** Single specimens at two stations on mid and lower slope.

**Pelosina aff. bicaudata** (Parr)

*Loeblich and Tappan 1964, fig. 112, no. 8.*

**Remarks:** Mostly smaller than Loeblich and Tappan’s figured specimen.

**Length:** 0.3–0.5 mm, maximum width: 0.09–0.16 mm.

**Depth range:** 1240–2469 m, living: 1240–2469 m.

**Occurrence:** Common at one station on lower slope.

**Thurammina albicans** Brady

*Brady 1884, pl. 37, figs 2–7.*

**Remarks:** Wall slightly rougher than type specimens and generally yellow-brown rather than white; apertures at right angles.

**Diameter:** About 0.20 mm.

**Depth range:** 186–2432 m, no living specimens.

**Occurrence:** Rare, mainly on mid and lower slope.

**Thurammina compressa** Brady

*Heron-Allen and Earland 1917, pl. 28, figs 4, 6, 10; pl. 26, fig. 15; Brady 1884, pl. 36, figs 137, 14 only.*

**Remarks:** Broadly rounded; thin, white wall; few elongate, randomly distributed papillae. Examination of original material in the British Museum (Natural History) shows Brady’s *T. compressa* falls well within the range of variation of *T. heusleri*, which is therefore regarded as a junior synonym of *T. compressa*.

**Diameter:** 0.10–0.20 mm.

**Depth range:** 1419–2469 m.

**Occurrence:** Rare, on mid and lower slope.

Family AMMODISCIDAE

Subfamily AMMODISCINAE

**Ammodiscus gullmarensis** Höglund

**Remarks:** Surface not polished; coiling tending to become irregular.

**Length:** 0.18–0.22 mm.

**Depth range:** 48–2329 m, living: 48–1240 m.

**Occurrence:** Rare, but generally distributed.
**Ammodiscus planorbis** Höglund
Remarks: Wall brown and highly polished.
Length: 0.3–0.5 mm.
Depth range: 186–2329 m, living: 276–1240 m.
Occurrence: A few specimens at many stations on slope.

**Ammodiscus tenuis** Brady
Brady 1884, pl. 38, fig. 5.
Remarks: Tube laterally compressed.
Length: 0.7–1.6 mm.
Depth range: 276–479 m, living: 375 m.
Occurrence: Rare, on upper slope only.

**Glomospira charoides** (Jones and Parker)
Brady 1884, pl. 38, figs 13, 14.
Length: About 0.25 mm.
Depth range: 1419–2329 m, no living specimens.
Occurrence: Common at several stations on mid and lower slope.

**Glomospira cf. elongata** Collins
Remarks: Smaller than original figures.
Length: About 0.15 mm.
Depth range: 1419 m, no living specimens.
Occurrence: Rare, on mid slope.

**Glomospira gordialis** (Jones and Parker)
Loeblich and Tappan 1964, fig. 122, no. 6.
Remarks: Many specimens even more irregular than Loeblich and Tappan’s figure.
Diameter of test: 0.15–0.25 mm, maximum diameter of tube: 0.04–0.06 mm.
Depth range: 186–2469 m, living: 375–2329 m.
Occurrence: A few specimens at most stations on slope, most common on mid slope.

**Glomospira scabra** Brady
Brady 1884, pl. 27, figs 1, 2, 4, 5, 7.
Remarks: Chamber shape as Brady’s but chambers smaller, smallest being flexible.
External diameter of each chamber: 0.5–1.0 mm.
Depth range: 2439–2469 m, no living specimens.
Occurrence: Rare, at two deepest stations only.

**Hormosina globulifera** Brady
Brady 1884, pl. 39, figs 1–4; Lewis 1970, frontispiece.
Length: 0.4–1.5 mm.
Depth range: 329–2469 m, living: 329–2063 m.
Occurrence: Common at most stations on continental slope.

**Reophax bacillaris** Brady
Brady 1884, pl. 30, figs 23, 24.
Remarks: Smaller than Brady’s figures and consisting of only 2–4 chambers.
Length: 0.6–1.5 mm, width of final chamber: 0.20–0.30 mm.
Depth range: 479–2469 m, living: 479–2469 m.
Occurrence: Moderately common at most stations on mid and lower slope.

**Reophax guttifer** Brady
Brady 1884, pl. 31, figs 10–15
Remarks: Some specimens have a few projecting spicules – these give the test a hispid appearance.
External diameter of chambers: 0.15-0.22 mm.
Depth range: 304-2469 m, living: 1439 m.
Occurrence: Rare on upper and mid slope, common on lower slope.

Reophax aff. guttifer Brady
Remarks: Smaller and more delicate than R. guttifer; wall fine grained and almost smooth, 2-4 chambers.
External diameter of chambers: 0.11-0.14 mm.
Depth range: 1240-2432 m, living: 1240-2432 m.
Occurrence: Moderately common on mid slope.

Reophax micaceus Earland
Remarks: Test wall includes grains other than mica but shape and size as R. micaceus; test of 1-5 chambers.
Length: 0.4-0.9 mm; diameter of chamber: 0.14-0.16 mm.
Depth range: 2469 m, no living specimens.
Occurrence: Rare, at single station on lower slope.

Reophax scorpiurus Montfort
Hedley et al. 1965, pl. 1, fig. 1.
Length: 0.8-1.2 mm.
Depth range: 71-2028 m, living: 71-479 m.
Occurrence: Almost ubiquitous, but rare at any station.

Reophax subfusiformis Earland
Högland 1947, pl. 9, figs 1, 2, 4.
Remarks: Coarse grained wall, neck fine with phialine lip.
Length: About 0.9 mm.
Depth range: 329 m.
Occurrence: Rare, on Motukura Bank only.

Reophax spp.
Remarks: Several small, thin-walled species of Reophax.
Length: 0.3-0.9 mm.
Occurrence: Common on mid slope.

Family LITUOLIDAE
Subfamily HAPLOPHRAGMOIDINAE

Haplophragmoides canariensis (d’Orbigny)
Remarks: Small, thin-walled, smooth, moderately compressed. Similar size and shape to Brady’s (1884) pl. 35 figs 1, 2, but aperture interiomarginal without lower lip.
Length: 0.25-0.35 mm.
Depth range: 18-2432 m, living: 18-2432 m.
Occurrence: Common on shelf, rare on slope.

Haplophragmoides aff. scitulum (Brady)
Remarks: Test tiny, well rounded, with wide apertural face and deep umbilicus, 5-6 chambers in whorl; wall pale orange and polished. Similar in shape to H. scitulum of Brady (1884) pl. 34, figs 11-13, but much smaller and fewer chambers in the whorl.
Length: 0.11-0.14 mm.
Depth range: 375-1439 m, living: 375-1439 m.
Occurrence: Rare, on upper and mid slope.

Haplophragmoides sphaeriloculus Cushman
Remarks: Specimens from study area smaller than holotype.
Length: 0.30-0.45 mm.
Depth range: 186-2469 m, no living specimens.
Occurrence: Rare, at several stations on slope.

Haplophragmoides subtrullissatus Parr
Remarks: Test with 5-7 chambers in final whorl, large specimens have 7; wall of fairly large grains neatly fitted together to form smooth surface.
Length: 0.5-1.0 mm.
Depth range: 91-1439 m, living: 91-1439 m.
Occurrence: Moderately common on outer shelf and upper slope.

Haplophragmoides trullissata (Brady)
Brady 1884, pl. 40, fig. 13.
Remarks: Wall is not labyrinthic but shows merely “a few slightly raised reticulations” (Brady 1879); finer-grained, more polished, and darker orange-brown in colour than H. subtrullissata; periphery relatively angular.
Length: 0.5-0.9 mm.
Depth range: 2432 m, no living specimens.
Occurrence: Rare, at single station on lower slope.

Adercotryma glomeratum (Brady)
Brady 1884, pl. 34, figs 15-18.
Length, along axis: About 0.15 mm.
Depth range: 1240-2469 m, living: 1240-2469 m.
Occurrence: Common on mid and lower slope.
Cribrostomoides wiesneri Parr

REMARKS: Usually 6–7 chambers in final whorl of test.
LENGTH: 0.30–0.45 mm.
DEPTH RANGE: 48–2432 m, living: 48–2329 m.
OCCURRENCE: Ubiquitous, common at only a few stations on mid and lower slope.

Cribrostomoides sp.
Wiesner 1931, pl. 11, fig. 135.
REMARKS: Test small, white or pale orange; 5–6 globose chambers in final whorl; wall of coarse grains but moderately smooth finish; aperture at base of terminal face with recessed lower lip.
LENGTH: 0.3–0.5 mm.
DEPTH RANGE: 40–375 m, living: 71–375 m.
OCCURRENCE: Common on outer shelf, rare elsewhere.

Discammina compressa (Goes)
Loeblich and Tappan 1964, fig. 136, no. 10.
REMARKS: Specimens are so coarse grained that it is difficult to see sutures.
LENGTH: 0.4–0.6 mm.
DEPTH RANGE: 2432 m, no living specimens.
OCCURRENCE: Rare, at single station on lower slope.

Recurvoides contortus Earland
REMARKS: Wall of moderately coarse grains, but neatly fitted together and surface smooth or polished.
LENGTH: 0.4–0.7 mm.
DEPTH RANGE: 276–2469 m, living: 276–2469 m.
OCCURRENCE: Moderately common on continental slope.

Recurvoides sp.
REMARKS: Test larger and more globose than R. contortus, apertural face broader with more slit-like aperture; wall of large grains but smoothly finished. Possibly the same as specimens assigned to R. turbinatus by Loeblich and Tappan (1953), pl. 2, fig. 11.
LENGTH: 0.5–0.8 mm.
DEPTH RANGE: 1240–2432 m, no living specimens.
OCCURRENCE: Rare, on mid and lower slope.

Subfamily CYCLAMMININAE

Cyclammina cancellata Brady
Brady 1884, pl. 37, figs 8–16.
REMARKS: Many specimens with chambers more globose than Brady’s specimens.

LENGTH: 1.0–1.5 mm.
DEPTH RANGE: 479–1649 m, no living specimens.
OCCURRENCE: Rare, on upper and mid slope.

Cyclammina aff. pusilla Brady
Wiesner 1931, pl. 8, fig. 151.
LENGTH: 0.6–0.7 mm.
DEPTH RANGE: 304 m, no living specimens.
OCCURRENCE: Rare, at single station on upper slope.

Alveolophagmium zealandicum Vella
LENGTH: 0.55–0.80 mm.
DEPTH RANGE: 142–2469 m, living: 2432 m.
OCCURRENCE: Rare, on banks and slope.

Subfamily LITUOLINAE

Ammobaculites filiformis Earland
Earland 1934, pl. 3, figs 11, 13; Brady 1884, pl. 32, fig. 22.
REMARKS: Small, with rough surface and moderately globose chambers; growth tends to be irregular.
LENGTH: 0.4–0.7 mm, width: 0.07 mm.
DEPTH RANGE: 1240–2432 m, living: 1240 m.
OCCURRENCE: Moderately common on mid slope.

Ammobaculites aff. filiformis Earland
Earland 1934, pl. 3, fig. 12; Brady 1884, pl. 32, fig. 23.
REMARKS: Relatively smooth walled, chambers not globose and sutures not as deep as A. filiformis; growth regular. Appears to be quite distinct from A. filiformis.
LENGTH: 0.4–0.7 mm, width: 0.07–0.09 mm.
DEPTH RANGE: 1240–2432 m, living: 1240–2432 m.
OCCURRENCE: Common on mid and lower slope.

Ammomarginulina cf. ensis Wiesner
REMARKS: Initial coil same size and shape as A. ensis but only 1–3 uncoiled chambers; colour pale orange-brown.
LENGTH: 0.20–0.35 mm.
DEPTH RANGE: 329–2329 m, living: 329–2329 m.
OCCURRENCE: Common at a few station on continental slope.

Ammomarginulina cf. foliaceus (Brady)
cf. Brady 1884, pl. 33, figs 20–25.
REMARKS: Similar to Brady’s figure but with thin, fragile keel of fine grains; rest of test coarse grained; central area orange-brown, keel white.
LENGTH: 0.5–1.2 mm, width: 0.15–0.25 mm.
DEPTH RANGE: 304–2432 m, living: 304–1419 m.
OCCURRENCE: Moderately common on upper and mid slope.

Ammoscalaria tenuimargo (Brady)
Högland 1947, pl. 31, fig. 2.
REMARKS: Considerable variation in size of initial coil.
LENGTH: 0.9–1.6 mm.
DEPTH RANGE: 1240–2432 m, living: 1240–2432 m.
OCCURRENCE: Rare, on mid and lower slope.

Family TEXTULARIIDAE
Subfamily SPIROPECTAMMININAE

Spiropectammina cf. biformis Parker and Jones
Brady 1884, pl. 45, fig. 25.
REMARKS: Some specimens are longer than Brady's figure with one or two uniserial chambers.
LENGTH: 0.20–0.40 mm, width: about 0.08 mm.
DEPTH RANGE: 1240–2469 m, living: 1240–1419 m.
OCCURRENCE: Common on mid slope, moderately common on lower slope.

Subfamily TEXTULARIIDAE

Textularia conica d'Orbigny
Brady 1884, pl. 43, figs 13, 14.
LENGTH: 0.4–1.0 mm.
DEPTH RANGE: 40–427 m, living: 42–427 m.
OCCURRENCE: Common on inner shelf and Madden Banks, where sediment is relatively coarse.

Textularia earlandi Parker
Högland 1947, pl. 13, fig. 1, text-figs 154, 155.
LENGTH: 0.3–0.5 mm.
DEPTH RANGE: 40–1419 m, living: 71–1240 m.
OCCURRENCE: Common on outer shelf.

Textularia proxispira Vella
REMARKS: Specimens show large variation in size.
LENGTH: 0.30–0.75 mm.
DEPTH RANGE: 18–427 m, no living specimens.
OCCURRENCE: Rare, on shelf and upper slope.

Textularia aff. sagittula Defrance
Brady 1884, pl. 42, fig. 18.
REMARKS: Test compressed with angular periphery; fine grained with glassy nodes in central portion; periphery white, rest orange-brown; some specimens have conspicuous initial coil.
LENGTH: 0.5–1.1 mm.
DEPTH RANGE: 183–1649 m, no living specimens.
OCCURRENCE: Rare, on middle slope.

Subfamily PSEUDOBOLIVININAE

Pseudobolina sp.
Heron-Allen and Earland 1922, pl. 4, figs 31–35.
REMARKS: Tiny, fragile, pale orange-brown; twisted growth.
LENGTH: About 0.20 mm.
DEPTH RANGE: 130–186 m, no living specimens.
OCCURRENCE: Rare, on outer shelf.

Siphotextularia fretensis Vella
LENGTH: 0.35–0.65 mm.
DEPTH RANGE: 186–1240 m, living: 186–375 m.
OCCURRENCE: Abundant on banks, common on upper slope.

Siphotextularia aff. fretensis Vella
REMARKS: Smaller and narrower than S. fretensis, with deeper sutures, thinner, more finely grained wall, and aperture on conspicuous protruding neck.
LENGTH: 0.2–0.4 mm.
DEPTH RANGE: 2329–2432 m, no living specimens.
OCCURRENCE: Rare, on lower slope only.

Siphotextularia mestayerae Vella
LENGTH: About 0.75 mm.
DEPTH RANGE: 142–625 m, no living specimens.
OCCURRENCE: Common on North Madden Bank.

Family TROCHAMMINIDAE
Subfamily TROCHAMMININAE

Trochammina ? aff. globigeriniformis (Parker and Jones)
REMARKS: Test tiny, smooth-walled, orange-coloured, with a total of 5–6 globose chambers, 3–4 of them in final whorl; chambers too few to be sure that coiling is trochospiral, it may be streptospiral.
LENGTH: 0.09–0.13 mm.
DEPTH RANGE: 1419–2329 m, living: 1439–2028 m.
OCCURRENCE: Moderately common on mid slope.
Trochammina inflata (Montague)

Hedley et al. 1967, pl. 6, fig. 3; Brady 1884, pl. 41, fig. 4.

REMARKS: Wall fine grained and smooth; 5–5.5 chambers in final whorl; sutures clear but not as depressed as those of T. rolliformis.

LENGTH: 0.18–0.35 mm.

DEPTH RANGE: 329–2432 m, living: 329–1619 m.

Occurrence: A few specimens at most stations on continental slope.

Trochammina ochracea (Williamson)

Hedley et al. 1964, fig. 2, no. 2.

REMARKS: Considerable variation in shape and height of sutural ridges on umbilical side.

LENGTH: 0.15–0.25 mm.

DEPTH RANGE: 71–427 m, living: 91–427 m.

Occurrence: Moderately common on outer shelf.

Trochammina pusilla Höglund

REMARKS: Test tiny, coarse grained, fragile, with 3–4 globose chambers in final whorl; very pale orange; considerable variation in height of spire.

LENGTH: 0.15–0.30 mm.

DEPTH RANGE: 71–2432 m, living: 71–2432 m.

Occurrence: Occurs at almost every station from outer shelf to lower slope, common on mid and lower slope.

Trochammina sorosa Parr

Hedley et al. 1967, text-figs 11–15.

REMARKS: Test small, orange, fairly smooth, with four chambers in final whorl.

LENGTH: 0.20–0.30 mm.

DEPTH RANGE: 42–2469 m, living: 48–427 m.

Occurrence: Moderately common at a few isolated stations on both shelf and slope.

Trochammina squamata Jones and Parker

Hedley et al. 1964, fig. 1, no. 1.

REMARKS: Most specimens smaller and more regular than the figures of Hedley et al.; low spires with four chambers in final whorl; wall smooth.

LENGTH: 0.12–0.22 mm.

DEPTH RANGE: 18 m–1240 m, living throughout this range.

Occurrence: Moderately common on shelf, rare on slope.

Trochammina tasmanica Parr

REMARKS: Wall coarser than T. inflata, sutures deeper, chambers fewer and more globose.

LENGTH: 0.20–0.43 mm.

Occurrence: Moderately common at many places between inner shelf and mid slope.

Trochammina sp.

REMARKS: Test small with flat spiral side and high domed umbilical side; periphery angular; about three whorls on spiral side and about seven chambers in final whorl; wall relatively coarse for test size but smoothly finished; smaller and more finely grained than T. planoconvexa.

LENGTH: 0.10–0.15 mm.

DEPTH RANGE: 48–113 m, living: 48–113 m.

Occurrence: Moderately common on outer shelf.

Ammosphaeroidina sphaeroidiniformis (Brady)

Loeblich and Tappan 1964, fig. 174, no. 1.

REMARKS: Considerable variation in size and wall texture.

LENGTH: 0.30–0.75 mm.

DEPTH RANGE: 329–2432 m, living: 479–2329 m.

Occurrence: A few specimens at most stations on continental slope, common only on mid slope.

Cystammina pauciloculata (Brady)

Brady 1884, pl. 41, fig. 1.

LENGTH: 0.25–0.45 mm.

DEPTH RANGE: 1419–2469 m, living: 2329–2469 m.

Occurrence: Moderately common on lower slope.

Tritaxis conica (Parker and Jones)

Brady 1884, pl. 49, fig. 16.

LENGTH (HEIGHT OF CONE): 0.15 mm.

DEPTH RANGE: 40–1419 m, no living specimens.

Occurrence: Single specimens attached to sand grains at two stations, one on inner shelf and the other on mid slope.

Family ATAXOPHRAGMIIDAE

Subfamily VERNEUILININAE

Gaudryina convexa (Karrer)

Burdett et al. 1963, figs 2–6.

LENGTH: 0.7–1.2 mm.

DEPTH RANGE: 42–183 m, no living specimens.

Occurrence: Occurs on the inner shelf and on slope banks where sediment is coarse.
Subfamily GLOBOTEXTULARIINAE

Eggerella bradyi (Cushman)
Brady 1884, pl. 47, figs 4-6.
REMARKS: Specimens white and mainly calcareous, aperture with raised lip.
LENGTH: 0.4-1.1 mm.
DEPTH RANGE: 625-2469 m, living: 625-1419 m.
Occurrence: Common on mid slope, moderately common on lower slope.

Eggerella scabra (Williamson)
Brady 1884, pl. 47, figs 15-17.
REMARKS: Smaller specimens are more fine grained and have a smoother wall than large specimens.
LENGTH: 0.16-0.35 mm.
DEPTH RANGE: 18-2432 m, living: 1419-1649 m.
Occurrence: A few specimens at many stations, moderately common on mid slope.

Karreriella apicularis (Cushman)
Brady 1884, pl. 46, fig. 17.
REMARKS: Wall coarse grained, rough, and orange-brown.
LENGTH: 0.35-0.85 mm.
DEPTH RANGE: 1240-2469 m, living: 1240-2329 m.
Occurrence: Moderately common on mid and lower slope.

Karreriella bradyi (Cushman)
Brady 1884, pl. 46, figs 1-4, also figs 9, 10.
REMARKS: Most specimens resemble Brady's figures 1-4 but some aberrant specimens resemble figures 9, 10 which Brady and subsequent authors have regarded as a separate species. Aperture slit with raised lip.
LENGTH: 0.60-0.95 mm.
DEPTH RANGE: 625-2127 m, living: 1419 m.
Occurrence: Common at a few stations on the continental slope.

Subfamily VALVULININAE

Martinottiella cf. communis (d'Orbigny)
cf. Brady 1884, pl. 48, figs 1-8.
REMARKS: Test smaller than Brady's figures and wall composed of even-sized grains; apertural face flattened with aperture at end of distinct neck.
LENGTH: 1.0-1.9 mm, width: 0.40-0.45 mm.

DEPTH RANGE: 276-625 m, no living specimens.
Occurrence: Rare, at only two stations on the upper slope.

Suborder MILIOLINA
Superfamily MILIOLACEA
Family FISCHERINIDAE
Subfamily CYCLOGRYINAE

Cornuspirodes foliaceus (Philippi)
Brady 1884, pl. 11, fig. 6.
LENGTH: About 0.4 mm.
DEPTH RANGE: 276-2063 m, living: 625 m.
Occurrence: Rare, on upper and lower slope.

Family NUBECULARIIDAE
Subfamily SPIROLOCULININAE

Spiroloculina acutimargo (Brady)
Brady 1884, pl. 10, figs 12, 13.
REMARKS: Brady's fig. 12 is the type figure of S. acutimargo and cannot, therefore, be referred to S. elevata (Wiesner, quoted in Barker 1960). Specimens illustrated by Vella (1957) pl. 6, figs 122, 123 are considered to be S. acutimargo, not S. disparilis which is a more elongate form from the Pliocene of Greece.
LENGTH: 0.55-0.95 mm.
DEPTH RANGE: 18-1419 m, no living specimens.
Occurrence: Rare, at several stations on inner shelf and upper slope.

Family MILIOLIDAE
Subfamily QUINQUELOCULININAE

Quinqueloculina cookei Vella
REMARKS: Chambers quadrate but not carinate.
LENGTH: 0.35-0.95 mm.
DEPTH RANGE: 40-48 m, no living specimens.
Occurrence: Rare, on inner shelf only.
Quinqueloculina incisa Vella
REMARKS: Distinguished by having perfectly rounded chambers.
LENGTH: 0.30–0.75 mm.
DEPTH RANGE: 18–2329 m, living: 18–48 m.
OCCURRENCE: Moderately common on inner shelf, single specimen from lower slope.

Quinqueloculina kapitiensis Vella
REMARKS: No specimens have the brownish-yellow bands referred to in the original description and some have their aperture on a slight neck.
LENGTH: 0.35–0.50 mm.
DEPTH RANGE: 18–113 m, living: 18–113 m.
OCCURRENCE: Moderately common on inner and outer shelf.

Quinqueloculina lamarkiana d'Orbigny
Vella 1957, pl. 6, figs 105–107.
REMARKS: Similar to Q. triangularis but with an angular periphery that is curved towards the direction of growth.
LENGTH: 0.40–0.80 mm.
DEPTH RANGE: 18–91 m, living: 91 m.
OCCURRENCE: Moderately common on shelf.

Quinqueloculina aff. lata Terquem
Vella 1957, pl. 6, figs 105–107.
REMARKS: More elongate than Q. triangularis with distinct L-shaped chambers.
LENGTH: 0.25–0.40 mm.
DEPTH RANGE: 18–48 m, living: 18–48 m.
OCCURRENCE: Common at some stations on inner shelf.

Quinqueloculina neosigmoilinoides Kennett
Vella 1957, pl. 6, figs 116, 117.
REMARKS: Included are all specimens with subangular periphery that appear sigmoidal in apertural view. Shape in side view varies from elongate specimens similar to holotype to specimens that are almost circular.
LENGTH: 0.35–0.60 mm.
DEPTH RANGE: 18–1439 m, living: 18–427 m.
OCCURRENCE: Common on shelf, single specimens at several stations on slope.

Quinqueloculina suborbicularis d'Orbigny
Vella 1957, pl. 6, figs 105–107.
REMARKS: More nearly circular in side view than Q. triangularis, but otherwise similar.
LENGTH: 0.20–0.50 mm.
DEPTH RANGE: 18–48 m, no living specimens.
OCCURRENCE: Rare, on inner shelf.

Quinqueloculina triangularis d'Orbigny
Vella 1957, pl. 6, figs 100, 101, 108; Hedley et al. 1965, pl. 2, fig. 8.
REMARKS: Specimens of this species have frequently been recorded as Q. seminulum, which is distinctly more elongate (cf. Loeblich and Tappan 1964, fig. 349, no. 1).
LENGTH: 0.5–1.2 mm.
DEPTH RANGE: 18–329 m, living: 42–329 m.
OCCURRENCE: Moderately common on inner shelf and on banks.

Quinqueloculina cf. venusta Karrer
REMARKS: Test small, triangular, with slightly raised edges in apertural view, aperture rounded with tooth and sometimes on slight neck, no lip.
LENGTH: 0.23–0.40 mm.
DEPTH RANGE: 1649–2432 m, no living specimens.
OCCURRENCE: Common at two stations on mid and lower slope.

Quinqueloculina wiesneri Parr
REMARKS: Described by Parr (1950) as Q. anguina var.; small with aperture on neck and phialine lip.
LENGTH: 0.25–0.30 mm.
DEPTH RANGE: 375–2432 m, living: 2432 m.
OCCURRENCE: Common only on lower slope.

Massilina brodiei Hedley, Hurdle and Burdett
LENGTH: 0.35–0.45 mm.
DEPTH RANGE: 18–40 m.
OCCURRENCE: Rare, on inner shelf only.

Pyrgo murrhyna (Schwager)
Brady 1884, pl. 2, figs 10, 11, 15.
REMARKS: Periphery with two points near base, periphery of some specimens is serrated; aperture rounded with bifid tooth.
LENGTH: 0.9–1.6 mm.
DEPTH RANGE: 372–2432 m, living: 2063 m.
OCCURRENCE: Rare, at only a few stations on slope.

Pyrgo pisum (Schlumberger)
Vella 1957, pl. 7, figs 130, 135, 136, 138, 139, 144, 145.
REMARKS: A large number of specimens from the North Madden Bank show that this is a very variable species. There appears to be continuous variation between...
forms recorded by Vella (1957) as *Biloculina pisum, B. anomalata, B. guerreri* and *Pyrgo aff. ezo*.

**LENGTH:** 0.75–1.35 mm.

**DEPTH RANGE:** 142–1649 m, living: 329–375 m.

**OCCURRENCE:** Common on North Madden Bank, rare elsewhere.

**Pyrgoella sphaera** (d’Orbigny)

Brady 1884, pl. 2, fig. 4.

**LENGTH:** 0.30–0.55 mm.

**DEPTH RANGE:** 276–625 m, no living specimens.

**OCCURRENCE:** Rare, on upper slope.

**Sigmoilopsis schlumbergeri** (Silvestri)

Brady 1884, pl. 8, figs 1–4.

**LENGTH:** 0.25–0.55 mm.

**DEPTH RANGE:** 1240–2469 m, living: 1419 m.

**OCCURRENCE:** Common on mid slope, rare on lower slope.

**Sigmoilopsis wanganuinesis** Vella

**LENGTH:** About 0.7 mm.

**DEPTH RANGE:** 329–2028 m, no living specimens.

**OCCURRENCE:** Abundant on Motukura Bank, rare elsewhere.

**Siphonaperta crassa** Vella

**REMARKS:** A few specimens have a fragile neck with phialine lip preserved.

**LENGTH:** 0.7–1.1 mm.

**DEPTH RANGE:** 186–329 m, no living specimens.

**OCCURRENCE:** Common only on Madden Banks.

**Siphonaperta macbeathi** Vella

**REMARKS:** Smaller than most fossil specimens.

**LENGTH:** 0.3–0.4 mm.

**DEPTH RANGE:** 40–329 m, living: 40 m.

**OCCURRENCE:** Occurs where sediments are coarse on inner shelf and on banks.

**Siphonaperta parvaglutta** (Vella)

**REMARKS:** Recorded as *Quinqueloculina* by Vella (1957).

**LENGTH:** 0.20–0.35 mm.

**DEPTH RANGE:** 42–48 m, no living specimens.

**OCCURRENCE:** Rare, on inner shelf only.

**Triloculina trigonula** (Lamarck)

Brady 1884, pl. 3, figs 15, 16.

**LENGTH:** 0.47–0.67 mm.

**DEPTH RANGE:** 142–183 m, no living specimens.

**OCCURRENCE:** On Madden Banks only.

**Subfamily MILIOLINELLINAE**

**Miliolinella subrotunda** (Montague)

Brady 1884, pl. 4, fig. 3, pl. 5, figs 10, 11, 13, 14. Loeblich and Tappan 1964, fig. 335, no. 1.

**REMARKS:** Large specimens are typical of *M. subrotunda*, but small specimens, which tend to be flattened with chambers in a planospiral or streptospiral coil, are similar to *M. australis* (Parr).

**LENGTH:** 0.25–0.55 mm.

**DEPTH RANGE:** 18–183 m, living: 42–48 m.

**OCCURRENCE:** Moderately common on inner shelf and on Madden Banks; may occur only where sediment is relatively coarse.

**Biloculina depressa** (d’Orbigny)

Vella 1957, pl. 7, figs 137, 140.

**LENGTH:** 0.75–1.00 mm.

**DEPTH RANGE:** 42–375 m, living 42 m.

**OCCURRENCE:** Inner shelf and Madden Banks where sediment relatively coarse.

**Scutuloris hornibrooki** (Vella)

**LENGTH:** About 0.3 mm.

**DEPTH RANGE:** 48–2028 m, living: 48–2028 m.

**OCCURRENCE:** Rare, occurs at only two stations, one on the inner shelf, the other on the lower slope.

**Suborder ROTALIINA**

**Superfamily NODOSARIACEA**

**Family NODOSARIIDAE**

**Nodosaris calomorpha** Reuss

Brady 1884, pl. 61, figs 23–27.

**LENGTH:** About 0.3 mm.

**DEPTH RANGE:** 329–2127 m, no living specimens.

**OCCURRENCE:** A few specimens at many stations on slope.
**Nodosaria simplex** (Silvestri)

Brady 1884, pl. 62, fig. 4.

LENGTH: 0.6–0.7 mm.

DEPTH RANGE: 276 m, no living specimens.

**Occurrence:** Rare, on upper slope.

**Amphicoryna hirsuta** (d’Orbigny)

Brady 1884, pl. 63, figs 12-15.

LENGTH: 0.50–0.75 mm.

DEPTH RANGE: 276–625 m, no living specimens.

**Occurrence:** Common on Motukura Bank, rare elsewhere.

**Amphicoryna separans** (Brady)

Brady 1884, pl. 63, figs 29–31; pl. 64, figs 16–19; pl. 65, figs 7–9.

**Remarks:** All of Brady’s figured specimens are from the Pacific, and most of these are from New Zealand. Those recorded as *A. scalaris* by Barker (1960) are immature specimens of *A. separans*. *A. scalaris* (Brady 1884, pl. 63, fig. 28) has no ribs around neck and is probably confined to the Atlantic Ocean.

LENGTH: 0.7–1.8 mm.

DEPTH RANGE: 71–625 m, no living specimens.

**Occurrence:** Rare, on outer shelf and upper slope.

**Astatolus** sp.

**Remarks:** Angular periphery and broad, globose apertural face; tends towards shape of *Saracenaria*; resembles *Lenticulina altifrons* (Parr), but less tightly enrolled initial coil.

LENGTH: 0.6–0.9 mm.

DEPTH RANGE: 276–375 m, living: 329 m.

**Occurrence:** Common on Motukura Bank, rare on upper slope.

**Dentalina cf. caudata** d’Orbigny

LENGTH: 0.45–0.90 mm.

DEPTH RANGE: 276–329 m, no living specimens.

**Occurrence:** Rare, on Motukura Bank and upper slope.

**Dentalina spp. aff. filiformis** (d’Orbigny)

Brady 1884, pl. 63, figs 3–5.

LENGTH: 0.5–2.0 mm.

DEPTH RANGE: 18–1240 m, living: 304–375 m.

**Occurrence:** A few specimens at many stations.

**Dentalina subemaciata** Parr

LENGTH: 0.8–2.5 mm.

DEPTH RANGE: 276–2432 m, living: 304–1419 m.

**Occurrence:** Common Motukura Bank and at some places on upper and mid slope, rare on upper and mid slope.

**Dentalina subolenta** (Cushman)

Brady 1884, pl. 62, figs 13–16.

LENGTH: 1.0–4.3 mm.

DEPTH RANGE: 113–625 m, no living specimens.

**Occurrence:** Common on Motukura Bank, rare on outer shelf and upper slope.

**Lagenaspp.**

**Remarks:** It was found difficult to group specimens of *Lagenas* into well defined species, so they were counted collectively and the presence of some conspicuous forms was noted. These forms are listed below.

**Lagenaelongata** (Ehrenberg)

Brady 1884, pl. 56, figs 27, 29.

**Occurrence:** Rare, occurs at several stations on slope.

**Lagenagracilis** Williamson

Brady 1884, pl. 58, figs 1, 2, 23.

**Occurrence:** Fairly common on outer shelf and slope.

**Lagenagracillim** (Seguenza)

(Brady 1884, pl. 56, figs 21, 22.

**Occurrence:** Rare, on inner shelf only.

**Lagenahispida** Reuss

Brady 1884, pl. 57, figs 2–4.

**Occurrence:** Rare, on upper slope and Motukura Bank.

**Lagenalaevis** (Montague)

Brady 1884, pl. 56, figs 7, 8.

**Occurrence:** Moderately common on banks and slope.

**Lagenaff. laevis** (Montague)

Brady 1884, pl. 57, fig. 14.

**Occurrence:** Rare, on outer shelf and slope.

**Lagenaplumigera** Brady

Brady 1884, pl. 58, figs 18, 25, 27.

**Occurrence:** Rare, outer shelf and upper slope.

**Lagenastriata** (d’Orbigny)

Brady 1884, pl. 57, figs 22, 24, 28.

**Occurrence:** Common from inner shelf to mid slope.
Lagena sulcata (Walker and Jacobs)
Brady 1884, pl. 58, figs 4, 17.
**Occurrence:** Rare, on Motukura Bank and slope.

**Lenticulina spp.**
**Remarks:** Many species of *Lenticulina* are very variable and it was found difficult to assign many specimens to particular species. Therefore, all specimens of *Lenticulina* were counted collectively and the presence of some conspicuous species was noted. These species are listed below.
**Occurrence:** Present in most samples, but common on outer shelf and upper slope, and abundant on banks.

**Lenticulina calcar (Linnaeus)**
Brady 1884, pl. 70, figs 11, 12.
**Remarks:** Test with glassy spines around periphery.
**Occurrence:** Rare, on upper slope only.

**Lenticulina cultratis (Montfort)**
Hedley et al. 1965, pl. 4, fig. 15.
**Remarks:** Test with sharp keel, and umbilical plug.
**Occurrence:** Occurs at most stations from inner shelf to lower slope, common on banks.

**Lenticulina gibba (d’Orbigny)**
Hedley et al. 1965, pl. 3, fig. 11.
**Remarks:** Test without keel and umbilical plug or with very small umbilical plug.
**Occurrence:** Rare, on outer shelf and upper slope.

**Lenticulina loculosa (Stache)**
Horinbrook 1961, pl. 4, fig. 63.
**Remarks:** Test with many chambers in whorl, large umbilical plug, keel.
**Occurrence:** Rare, outer shelf to mid slope.

**Lenticulina peregrina (Schwager)**
Brady 1884, pl. 68, figs 11-16.
**Remarks:** One of the few really distinctive species.
**Occurrence:** Common and living on upper slope, common on Motukura Bank, single specimens on outer shelf and on mid slope.

**Lenticulina subgibba Parr**
Hedley et al. 1965, pl. 3, fig. 12.
**Remarks:** Test flaring and without keel.
**Occurrence:** Rare, on outer shelf and upper slope.

**Lenticulina suborbicularis (Parr)**
Hedley et al. 1965, pl. 5, fig. 16.
**Remarks:** Test small and with spiral sutures.
**Occurrence:** Rare, on bank and on inner shelf.

**Lenticulina tasmanica (Parr)**
Hedley et al. 1965, pl. 5, fig. 17.
**Remarks:** Test with few chambers, large glassy umbilical plug, and keel.
**Occurrence:** Rare at isolated stations on inner shelf and on mid slope.

**Marginulina glabra d’Orbigny**
Loeblich and Tappan 1964, fig. 406, no. 10.
**Length:** 0.8-1.1 mm, width: 0.40-0.55 mm.
**Depth range:** 329-2127 m, no living specimens.
**Occurrence:** Rare, at only two stations on upper and lower slope.

**Marginulina tenuis Bornemann**
Brady 1884, pl. 66, fig. 21.
**Length:** 1.1-1.6 mm, width: 0.19-0.24 mm.
**Depth range:** 276-329 m, no living specimens.
**Occurrence:** Common on Motukura Bank, rare on upper slope.

**Marginulinaopsis bradyi (Goes)**
Brady 1884, pl. 65, fig. 12.
**Remarks:** Specimens appear to be referable to *Marginulina*, but may be within the range of variation of *Marginulinaopsis bradyi*.
**Length:** 1.6-3.2 mm, width: 0.50-0.55 mm.
**Depth range:** 142-329 m, no living specimens.
**Occurrence:** Rare, on banks.

**Orthomorphina georgiana (Cushman)**
**Remarks:** Described as *Nodogenerina*.
**Length:** About 0.6 mm.
**Depth range:** 18-429 m, no living specimens.
**Occurrence:** Rare, on shelf and upper slope.

**Planularia tricarinella (Reuss)**
Hedley et al. 1965, pl. 4, fig. 13.
**Length:** 0.5-1.1 mm.
**Depth range:** 113-304 m, living: 113-276 m.
**Occurrence:** Rare, on outer shelf and upper slope.
Saracenaria latifrons (Brady)
Brady 1884, pl. 113, fig. 11.
Remarks: Sharp angles at each of three corners of test.
Depth range: 186-427 m, living: 427 m.
Occurrence: Common on Motukura Bank, rare on upper slope.

Family POLYMORPHINIDAE
Subfamily POLYMORPHININAE

Sigmomorphina lacrimosa Vella
Length: 1.2-1.8 mm.
Depth range: 142-183 m, no living specimens.
Occurrence: Only on Madden Banks.

Subfamily RAMULININAE

Ramulina globulifera Brady
Brady 1884, pl. 76, figs 22-28.
Length of individual chambers: 0.3-0.5 mm.
Depth range: 329-479 m, no living specimens.
Occurrence: Common on Motukura Bank, rare on upper slope.

Family GLANDULINIDAE
Subfamily GLANDULININAE

Entolingulina sp.
Remarks: Test has three chambers in rectilinear series.
Length: 1.65 mm.
Depth range: 2469 m, living: 2469 m.
Occurrence: Only at deepest station.

Laryngosigma hyalascidia Loeblich and Tappan
Loeblich and Tappan 1964, fig. 421, no. 9.
Length: 0.45 mm.
Depth range: 42 m, no living specimens.
Occurrence: Rare, at single station on inner shelf.

Subfamily SEABROOKIINAE

Seabrookia earlandi Wright
Remarks: Final chamber not completely enclosing earlier chambers.
Length: 0.16-0.25 mm.

Depth range: 186-2432 m, living: 329-1419 m.
Occurrence: Common at many stations on slope.

Seabrookia sp.
Remarks: Chambers even less embracing than S. earlandi; reminiscent of Edentostomina, but wall clear and glassy.
Length: 0.16-0.20 mm.
Depth range: 1240-2329 m, living: 1240 m.
Occurrence: Occurs at only two stations on mid and lower slope.

Subfamily OOLININAE

Oolina spp.
Remarks: As with Lagena and Lenticulina it was found difficult to assign many specimens to recognised species. Those species that definitely occur are listed below.
Occurrence: Most specimens on the shelf are O. melo, those on the slope are referred to many species.

Oolina apicularis Reuss
Brady 1884, pl. 56, fig. 15.
Occurrence: Rare, on outer shelf.

Oolina botelliformis (Brady)
Brady 1884, pl. 56, fig. 6.
Occurrence: Rare, on lower slope.

Oolina felsinea (Fornasini)
Brady 1884, pl. 56, fig. 4.
Occurrence: Rare, on lower slope.

Oolina globosa (Montague)
Brady 1884, pl. 56, figs 1-3.
Occurrence: Ubiquitous but rare.

Oolina hexagona (Williamson)
Loeblich and Tappan 1953, pl. 14, figs 1-2.
Occurrence: Rare, on shelf, upper slope and banks.

Oolina melo d’Orbigny
Loeblich and Tappan 1953, pl. 12, figs 8-15.
Occurrence: Common on inner shelf, moderately common on outer shelf and rare on upper slope.
Oolina ovum (Ehrenberg)
Brady 1884, pl. 56, fig. 5.

Occurrence: Rare, on lower slope.

Fissurina spp.
Remarks: Many specimens of Fissurina could not be assigned to known species, but those species that were recognised are listed below.

Fissurina annectens (Burrows and Holland)
Brady 1884, pl. 59, fig. 15.

Occurrence: Ubiquitous but rare at any station.

Fissurina clathrata (Brady)
Brady 1884, pl. 60, fig. 4.

Occurrence: Rare, at many stations from inner shelf to mid slope.

Fissurina crebra (Matthes)
Brady 1884, pl. 59, fig. 6.

Occurrence: Rare, on upper slope.

Fissurina aff. cucullata Silvestri
Brady 1884, pl. 59, fig. 25.

Occurrence: Rare, on upper slope.

Fissurina earlandi Parr
Occurrence: Ubiquitous but rare.

Fissurina kerguelensis Parr
Brady 1884, pl. 59, figs 8, 9.

Occurrence: Ubiquitous but rare.

Fissurina laevigata Reuss
Brady 1884, pl. 114, fig. 8.

Occurrence: Rare, on slope.

Fissurina lucida (Williamson)
Occurrence: Ubiquitous, fairly common on shelf.

Fissurina aff. orbignyanana Seguenza
Brady 1884, pl. 59, fig. 18.

Occurrence: Rare, on lower slope.

Fissurina revertens (Heron-Allen and Earland)
Heron-Allen and Earland 1932, pl. 11, figs 26-28

Occurrence: Ubiquitous but rare.

Fissurina squamoso-marginata (Parker and Jones)
Brady 1884, pl. 60, fig. 24.

Occurrence: Rare, on mid slope.

Fissurina submarginata (Boomgart)
Brady 1884, pl. 59, fig. 22.

Occurrence: Rare, on upper slope.

Fissurina unguiculata (Brady)
Brady 1884, pl. 59, fig. 12.

Occurrence: Rare, on upper slope.

Parafissurina spp.
Remarks: Some specimens of Parafissurina could not be assigned to known species. Those species that were recognised are listed below.

Parafissurina curta Parr
Occurrence: Rare, on slope.

Parafissurina quadrata Parr
Occurrence: Rare, on lower slope.

Parafissurina ventricosa (Silvestri)
Loeblich and Tappan 1964, fig. 425, no. 9.

Occurrence: Rare, on lower slope.

Superfamily BULIMINACEA
Family TURRILINIDAE
Subfamily TURRILININAE

Buliminella madagascariensis (d'Orbigny)
Cushman and Parker 1947, pl. 17, figs 15-18.

Length: 0.15-0.35 mm.

Depth range: 18-625 m, no living specimens.

Occurrence: Rare, at only two stations on inner shelf and upper slope.

Family SPHAEROIDINIDAE

Sphaeroidina bulboides d'Orbigny
Brady 1884, pl. 84, figs 1, 2.

Remarks: The difference between S. bulboides and S. compressa is not clear so all specimens are referred to the first described species, S. bulboides; wall of most specimens is translucent.

Length: 0.18-0.53 mm.
DEPTH RANGE: 18–2432 m, living: 42–2063 m.
OCCURRENCE: Common everywhere except inner shelf, most common on outer shelf and on Motukura Bank.

Family BOLIVINITIDAE

Boli
\textit{vinita quadrilaterata} (Schwager)
Brady 1884, pl. 42, figs 8–12.
LENGTH: 0.35–0.95 mm.
DEPTH RANGE: 48–2469 m, living: 1419 m.
OCCURRENCE: Moderately common on mid and lower slope.

Boli\textit{vina pseudo-plicata} Heron-Allen and Earland
LENGTH: 0.15–0.30 mm, width: 0.10–0.13 mm.
DEPTH RANGE: 18–1649 m, living: 48–375 m.
OCCURRENCE: Common from inner shelf to mid slope.

Boli
\textit{vina sphenoides} Chapman and Parr
REMARKS: Specimens were compared with topotype material – there is no adequate figure of this species; it is quadrilateral in apertural view and has raised crenulate sutures.
LENGTH: 0.14–0.35 mm, width: 0.11–0.19 mm.
DEPTH RANGE: 375–2469 m, living: 1240–1649 m.
OCCURRENCE: Abundant on mid slope, common on lower slope.

Boli
\textit{vina} ? sp.
REMARKS: Has areal aperture so is not typical of the genus Boli\textit{}vina; test oval in apertural view, side view varies from moderately flaring to almost parallel sided. Chambers with retral processes similar to those of B.\textit{pseudo-plicata}; aperture areal with lip; large internal tooth plate.
LENGTH: 0.24–0.36 mm.
DEPTH RANGE: 42–479 m, living: 42–329 m.
OCCURRENCE: Abundant on Motukura Bank, rare elsewhere.

Brizalina alata (Seguenza)
Brady 1884, pl. 53, figs 2, 3.
LENGTH: About 0.7 mm.
DEPTH RANGE: 329–1649 m, no living specimens.
OCCURRENCE: Rare, on Motukura Bank and upper and mid slope.

Brizalina cacozela Vella
REMARKS: More rounded periphery than B.\textit{spathulata} and usually narrower.
LENGTH: 0.20–0.45 mm, width: 0.08–0.14 mm.
DEPTH RANGE: 18–2469 m, living: 18–1240 m.
OCCURRENCE: Common at most stations from inner shelf to mid slope, abundant on middle part of shelf and on banks.

Brizalina earlandi Parr
LENGTH: 0.12–0.48 mm.
DEPTH RANGE: 91–2469 m, living: 375–2432 m.
OCCURRENCE: Common only on mid and lower slope.

Brizalina \textit{spathulata} (Williamson)
Hedley \textit{et al.} 1965, pl. 6, fig. 22, text-fig. 6.
REMARKS: Test distinctly more carinate than B.\textit{cacozela} and usually more flaring.
LENGTH: 0.25–0.49 mm.
DEPTH RANGE: 18–2432 m, living: 48–71 m.
OCCURRENCE: Common on continental shelf at depths of less than 75 m, a few specimens found in two samples from continental slope.

Brizalina \textit{aff. subspinescens} (Cushman)
REMARKS: Pustulose lower part of each chamber, aperture broad, loop-shaped, partly closed by plate formed by incurved part of apertural face; initial growth tends to be twisted; may be referable to genus \textit{Laterostomella} or perhaps to \textit{Stainforthia}.
LENGTH: 0.15–0.46 mm.
DEPTH RANGE: 130–2329 m, living: 130 m.
OCCURRENCE: Common from outer shelf to mid slope.

Brizalina ? \textit{karreriana} (Brady)
Brady 1884, pl. 53, figs 19–21.
REMARKS: Hedley \textit{et al.} (1967) noted that this species has a radial wall structure and belongs with the Bolivinidae. However, its areal aperture is not typical of the genus \textit{Brizalina}.
LENGTH: 0.28–0.80 mm.
DEPTH RANGE: 40-1419 m, living: 40-427 m. 
Occurrence: Common or abundant on outer shelf, banks and upper slope, rare elsewhere.

Rectobolivina columellaris (Brady) 
Brady 1884, pl. 75, figs 15-17.
LENGTH: 0.67–0.92 mm, width: 0.20–0.22 mm.
DEPTH RANGE: 329 m, no living specimens. 
Occurrence: Moderately common on Motukura Bank.

Family BULIMINIDAE
Subfamily BULIMININAE

Bulimina aculeata d’Orbigny 
Brady 1884, pl. 51, figs 7-9.
LENGTH (WITHOUT BASAL SPINE): 0.2–0.7 mm.
DEPTH RANGE: 180–2469 m, living: 276–2469 m.
Occurrence: Abundant and living at almost every station on slope.

Bulimina marginata d’Orbigny 
Hedley et al. 1965, text-fig. 5.
LENGTH: 0.15–0.55 mm.
DEPTH RANGE: 18–625 m, living: 40–427 m.
Occurrence: Common on shelf and upper slope, range overlaps with that of B. aculeata on upper slope.

Bulimina nipponica Asano 
Brady 1884, pl. 5, figs 11–13.
Remarks: Brady’s figures are not B. costata, which does not have spines.
LENGTH: 0.20–0.93 mm, but mostly about 0.4–0.5 mm.
DEPTH RANGE: 18–2469 m, living: 186–2329 m.
Occurrence: Moderately common everywhere.

Bulimina rostrata Brady 
Cushman and Parker 1947, pl. 28, fig. 34.
Remarks: Similar to B. truncanella. 
LENGTH: 0.24–0.28 mm.
DEPTH RANGE: 1240–2432 m, living: 1240–1419 m.
Occurrence: Common on mid slope, rare on lower slope.

Globobulimina turgida (Bailey) 
Hedley et al. 1965, pl. 7, fig. 26, Höglund 1947, pl. 21, figs 4, 8, text-figs 247–257.
LENGTH: 0.4–0.8 mm.

Globobulimina aculeata (Brady)
Brady 1884, pl. 75, figs 15-17.
LENGTH: 0.67–0.92 mm, width: 0.20–0.22 mm.
DEPTH RANGE: 329 m, no living specimens. 
Occurrence: Moderately common on Motukura Bank.

Globobulimina aculeata (Brady)
Brady 1884, pl. 75, figs 15-17.
LENGTH: 0.67–0.92 mm, width: 0.20–0.22 mm.
DEPTH RANGE: 329 m, no living specimens. 
Occurrence: Moderately common on Motukura Bank.

Globobulimina marginata (Brady) 
LENGTH: 0.32–0.80 mm.
DEPTH RANGE: 276–2469 m, living: 276–2028 m.
Occurrence: Common on Motukura Bank and at some stations on upper slope.

Globobulimina notovata (Chapman) 
Brady 1884, pl. 5, figs 11–13.
Remarks: Brady’s figures are not B. costata, which does not have spines.
LENGTH: 0.20–0.93 mm, but mostly about 0.4–0.5 mm.
DEPTH RANGE: 186–2432 m, living: 1649–2329 m.
Occurrence: Moderately common on mid and lower slope.

Praeglobulimina spinescens (Brady) 
Loeblich and Tappan 1964, fig. 442, nos 12, 13.
LENGTH: 0.22–0.53 mm.
DEPTH RANGE: 130–1419 m, living: 276–479 m.
Occurrence: Moderately common on upper slope.

Stainforthia concava (Höglund) 
Loeblich and Tappan 1964, fig. 442, nos 10, 11.
Remarks: Specimens have been compared with a single, damaged, topotype specimen of Virgulina davisi and appear to have more inflated chambers. However, as pointed out by Höglund (1947), the original description and figures of V. davisi are completely inadequate.
LENGTH: 0.20–0.40 mm.
DEPTH RANGE: 329–2432 m, living: 2329–2432 m.
Occurrence: Common at most places on slope, most common on mid and lower slope.

Stainforthia sp.
Remarks: Test small, fusiform, chambers in twisted biserial arrangement. Aperture and apertural face smaller than S. concava but otherwise similar.
LENGTH: 0.36-0.42 mm, width: 0.10-0.11 mm.
DEPTH RANGE: 91-2329 m, living: 91-1649 m.
OCCURRENCE: Common on mid slope, and at some stations elsewhere.

Family UVIGERINIDAE

Euvigera peregrina (Cushman)
Brady 1884, pl. 74, figs 11, 12.
REMARKS: Many specimens have ridges on final chamber broken up into spines; some have long spines near proximal edge.
LENGTH: 0.3-1.1 mm.
DEPTH RANGE: 18-2469 m, living: 276-2329 m.
OCCURRENCE: Rare worn specimens occur on shelf. Abundant on upper slope and on Motukura Bank, common on mid and lower slope.

Hopkinsina pacifica Cushman
REMARKS: Immature specimens do not have an areal aperture but have a Bulimina-type slit.
LENGTH: 0.18-0.38 mm.
DEPTH RANGE: 91-1241 m, living: 91-479 m.
OCCURRENCE: Ubiquitous, but common only on Motukura Bank.

Siphouvigerina asperula (Czjek)
Brady 1884, pl. 75, figs 6, 7, 8.
LENGTH: 0.23-0.63 mm.
DEPTH RANGE: 48-2432 m, living: 186 m.
OCCURRENCE: Ubiquitous, but common only on Motukura Bank.

Siphouvigerina interrupta (Brady)
Brady 1884, pl. 75, figs 12-14.
LENGTH: 0.42-0.65 mm.
DEPTH RANGE: 186-1240 m, living: 186-375 m.
OCCURRENCE: Abundant on Motukura Bank, common on upper slope.

Trifarina angulosa (Williamson)
Brady 1884, pl. 74, figs 15, 16.
LENGTH: 0.12-0.29 mm.
DEPTH RANGE: 18-2432 m, living: 329-2329 m.
OCCURRENCE: Abundant on Motukura Bank, common on slope, rare on shelf.

Trifarina bradyi Cushman
Brady 1884, pl. 67, figs 1-3.
LENGTH: About 0.4 mm.

Depth range: 18-1240 m, no living specimens.
OCCURRENCE: Common on Motukura Bank, rare elsewhere.

Trifarina gracilis Vella
LENGTH: About 0.4 mm.
DEPTH RANGE: 71-91 m, no living specimens.
OCCURRENCE: Rare, on outer shelf.

Virgulinopsis turris (Heron-Allen and Earland)
Hedley et al. 1967, pl. 9, fig. 5.
LENGTH: 0.09-0.25 mm.
DEPTH RANGE: 18-625 m, living: 18 m.
OCCURRENCE: Common on shelf, single dead specimen from lower slope, large living population on inner shelf.

Superfamily DISCORBACEA
Family DISCORBIDAE
Subfamily DISCORBINAE

Discorbis dimidiatus (Jones and Parker)
Hedley et al. 1967, text-figs 28-43.
LENGTH: 0.25-0.72 mm.
DEPTH RANGE: 18-130 m, living: 18-40 m.
OCCURRENCE: Common on inner shelf.

Discorbinella cf. bertheloti (d'Orbigny)
cf. Loeblich and Tappan 1964, fig. 453, no. 3.
REMARKS: Domed side of test more involute than Loeblich and Tappan's figure; some specimens tend towards shape of D. baconica var. baconica as illustrated by Brady 1884, pl. 90, fig. 1; conspicuous umbilical chamber flaps.
LENGTH: 0.28-0.48 mm.
DEPTH RANGE: 40-479 m, living: 276-375 m.
OCCURRENCE: Rare on shelf, common on Motukura Bank and upper slope.

EpistomineUa exigua (Brady)
REMARKS: Many specimens have more globose chambers and less angular periphery than type figures (Brady 1884, pl. 10, figs 13, 14); all have conspicuous slit extending from base of apertural face towards periphery.
LENGTH: 0.10-0.27 mm.
DEPTH RANGE: 18-2469 m, living: 18-2469 m.
OCCURRENCE: Abundant on outer shelf, common elsewhere.
Gavelinopsis hamatus Vella
LENGTH: 0.17-0.50 mm.
DEPTH RANGE: 18-1419 m, living: 18-42 m.
OCCURRENCE: Common on inner shelf and on Motukura Bank, rare elsewhere; occurs where sediment is coarse.

Gavelinopsis lobatusus Parr
Brady 1884, pl. 88, fig. 1.
LENGTH: 0.13-0.41 mm.
DEPTH RANGE: 130-1419 m, living: 186-1240 m.
OCCURRENCE: Common on upper slope and mid slope, abundant on banks.

Laticarina altocamerata (Heron-Allen and Earland)
Brady 1884, pl. 93, fig. 2.
LENGTH: 0.3-0.4 mm.
DEPTH RANGE: 329-1649 m, no living specimens.
OCCURRENCE: Common on Motukura Bank, rare on upper and mid slope.

Laticarina pauperata (Parker and Jones)
Brady 1884, pl. 104, figs 3-11; Eade 1967, frontispiece.
LENGTH: About 1-2 mm.
DEPTH RANGE: 1649-2432 m, no living specimens.
OCCURRENCE: Moderately common at three stations on mid and lower slope.

Planodiscorbis rarescens (Brady)
LENGTH: 0.3-0.7 mm.
DEPTH RANGE: 329-1419 m, no living specimens.
OCCURRENCE: Common on Motukura Bank, rare on slope.

Rosalina bradyi (Cushman)
Hedley et al. 1967, fig. 2, text-figs 50-55.
LENGTH: 0.18-0.55 mm.
DEPTH RANGE: 18-276 m, living: 18-130 m.
OCCURRENCE: Abundant on inner shelf, common on outer shelf.

Rosalina irregularis (Rhumbler)
Hedley et al. 1967, pl. 11, fig. 3.
LENGTH: 0.20-0.45 mm.
DEPTH RANGE: 18-48 m, living: 18-42 m.
OCCURRENCE: Common, on inner shelf.

Rosalina paupereques Vella
LENGTH: 0.27 mm.

DEEP RANGE: 71 m, no living specimens.
OCCURRENCE: Rare, on outer shelf.

Subfamily BAGGININAE

Cancris maoricus Finlay
LENGTH: 0.6-1.5 mm.
DEPTH RANGE: 329 m, no living specimens.
OCCURRENCE: Common on Motukura Bank only.

Valvulineria aff. laevigata Phleger and Parker
REMARKS: Test more flaring and apertural flaps larger than V. laevigata.
LENGTH: 0.24-0.30 mm.
DEPTH RANGE: 375-2329 m, living: 479-2329 m.
OCCURRENCE: Common on upper and mid slope, rare on lower slope.

Family GLABRATELLIDAE

Glabratella radiata (Vella)
LENGTH: 0.27-0.52 mm.
DEPTH RANGE: 18-48 m, no living specimens.
OCCURRENCE: Common on inner shelf.

Glabratella zealandica (Vella)
LENGTH: 0.17-0.37 mm.
DEPTH RANGE: 18-71 m, no living specimens.
OCCURRENCE: Common on inner shelf.

Family SIPHONINIDAE

Sipbonina cf. tubulosa (Cushman)
Brady 1884, pl. 96, figs 5-7.
REMARKS: Frilled keel not as well developed as in Brady's figures; shell opaque.
LENGTH: 0.43-0.60 mm.
DEPTH RANGE: 329 m, no living specimens.
OCCURRENCE: Common, on Motukura Bank only.

Superfamily SPIRILLINAClAE
Family SPIRILLINIDAE
Subfamily SPIRILLININAE

Spirillina obconica Brady
Brady 1884, pl. 85, fig. 6.
LENGTH: 0.25 mm.
DEPTH RANGE: 42 m, no living specimens. 
Occurrence: Rare, at single station on inner shelf only.

**Spirillina vivipara** Ehrenberg  
Brady 1884, pl. 85, fig. 2.  
**Length:** 0.15–0.20 mm.  
**Depth range:** 40–2469 m, living: 42 m.  
**Occurrence:** A few specimens on inner shelf and single specimen on lower slope.

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**Superfamily ROTALIACEA**  
**Family ROTALIIDAE**  
**Subfamily ROTALIINAE**

**Ammonia aoteanus** (Finlay)  
Hedley *et al.* 1967, pl. 11, fig. 4, text-figs 56-60.  
**Length:** 0.3–0.7 mm.  
**Depth range:** 18–276 m, living: 18–48 m.  
**Occurrence:** Moderately common on inner shelf, rare on outer shelf.

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**Family ELPHIDIIDAE**  
**Subfamily ELPHIDIINAE**

**Elphidium novozealandicum** Cushman  
Hedley *et al.* 1967, pl. 12, fig. 4.  
**Length:** 0.20–0.85 mm.  
**Depth range:** 18–71 m, no living specimens.  
**Occurrence:** Common on inner shelf.

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**Cribrononion argenteum** (Parr)  
Hedley *et al.* 1967, pl. 12, fig. 2.  
**Length:** 0.20–0.38 mm.  
**Depth range:** 40–625 m, living: 48–427 m.  
**Occurrence:** Common on outer shelf, rare elsewhere.

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**Cribrononion charlottensis** (Vella)  
Hedley *et al.* 1967, pl. 12, fig. 3.  
**Length:** 0.2–0.5 mm.  
**Depth range:** 18–2469 m, living: 18–130 m.  
**Occurrence:** Common on shelf, a few dead specimens on slope.

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**Cribrononion simplex** (Cushman)  
Hedley *et al.* 1967, pl. 12, fig. 1.  
**Length:** 0.15–0.45 mm.

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**Superfamily ORBITOIDACEA**  
**Family EPONIDIDAE**

**Eponides pusillus** Parr  
**Length:** 0.11–0.21 mm.  
**Depth range:** 18–2432 m, living: 48–1240 m.  
**Occurrence:** Rare on shelf, very common on slope, abundant on Motukura Bank.
Eponides tumidulus (Brady)
Brady 1884, pl. 95, fig. 8.
REMARKS: Small, but with more globose chambers than E. pusillus.
LENGTH: 0.10-0.12 mm.
DEPTH RANGE: 329-1649 m, living: 1649 m.
OCCURRENCE: Rare, on upper and mid slope.

Family CIBICIDIDAE
Subfamily PLANULININAE

Planulina aff. ariminensis d'Orbigny
REMARKS: Has more pronounced apertural flaps than P. ariminensis (Loeblich and Tappan 1964, fig. 552, no. 1)
LENGTH: About 0.35 mm.
DEPTH RANGE: 304-1419 m, living: 375 m.
OCCURRENCE: Common on banks, rare on slope.

Subfamily CIBICIDINAE

Cibicides ihungia Finlay
LENGTH: About 0.5 mm.
DEPTH RANGE: 329-2063 m, no living specimens.
OCCURRENCE: Common on upper slope, rare elsewhere.

Cibicides marlboroughensis Vella
REMARKS: Final chambers are added more loosely than early chambers so that some large specimens resemble C. delicata although C. delicata is generally flatter than large specimens of C. marlboroughensis.
LENGTH: 0.17-0.70 mm.
DEPTH RANGE: 18-2469 m, living: 18-304 m.
OCCURRENCE: Common on shelf and upper slope, abundant on Motukura Bank, moderately common on mid and lower slope.

Cibicides wuellerstorfi (Schwager)
Brady 1884, pl. 93, fig. 9.
LENGTH: 0.3-0.7 mm.
DEPTH RANGE: 304-2329 m, no living specimens.
OCCURRENCE: Common on Motukura Bank and upper slope, moderately common on mid and lower slope.

Dyocibicides primitiva Vella
REMARKS: Early coil similar to small C. marlboroughensis.
LENGTH: 0.2-0.8 mm.
DEPTH RANGE: 18-1419 m, living: 42 m.
OCCURRENCE: Moderately common on inner shelf and Motukura Bank, rare elsewhere; may be confined to places where suitable rock or shell substrate present.

Family CAUCASINIDAE
Subfamily FURSENKOININAE

Fursenkoina rotundata Parr
Brady 1884, pl. 52, figs. 10, 11.
LENGTH: 0.38-0.62 mm.
DEPTH RANGE: 276-2432 m, living: 479-1240 m.
OCCURRENCE: Common on upper and mid slope.

Fursenkoina squammosa (d'Orbigny)
Loeblich and Tappan 1964, fig. 600, nos. 1-4.
LENGTH: 0.35-1.08 mm.
DEPTH RANGE: 186-479 m, living: 186-479 m.
OCCURRENCE: Common on upper slope.

Ehrenbergina mestayeri Cushman
Eade 1967, fig. 8, nos. 6, 7.
REMARKS: Specimens from the Madden Banks do not have spines around the margin and may have been eroded from Tertiary mudstone.
LENGTH: 0.4-0.7 mm.
DEPTH RANGE: 18-329 m, no living specimens.
OCCURRENCE: Occurs on shelf and on banks, but only where sediment is relatively coarse.

Evolvocassidulina orientalis (Cushman)
Eade 1967, fig. 4, nos. 1, 2, Hedley et al. 1967, pl. 12, fig. 5.
LENGTH: 0.2-0.5 mm.
DEPTH RANGE: 18-2469 m, living: 40-479 m.
OCCURRENCE: Abundant on banks, common on outer shelf and upper slope, moderately common on inner shelf and mid slope.
Globoideidulina canalisuturata Eade
Eade 1967, fig. 3, nos 5-7, fig. 5, nos 7-8.
LENGTH: 0.35–0.55 mm.
DEPTH RANGE: 142–479 m, no living specimens.
OCCURRENCE: Abundant on banks.

Globoideidulina aff. inflata (Le Roy)
Eade 1967, fig. 4, no. 4.
LENGTH: 0.10–0.22 mm.
DEPTH RANGE: 18–2469 m, living: 130–2329 m.
OCCURRENCE: Common at many stations between outer shelf and mid slope.

Globoideidulina minuta (Cushman)
Eade 1967, fig. 5, nos 2, 3.
LENGTH: 0.2–0.3 mm.
DEPTH RANGE: 329–2469 m, living: 329 m.
OCCURRENCE: Common on Motukura Bank and at one station on mid slope, rare on rest of slope.

Globoideidulina producta (Chapman and Parr)
Eade 1967, fig. 4, no. 5.
LENGTH: 0.17–0.53 mm.
DEPTH RANGE: 18–2469 m, living: 130 m.
OCCURRENCE: Common on Motukura Bank and on mid and lower slope, rare on shelf.

Globoideidulina spherica Eade
Eade 1967, fig. 7, nos 1–3.
LENGTH: 0.2–0.5 mm.
DEPTH RANGE: 18–91 m, no living specimens.
OCCURRENCE: Rare, on shelf only.

Family NONIONIDAE
Subfamily CHILOSTOMELLINAE

Chilostomella cushmani Chapman
Brady 1884, pl. 56, fig. 13.
LENGTH: 0.20–0.75 mm, width: 0.08–0.47 mm.
DEPTH RANGE: 18–2063 m, living: 113–479 m.
OCCURRENCE: Common on upper slope, rare elsewhere.

Chilostomella cf. oolina Schwager
Brady 1884, pl. 55, figs 14, 17.
REMARKS: Test with almost parallel sides and bluntly rounded ends.
LENGTH: 0.40–0.85 mm, width: 0.17–0.40 mm.

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chamber that droops down over the umbilical area on one side.
LENGTH: 0.12-0.42 mm.
DEPTH RANGE: 40-2063 m, living: 40-1419 m.
OCCURRENCE: Common at all stations from outer shelf to mid slope.

Nonionella flemingi (Vella)
Lewis and Jenkins 1969, pl. 1, figs 1-9.
LENGTH: 0.14-0.38 mm.
DEPTH RANGE: 40-2469 m, living: 40-625 m.
OCCURRENCE: Abundant from mid shelf to upper slope, rare elsewhere.

Pullenia bulloides d'Orbigny
Brady 1884, pl. 84, figs 12, 13.
LENGTH: 0.16-0.23 mm.
DEPTH RANGE: 1240-2469 m, living: 1419-2432 m.
OCCURRENCE: Common on mid and lower slope.

Pullenia subcarinata (d'Orbigny)
Brady 1884, pl. 84, fig. 14.
LENGTH: 0.22-0.40 mm.
DEPTH RANGE: 18-2469 m, living: 329-2432 m.
OCCURRENCE: Rare on shelf, common on slope.

Zeaflorilus parri (Cushman)
Cushman 1939, pl. 9, fig. 12.
LENGTH: 0.20-0.65 mm.
DEPTH RANGE: 18-625 m, living: 18-48 m.
OCCURRENCE: Abundant on inner shelf, moderately common on outer shelf and rare on upper slope.

Family ALABAMINIDAE

Gyroidina orbicularis d'Orbigny
Brady 1884, pl. 115, fig. 6.
REMARKS: Much smaller and much more compressed than Gyroidinoides neosoldanii; sutures recurved in immature specimens and almost radial in adults.
LENGTH: 0.21-0.45 mm.
DEPTH RANGE: 18-2432 m, living: 375-1649 m.
OCCURRENCE: Common everywhere.

Oridorsalis tenera (Brady)
Brady 1884, pl. 95, fig. 11.
LENGTH: 0.18-0.46 mm.
DEPTH RANGE: 71-2329 m, living: 71-2329 m.
OCCURRENCE: Common from outer shelf to mid slope, abundant on Motukura Bank.

Family OSANGULARIDAE

Osangularia bengalensis (Schwager)
Brady 1884, pl. 96, fig. 3.
LENGTH: 0.25-0.55 mm.
DEPTH RANGE: 1240-2329 m, living: 1240-2329 m.
OCCURRENCE: Common on mid and lower slope.

Osangularia sp.
REMARKS: Smaller and more thin-walled than O. bengalensis; keel not frilled and sutures curved.
LENGTH: 0.22-0.34 mm.
DEPTH RANGE: 625-2329 m, no living specimens.
OCCURRENCE: Rare, on slope.

Gyroidinoides neosoldanii (Brotzen)
Brady 1884, pl. 107, fig. 6.
LENGTH: 0.6-1.1 mm.
DEPTH RANGE: 48-2329 m, living: 2329 m.
OCCURRENCE: A few specimens at many stations.

Family ANOMALINIDAE

Subfamily ANOMALININAE

Anomalinoides nipponicus (Ishizaki)
REMARKS: Original description as Gyroidina.
LENGTH: 0.10-0.29 mm.
DEPTH RANGE: 40-1439 m, living: 91-625 m.
OCCURRENCE: Moderately common on outer shelf and upper slope, very common on Motukura Bank.

Anomalinoides spherica (Finlay)
REMARKS: Many specimens are involute on the spiral side and more compressed than typical A. spherica; they closely resemble A. pinguiglabra.
LENGTH: 0.25-0.50 mm.
DEPTH RANGE: 18-375 m, living: 40-71 m.
OCCURRENCE: Common on shelf, rare on upper slope.

Anomalinoides sp.
REMARKS: Smaller and more compressed than A. nipponicus.
LENGTH: 0.09–0.21 mm.
DEPTH RANGE: 18–2432 m, living: 375–1240 m.
OCURRENCE: Common on upper slope, occurs at isolated stations elsewhere.

**Heterolepa aff dutemplei** (d’Orbigny)

**Remarks:** Size, shape and wall structure as *H. dutemplei* of Loeblich and Tappan (1964), fig. 623, no. 3, but with supplementary aperture at proximal, peripheral margin of final chamber; one specimen has stained protoplasm streaming from primary and supplementary aperture and is partially covered with sand grains.

LENGTH: 0.6–1.5 mm.
DEPTH RANGE: 186–625 m, living: 625 m.
OCURRENCE: Common on Motukura Bank, rare elsewhere.

**Melonis** cf. *barleanum* (Williamson)

**Remarks:** Less open umbilicus than Brady’s figure.
LENGTH: 0.2–0.5 mm.
DEPTH RANGE: 479–2469 m, living: 1240 m.

**Melonis sphaeroides** Voloshinova

**Remarks:** The name *M. pomplioide* is retained for Albanian, Pliocene specimens and the name *M. sphaeroides* is used for more globose, more coarsely perforate, Recent specimens.
LENGTH: About 0.25 mm.
DEPTH RANGE: 2469 m, no living specimens.
OCURRENCE: Rare, only at deepest station.

Superfamily ROBERTINACEA
Family CERATOBIULIMINIDAE
Subfamily EPISTOMININAE

**Hoeglundina elegans** (d’Orbigny)

**Remarks:** Perforate, Recent
LENGTH: 0.5–1.0 mm.
DEPTH RANGE: 113–2469 m, living: 113–375 m.
OCURRENCE: A few specimens at many stations on outer shelf and on slope.

The abundance of benthonic foraminifera in each sample is a function of the rate of reproduction, the preservation of empty tests, and the dilution by other sediment. Thus, in 17 ml of wet sediment, numbers range from 400 to 110 000 specimens (Fig. 3a). Samples from the inner shelf contain less than 1000 specimens, most of the others contain 1000–6000 specimens. Benthonic foraminifera are most abundant on the banks where dilution by detrital sediment is minimal. They are least abundant on the inner shelf where there is a relatively large input of detrital sediment, where fragile tests are likely to be destroyed by turbulence, and where food is likely to be scarce. The number of specimens in 10 ml of sediment, a measure used commonly in distributional studies (Phleger 1960) is shown by the scale on the right of Fig. 3a.

The number of living foraminifera on a surface area of 1700 mm² ranges from 17–585 specimens (Fig. 3a). Largest numbers occur on the continental shelf at depths of 48–130 m. Walton (1955) found the largest number at similar depths (36–91 m) on the shelf off Mexico. The smallest numbers occur on the innermost part of the continental shelf and on the lower slope.

Samples were collected in November when the number of living specimens on the continental shelf might be expected to be less than later in the summer (Walton 1955).

The “standing crop” of foraminifera is commonly expressed as the living population per square metre of seabed (Phleger 1960). Values in the study area range from 1 000–350 000/m². These are high compared with abundances of 1000–100 000/m² in the Gulf of Maine but comparable with an average of 90 000/m² at the Mississippi Delta (Phleger 1960). The living population of benthonic foraminifera is a partial measure of productivity, which is apparently relatively high in the study area.

The total number of species (living and dead) per sample increases from the inner shelf to a maximum on the mid slope (Fig. 3b): i.e., the benthonic foraminiferal population is more diverse on the continental slope than on the shelf. The number of species that are living at each station shows a similar but less marked trend.

Planktonic foraminifera are rare on the continental shelf (Fig. 4a) except at two stations (Nos 1 and 3).
where the majority of planktonic foraminifera are worn, broken, and filled with sediment, and are probably derived from Tertiary strata on the adjacent land or seabed. However, the majority of foraminiferal tests on the continental slope belong to planktonic species. It is uncertain whether this is due to slow accumulation of benthonic tests or to relatively rapid accumulation of planktonic tests. Planktonic foraminifera tend to sink during their life (Bé 1965) so that it is likely that more are deposited on the slope than on the shelf.

In the benthonic population the relative proportions of the three main suborders Textulariina, Miliolina and Rotalina change with depth (Fig. 4b). At all depths Rotaliina are dominant, but specimens of the suborder Miliolina are relatively common on the inner shelf and also on the mid and lower slope, where species are different from those on the inner shelf. Specimens of the suborder Textulariina increase in abundance from 2% on the inner shelf to 43% on the lower slope.

Phleger (1955) showed that, at the Mississippi Delta, the percentage of living specimens in the benthonic population is, in general, directly proportional to the rate of deposition. In the present study area the percentage of living specimens in the benthonic population (Fig. 4b) is, in general, higher on the shelf where deposition is relatively rapid (Fig. 2e) than on the slope where deposition is relatively slow, and it is least on the banks where deposition is almost zero. The correlation does not work well on the inner shelf where dead specimens may be removed by turbulence.

The mean width of planktonic, total benthonic, and living benthonic populations has been estimated at each station from the numbers in each sieve class (Fig. 4c). The mean width of planktonic and benthonic specimens ranges from 0.09–0.18 mm and shows no marked trends with changes of depth. However, there appears to be a significant variation in the mean width of living specimens, which are generally smaller than the total benthonic population on the inner shelf but larger elsewhere. The small size of specimens on the inner shelf may be a seasonal phenomenon: samples were collected in early summer when specimens are likely to be immature. The relatively large difference in size between living and dead populations on the continental slope may be partly a result of small dead specimens being transported downslope and thereby depressing the mean width of the total population, and partly a result of large agglutinated species (that form a considerable part of the living population at some places) tending to disintegrate on death so that they are relatively rare in the total population.

**BIOFACIES**

The above study of individual species and total populations indicates that different environments have distinct foraminiferal faunas. It is seldom clear which environmental factors are controlling each part of the fauna.

The continental shelf (0–200 m) is characterised by:
1. A planktonic to benthonic ratio of less than 50%.
2. A benthonic foraminiferal fauna of less than 60 species, and
3. A mean width of living specimens less than about 0.15 mm.

Species that are common on the shelf and rare or absent on the slope include - *Ammonia aoteanaus*, *Brizalina spathulata*, *Cribronion sp.*, *Elphidium novozealandicum*, *Discorbis dimidiatus*, *Miliolinella subrotunda*, *Quinqueloculina* spp. (excluding Q. cf. *venusta* and Q. *wiesneri*), *Virgulopsis turris* and *Zeaflorilus parri*. Species that are common on the shelf and also occur on the upper slope include *Bulimina marginata*, *Nonionellops flemingi*, *Notorotalia finlayi* and *N. zelandica*.

The continental slope is characterised by:
1. A planktonic to benthonic ratio of more than 50%.
2. A benthonic fauna of more than 60 species, and
3. A living population with a mean width of more than 0.15 mm.


![Fig. 3. Frequency polygons showing abundance of benthonic foraminiferal fauna at each station. A. Numbers of specimens in 17 ml of wet sediment, broken line is numbers of living specimens; scale at right shows number of specimens in 10 ml of wet sediment. B. Number of species at each station, broken line is number of species that were living at each station.](image-url)
Different faunas of benthonic foraminifera characterise each of the five depth zones, the inner shelf, outer shelf, upper slope, mid slope and lower slope, as well as the banks on the continental slope. The distribution of most foraminifera appear to be controlled by some factor related to depth, but a few occur only on a particular type of substrate regardless of depth.

Characteristic of the inner shelf are the species Ammonia aucteans, Cribronion simplex, Discorbis dimidiatu, Elphidium novozealandicum, Glabratella spp., Massiliina brodiei, Virgulopsis turris and Zeaflorius parri.

The outer shelf is characterised by Anomalinoideos spherica, Cribronion argenteum, and the shallowest occurrence of many other species, notably Oridorsalis tenera and Trochammina pusilla. Many species are common on the outer shelf and on the upper slope including Brizalina karrerianum, Buliminina marginata, Cribrostomoides sp., Discorbinitina cf. bertheloti, Hophkinsina pacifica, Nonionella turgida, Nonionellina flemingi, Notorotalia finlayi, Notorotalia profunda, Reophax scorpionus, Saracenaria laitrons, and Trochammina ochracea.

On the upper slope the ranges of Buliminina marginata and B. aculeata overlap. Species that are common on the upper slope include those mentioned above as being common on the outer shelf and upper slope, and Chilostomella cushmani, Cibicides ihungia, Fursenkoina sp., Gavelinopsis lobatulus, Globobulimina turgida, G. hoeglundina, Praeglobobulimina spineescens, Siphouigerina sp.

The mid slope is characterised by many species that are rare or absent at shallower depths, but which continue downslope to the lower slope. These include Adenocytus glomeratum, Amonobaculites spp., Bathysphon sp., Bolivina sphenoides, Buliminina rostrata, Chilostomella oolina, Eggerella bradyi, Globobulimina pacifica, Karrielleria sp., Lagenammina diffusina, Osangularia bengalensis, Pelosina sp., Pullenia bulloides, Quinqueloculina cf. venusta, Reophax dentaliformis, R. aff. guttifer, Rhizammina sp., Sigoimoinops schlumbergeri, Spirelocitammina cf. biforos, Stithosphaera albidula, Thurammina sp., Trochammina aff. globigeriniformis. Many of these species have agglutinated walls and belong to the suborder Textulariina which forms 10–20% of the benthonic foraminiferal fauna.

Only a few species are confined to the lower slope. These include Aschemonella sp., Brachysiphon corbuliformis, Discamnina compressa, Lagenammina bulboasa, Melonis sphaeroides, Tolypaammina vagans. Specimens of several species of Lagenammina and Rhizammina are common and specimens of the suborder Textulariina constitute 25–30% of the benthonic foraminiferal fauna.

Banks on the continental slope have a fauna that includes most of the species occurring commonly at the same depth as the bank, but also includes a few species that do not occur or are comparatively rare on the adjacent muddy slopes. At Station 7 Bolivina robusta forms a large part of the benthonic fauna, but also common are Amphycyra hirsuta, Astrononion cf. todium, Globocassidulina canalissuturalis, Laticarinina altocamerata, Marginulina spp., Marginolinopsis bradyi, Planodiscorbidus rarescens, Ramulina globulifera, Rectobolivina columnellana, Sigoimoinops wanganuiensis, Siphonina cf. tubulosa. At Stations E and F on the Madden Banks the fauna includes Pygopium, Quinqueloculina collocneae, Sigmoimoinopsis lacrimosa, Siphonaperta crassa, Siphonapertasturalia testayeri and Triloculina trigonula.

A few species appear to be correlated with a coarse substrate and occur on the inner shelf and on slope banks. These include Dyocicribes primitiva, Ehrenberga testayeri, Gavelinopsis hamatus, and Siphonaperta macbethi. Species that occur wherever sediment is relatively coarse on the continental slope include Dyocicribes primitiva, Gavelinopsis hamatus, Laticarinina altocamerata and Planodiscorbidus rarescens. Thus some generalisations may be made about the environmental preferences of some species in the study area. However, species that are characteristic of a particular depth range in this area are not necessarily characteristic of the same depths everywhere. A limiting environmental factor that varies with depth may be at a completely different depth range elsewhere. For instance, Stauroanfora concava, noted in this account as being characteristic of the continental slope, was first described from cold, shallow waters off Scandinavia. It may be limited more by temperature than any other factor.

Until studies show which of the many environmental factors limit the distribution of each species, the depth ranges and biofaces described here should be used with caution in the interpretation of ancient environments. However, some long lived species appear to be useful indicators of relative depth, at least as far back as the Miocene (Vella 1962). For instance, Elphidium novozealandicum, diagnostic of Vella’s (1962) Elphidium biofacies, remains a useful indicator of depths less than about 75 m. Other species characteris-
tic of the Elphidium biofacies, *Ammonia aoteanus*, *Cribronion charlottensis*, *Notorotalia landalonda*, and *Zealorilus parri*, all extend out to a depth of 200–300 m. This is considerably deeper than Vella’s (1962) estimate of 60 m for the outer limit of the Elphidium biofacies. There seems to be a similar discrepancy for the Haeslerella biofacies where neritic species such as *Bulimina marginata* and *Nonionellina flemingi* coexist with bathyal species such as *Bulimina aculeata* and *Cibicides huanga*. Having access to very limited data, Vella (1962) estimated its depth range to be from 60 m to 300 m, but the present study suggests a range from about 200 m to perhaps 1000 m deep. Again the Robulus, Semipelagic and Eupelagic biofacies, characterised by *Zeaflorilus parri*, *Ph.D. I am grateful to Professor P. Vella and Dr J. D. Collen for their constructive criticism of the manu-

It should also be stressed that the proportion of various groups must be used with caution as absolute depth indicators, because the processes of fossilisation and extraction are highly selective. Robust species will be preferentially preserved. Many of the arenaceous species recorded from deeper stations are so fragile that few even survive drying and mounting. They are unlikely to be recorded as fossils.

Finally, a warning about application of the terms continental shelf and continental slope to ancient biofacies and sediments purely on the basis of estimated depth of deposition. The present continental shelf is a function largely of a geologically very recent rise of sea level. Obviously during the last glacial age, when the sea was about 130 m lower than at present, the continental shelf extended to a depth of only a few tens of metres and following a long period of constant sea level there may well have been no general break between shelf and slope (Lewis 1974b).

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