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# 9. QUATERNARY AND NEOGENE BENTHIC FORAMINIFERS FROM SITES 898 AND 900, IBERIA ABYSSAL PLAIN[1]

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**ABSTRACT**

Quaternary and Neogene benthic foraminifer faunas from Ocean Drilling Program Leg 149, Holes 898A, 898B, and 900A are documented. The Quaternary sections show a mixed signal of turbidite and hemipelagic levels, especially in sediments from Site 898. No benthic foraminifer assemblages associated with turbidite deposits were identified in Hole 900A sediments, but this may have been a result of sample spacing in the core. Hemipelagic sediments from Hole 900A have a less diverse benthic foraminifer assemblage than those from Holes 898A and 898B. Site 898 has abundant turbidite deposits and a record of dynamic bottom-water changes between North Atlantic Deep Water and Arctic Bottom Water. At the Pliocene/Pleistocene boundary, *Nuttallides umbonifera,* characteristic of Antarctic Bottom Water, becomes more significant. The abundance of this species also fluctuates throughout the Miocene, especially the upper Miocene, perhaps reflecting deep-water salt-balance changes caused by the Messinian salinity crisis.

## INTRODUCTION

Knowledge about abyssal Quaternary and Neogene benthic foraminifers in the eastern North Atlantic is limited. Although there are other DSDP and ODP sites in the vicinity of those cored during Leg 149 (Fig. 1), only the Leg 103 sites were in deep water. In any event, no quantitative studies of Quaternary and Neogene benthic foraminifers from Leg 103 were made, and thus no direct comparison is possible. Previous work on modern benthic foraminifer assemblages from this area suggests that certain groups of species characterize deep bottom-water masses (Murray et al., 1986). Murray et al. (1986) identify the principal species associated with North Atlantic Deep Water (NADW) (*Planulina wuellerstorfi = Cibicides wuellerstorfi, Globocassidulina subglobosa = Cassidulina subglobosa, Cibicidoides kullenbergi,* and *Oridorsalis umbonatus*), Antarctic Bottom Water (AABW) (*Osangularia umbonifera = Nuttallides umbonifera*), North-East Atlantic Deep Water (NEADW) or upper NADW (*Epistominella exigua*), and Mediterranean Water (MW) (*Cassidulina obtusa* and *Globocassidulina subglobosa*). Their work, however, was based on the >125 µm fraction and therefore excluded many of the smaller species we identify in this study. Murray (1991) also lists many of these same associations.

The purpose of this paper is first to document abyssal Neogene benthic foraminifers from the eastern North Atlantic and, second, to relate the assemblage composition to the hemipelagic and turbidite deposits from which they were recovered.

## METHODS

Samples of known varying sizes were processed for study of benthic foraminifers. The sediment was wet-sieved through a 63-µm (#230 mesh) screen; the residue was then dried at 40°C. Since many of the residues contained abundant foraminifers, the residues were subdivided with a microsplitter into fractions containing approximately 300 individuals for quantitative counts. The numbers picked were always 250-300 individuals, except in samples that contained less than 300 total specimens. Total numbers of individuals were then standardized for a 10-cm$^3$ sample. The percentages of all species and genera are presented in Tables 1 to 3.

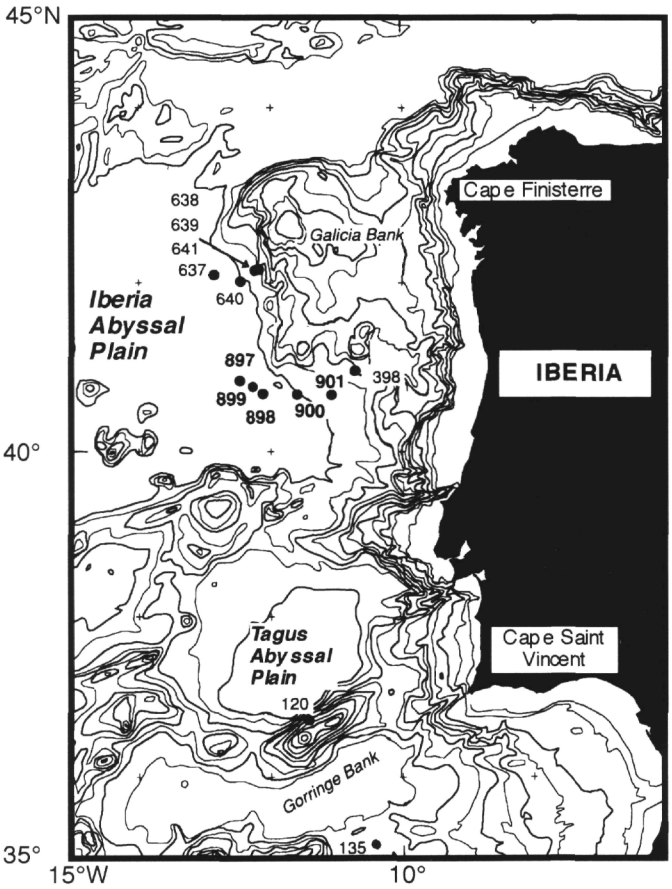


Figure 1. Location of Sites 898 and 900, other sites drilled during Leg 149, and nearby earlier DSDP and ODP sites.

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## RESULTS

### Hole 898A

This hole has a longer Quaternary section than Hole 900A (143 m vs. 43.5 m) and was sampled at a higher density of levels for benthic foraminifers (Table 1, Fig. 2). Based on calcareous nannofossils, the Pliocene/Pleistocene boundary occurs at about 143 m below sea floor (mbsf) (Liu and Maiorano, this volume). The Quaternary section contains a complex of benthic foraminifer assemblages that can be divided roughly into hemipelagic and turbidite levels. Turbidite levels usually have high numbers of individuals (often more than 20,000/10 $cm^3$) and a high diversity caused by total mixing of shallow- to deep-water forms; for example, shallow water bolivinids and *Ammonia beccarii* are found together with deep-sea forms. These intervals are shown distinctly in Figure 2 (note the numerous peaks of total numbers of individuals greater than 20,000). The hemipelagic samples generally contain lower numbers (2000-3000/10 cm) and a distinctively deep-sea faunal assemblage. This is exactly the same foraminiferal pattern recognized in ODP Leg 116 sediments in the distal Bengal Fan (4700 m) (Scott and Leger, 1990). In the upper Quaternary, *Epistominella exigua,* together with *Cassidulina subglobosa,* is the most common species. However, some levels are dominated by *Fursenkoina fusiformis, Stetsonia arctica,* or *Oridorsalis umbonatus.* In the middle to lower Quaternary (50-100 mbsf), *E. exigua* is rarely dominant while *Eponides weddellensis* becomes more dominant. *Stetsonia arctica* also occurs in significant abundance in the upper middle Quaternary (40-60 mbsf). In the middle to lower Quaternary *F. fusiformis* and *E. weddellensis* appear to co-dominate with *S. arctica.* The occurrence *of Bolivina arctica* in the 95-100 m interval is very significant (Samples 149-898A-9H-7, 64-66 cm to 149-898A-11H-2, 22-24 cm; Table 1). It is not abundant but occurs with other known arctic species (*Stetsonia arctica* and *Valvulineria arctica*). Because it does not occur in the Arctic Ocean after 400 Ka (Scott et al., 1989), this places a minimum age of no younger than 400 Ka on this section as well as denoting a very strong Arctic Bottom Water (ABW) influence at this time. Between 100 and 150 m *F. fusiformis* is the dominant species and *C. subglobosa* maintains its presence. Below 150 m, *Nuttallides umbonifera* suddenly appears in a sustained, strong occurrence.

During the Miocene, benthic foraminifers are dominated by *C. subglobosa, N. umbonifera, E. exigua,* and *Gyroidina* spp. (Table 1). However, three important changes indicated by alternations between *N. umbonifera* (indicator of the AABW) and *E. exigua* (indicator of the NADW) (Murray et al, 1986; Murray, 1991), took place in this interval. During the lower middle Miocene (Sample 149-898 A-23X-4, 97-99 cm), *N. umbonifera* reaches its highest peak (34%), while *E. exigua* is dramatically reduced in relative abundance. During the late middle (Sample 149-898A-22X-4, 111-113 cm) and middle early Miocene (Sample 149-898A-28X-2, 54-56 cm), *N. umbonifera* is significantly decreased (~ 1 %), with increasing proportions of *E. exigua.* We believe that these changes may have been related to major fluctuations of deep ocean circulation caused by the Messinian salinity crisis that turned the Mediterranean overflow on and off (Hsü et al., 1973). Even though the Mediterranean water off Iberia flows at 1000-1500 m depth (Sverdrup et al., 1942), its circulation affects water at all depths since it enters the Norwegian Sea between Iceland and Scotland, mixing with outflowing NADW (Open University, 1989; Murray, 1991).

### Hole 898B

This core was sampled at high resolution (13 levels in 5.4 m) to illustrate the complexity of the Quaternary sections. There are four well-defined turbidite levels (Samples 149-898B-1H-1, 0-1 cm; 1H-2, 3-5 cm; 1H-2, 77-79 cm; 1H-3, 53-55 cm; Table 2) that have high abundances of benthic foraminifers (8000-35,000/10 $cm^3$), high diversities, and particular high numbers of bolivinids and *Cassulina laevigata.* The hemipelagic samples, indicated by lower numbers and lower diversity compared to turbidite layers, show a higher diversity in this upper section than other hemipelagic units, just as they do in the more complete 898A section. The uppermost faunal assemblage (Sample 149-898B-1H-1, 24-26 cm; Table 2; Fig. 3) has *E. exigua* and *E. weddellensis* as co-dominants, but this is replaced by *Fursenkoina-Stetsonia* in the two levels below. Around 5 mbsf (Fig. 3), *Oridorsalis umbonatus* becomes dominant.

### Hole 900A

This hole was less densely sampled than Hole 898A. The Pliocene/Pleistocene boundary occurs at about 43.5 mbsf (Liu and Maiorano, this volume) (Table 3; Fig. 4), again based on nannofossils. The Quaternary benthic foraminifer assemblage is dominated by *E. exigua* with *N. umbonifera, C. subglobosa* and *Pullenia* spp. as subsidiary species. Total abundance of benthic foraminifers is fairly high (2000-5000/10 cm) through the section, except near the Pliocene/Pleistocene boundary where total numbers are less than 100/10 $cm^3$. In the Pliocene, *E. exigua* decreases in abundance and *E. weddellensis* becomes the dominant species. Other species remain relatively unchanged. In contrast to Hole 898A sediments, turbidite activity is not reflected in the faunal assemblages from Hole 900A sediments. This may be explained by the low sample density in Hole 900A, combined with the less common occurrence of turbidites at this Site (Milkert et al., this volume).

Neogene benthic foraminifer assemblages in this hole are dominated by *E. exigua, C. subglobosa, Gyroidina* spp., *N. umbonifera, O. umbonatus,* and *Pullenia* spp., with the exception of Sample 149-900A-22R-1, 102-104 cm, which is characterized by *Bolivina* spp. *Epistominella exigua* shows an important decrease in the early Miocene (Samples 149-900A-22R-1, 102-104 cm, and 22R-5, 12-14 cm). *Nuttallides umbonifera* occurs in low percentage in Samples 149-900A-1R-1 through 22R-5, 12-14 cm (middle to middle early Miocene). This distribution pattern is somewhat similar to that in Hole 898A, probably suggesting a similar deep-water circulation history in these two holes. However, it should be pointed out that the detailed correlation of Miocene sediments between Holes 900A and 898A is difficult because of strong carbonate dissolution and the presence of hiatuses in both holes. The most distinct downslope indication occurred in Sample 149-900A-22R-1, 102-104 cm, with the occurrence of an extremely shallow-water (<20 m) species, *Ammonia beccarii.*

### Comparisons between Sites 898 and 900

The benthic foraminifer assemblages in sediments from Holes 898A and 900A almost appear to be from different oceans even though these sites are relatively close to each other. Part of the reason for this is that the sequence at Hole 898A contains many turbidite layers; however, the hemipelagic intervals in this hole also have a higher diversity than those in Hole 900A. *Epistominella exigua* dominates the Quaternary in Hole 900A sediments but is a co-dominant with several other species at Site 898. However, the most striking difference is the lack of Arctic Bottom Water influence indicators (*S. arctica, V. arctica,* and *B. arctica*) (Scott et al., 1989; Scott and Vilks, 1991) at Site 900. None of the arctic species are significant in the Quaternary sediments of Hole 900A, while they dominate many intervals in Hole 898A. The one thing common to hemipelagic sediments from both sites is the pervasive occurrence of *C. subglobosa.* The reason for a thicker Quaternary section at Site 898 is more turbidite deposition at Site 898 than Site 900 (Milkert et al, this volume).

## DISCUSSION

The high-resolution analysis of Hole 898B illustrates just how dynamic the paleoceanography was at this Site, both in terms of rapid

sedimentation events and bottom-water turnover. There are many well-defined turbidite intervals in this short core, four of which we sampled, including the core surface. This high frequency of turbidites is comparable to that of the longer section sampled in Hole 898A. However, the short core at Hole 898B also shows the high frequency of bottom-water changes, from NADW to ABW, or vice-versa, recorded in 1 m of sediment; we speculate this probably represents less than one full glacial cycle. Compared to the western Atlantic, even at shallower depths, these cores appear to represent sites where the bottom water was not as sluggish during the glacial intervals as has been suggested in the western Atlantic (e.g., Thomas et al., 1990).

Probably the most striking characteristic of both Site 898 and Site 900 is a deep-sea calcareous benthic foraminifer fauna at depths greater than 5000 m. In the western Atlantic this fauna would not be found below 4500 m (Thomas et al., 1990), so there are some fundamental differences between the two Atlantic Basins. Reasons for this may include a more direct conduit from the Norwegian Sea which brings cool deep water to the eastern part of the Atlantic, rather than to the western Atlantic (Open University, 1989). At the same time AABW is more restricted in the eastern Atlantic than in the western Atlantic (Open University, 1989). The Mediterranean overflow water also influences the water column structure in the eastern Atlantic. Whatever the reason, there is a profound difference between the eastern and western Atlantic benthic foraminiferal assemblages at comparable depths.

Because of turbidites and some incomplete sections, the Quaternary stratigraphy is not well constrained chronologically at these Sites. However, the presence of *Bolivina arctica* at 95 mbsf in Hole 898A suggests an age not younger than 400 Ka (Scott et al., 1989).

There are diverse faunas in the hemipelagic intervals of Hole 898A. *Fursenkoina fusiformis* is interesting because it is not commonly associated with deep water, but it is associated with low oxygen conditions and its presence suggests that stagnant circulation (low oxygen) (Alve, 1994) occurred at the intervals where it occurs in high abundances. This species is observed in deep water off the Scotian margin in localities thought to be characterized by lower oxygen conditions (Thomas et al., 1990). The occurrence of *N. umbonifera* at the Pliocene/Pleistocene boundary at Site 898 also suggests the turn-off of NADW prior to the Quaternary and correlates with other records from the South Atlantic (DSDP Legs 72 and 73).

## CONCLUSIONS

The presence of a deep-sea calcareous benthic foraminifer fauna in Holes 898 and 900 at depths greater than 5000 m is strikingly different than that found at comparable depths in the western Atlantic. Murray et al. (1986) and Murray (1991) reported similar fauna in the eastern Atlantic but all these samples appear to have been in water depths of less than 5000 m. The Quaternary section in Site 898 is thicker than in Site 900, a result of more turbidite deposition at Site 898 than Site 900. A more diverse benthic foraminifer assemblage is observed in hemipelagic sediments from Hole 898A than at Hole 900A, while samples from turbidite intervals in Hole 898A contain extremely high numbers of benthic foraminifers. Diversity in turbidite intervals is generally higher than observed in hemipelagic sediments because of the mixed nature of the faunal assemblage (i.e., shallow- plus deep-water species). We also show that in the past there was Arctic Bottom Water influence in the Quaternary, as indicated by the presence of *Stetsonia arctica* in some Quaternary samples.

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**Table 1. Percentage occurrences of benthic foraminifers in sediments from Hole 898A.**

| Core, section: | 1H-1 | 1H-2 | 1H-3 | 1H-3 | 1H-4 | 1H-6 | 2H-2 | 2H-3 | 2H-3 | 2H-4 | 2H-4 | 3H-1 | 3H-2 | 3H-3 | 3H-4 | 3H-5 | 3H-6 | 4H-2 | 4H-3 | 4H-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 8–10 | 63–64 | 25–27 | 96–98 | 7–9 | 1–3 | 139–141 | 36–38 | 96–98 | 64–66 | 90–92 | 68–70 | 14–16 | 55–57 | 15–17 | 20–22 | 118–120 | 135–137 | 17–19 | 17–19 |
| Total individuals/10 cm$^3$: | 1947 | 2160 | 1312 | 1605 | 34,133 | 7389 | 11 | 100 | 14,080 | 3973 | 248 | 10,977 | 2000 | 1194 | 1740 | 29,324 | 699 | 1373 | 1787 | 2677 |
| *Ammobaculites agglutinans* | | | | | | | | | | | | | | | | | | | | |
| *Ammodiscoides japonicus* | | | | | | | | | | | | | | | | | | | | |
| *Ammonia beccarii* | | | 8.1 | | 2.8 | | | | | | | | | | | | | | 8.7 | 0.8 |
| *Anomalina globulosa* | 3.4 | 7.0 | 2.0 | 2.0 | | 4.3 | 7.7 | 27.5 | 0.3 | 3.7 | 7.1 | 1.1 | 3.6 | 2.4 | 6.1 | | 6.1 | 13.6 | | |
| *A.* spp. | 0.7 | | | | | | | | | | | | | | | | | | | |
| *Astrononion gallowayi* | | | | | | | | | | | | 0.7 | | | | 0.8 | | | | |
| *Bolivina arctica* | | | | | | 0.4 | | | | | | | | | | | | | | 2.0 |
| *B. decussata* | 1.0 | | 0.8 | | | 2.4 | | | | 1.7 | 1.2 | 4.9 | 2.8 | | | 5.2 | | | | |
| *B. inflata* | | | | | | | | | | | | | | | | | | | | |
| *B. pseudoplicata* | | | | | 0.9 | | 7.7 | | | | | | | | | | | | | 0.8 |
| *B. pygmaea* | | | 1.2 | | 0.3 | | | | | | | 0.4 | | | | 1.2 | | | | |
| *B. subspinescens* | | | | | | | | | | 0.3 | | | | | | | | | | |
| *Bolivinita truncatum* | | | | | | | | | | | | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Brizalina lowmani* | | | | | 0.9 | | | | | 4.7 | | | | 0.3 | | 3.2 | | | | |
| *B. pseudopunctata* | 1.4 | | | 1.0 | | 2.8 | | | | | | | | | | 0.8 | | | | 7.2 |
| *B. spathulata* | 6.2 | 1.9 | 19.9 | 3.3 | 24.1 | 7.9 | | 1.7 | 3.9 | | 1.2 | 15.2 | 11.6 | | | 9.9 | | 1.9 | | |
| *B. subaenariensis* | 3.1 | | | | | | | | | | | | | | | | | | | |
| *Bulimina alazaensis* | | | | | | | | | | | | | | | | | | | | 0.4 |
| *B. marginata* | 1.4 | | 2.0 | | 9.7 | 1.2 | | | 9.7 | | 0.3 | 3.9 | 2.0 | | | 4.4 | 0.4 | | | |
| *B. striata* | 1.7 | | | | 0.9 | | | | 0.9 | | | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Buliminella elegantissima* | | | | | | | | | | | | | | | | | | | 0.3 | 4.8 |
| *Cassidulina laevigata* | 12.3 | 0.4 | 27.2 | 1.0 | 28.1 | 6.3 | 23.1 | | 9.1 | | | 11.7 | 7.2 | | | 7.9 | 0.8 | 1.0 | 10.7 | 19.9 |
| *C. subglobosa* | 9.2 | 13.0 | 8.1 | 3.0 | 3.4 | 8.3 | 7.7 | 3.3 | 5.2 | 3.0 | 5.6 | 29.3 | 11.2 | 20.6 | 19.9 | 29.8 | 21.8 | 23.3 | | |
| *C.* spp. | | | | | | 1.2 | | | | | | 0.4 | | | | | | | | 33.9 |
| *Cibicides lobatulus* | 2.1 | | 16.7 | | 3.4 | | | 4.2 | | | | 7.8 | | | | | | | 2.7 | |
| *C. wuellerstorfi* | | 4.1 | | 0.7 | 0.6 | 2.0 | | 1.7 | 11.5 | 0.7 | 5.6 | 0.7 | 3.2 | 2.7 | 0.4 | 8.3 | 1.9 | 1.9 | | |
| *Cibicidoides mundulus* | | | | | | | | | 2.4 | | | | 1.6 | | | | | | | |
| *C. robertsonianus* | | | | | 0.6 | | | | 0.3 | | | | | 0.3 | | | | | | |
| *Cyclogyra involvens* | | | | | | | | | | | | | | | | | | | | |
| *Dentalina* spp. | | | | 0.3 | | | | | 0.3 | 0.3 | 0.3 | 0.7 | | | | 0.8 | | 0.3 | | |
| *Discorbinella* spp. | | | | | | | | | | | | | | | | | | | | 0.8 |
| *Dentalina* spp. | | | | | | | | | | | | 0.4 | | | | 0.8 | | | 0.6 | |
| *Eggerella bradyi* | | 0.4 | | | | | | | 0.6 | | 3.1 | | 0.8 | 0.3 | | | 0.8 | | | |
| *Elphidium advenum* | | | 0.4 | | 0.3 | | | | | | | | | | | | | | | 2.0 |
| *E. crispum* | 0.7 | 0.4 | | | 0.6 | | | | | | | | | | | | | | | |
| *E. discoidale* | | | 1.6 | | | | | | | | | | | | | | | | | 4.4 |
| *E. excavatum* | 1.4 | | | | 1.3 | | 7.7 | | | | | | | | | | | | | |
| *E. galvestonense* | | | | | | | | | | | | | | | | | | | | |
| *E. gunteri* | | | | | | | | | | | | | | | | | | | | 3.6 |
| *E. margaritaceum* | | | | | | | | | | | | | | | | | | | | |
| *E. poeyanum* | | | | | | | | | | | | 1.4 | | | | | | | | |
| *E.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Eoeponides pulchella* | | | | | | | | | | | | | 0.4 | | | | | | 29.0 | |
| *Epistominella exigua* | 5.8 | 24.4 | 1.6 | 8.3 | 0.3 | 3.1 | | 2.5 | 2.4 | 15.1 | | 1.4 | 16.8 | 1.4 | 17.6 | 2.4 | 22.1 | 24.6 | | 1.6 |
| *E. takayanagii* | | | 1.6 | | | | | | | | | 0.7 | | | | 1.6 | | 0.6 | 3.6 | |
| *Eponides tumidulus* | 3.1 | 4.4 | | 0.7 | | | | 4.2 | | 3.0 | 7.4 | | 1.2 | 7.9 | 4.6 | 0.8 | 7.3 | 1.3 | 15.2 | 4.0 |
| *E. weddellensis* | 10.3 | 1.1 | 2.8 | 10.6 | | 10.2 | 7.7 | 6.7 | 0.6 | 2.7 | 0.6 | 6.0 | 1.2 | | 0.4 | 2.4 | | | 2.1 | |
| *Fissurina* spp. | 2.1 | 3.7 | | 2.3 | 0.3 | 2.4 | | 3.3 | 1.2 | 1.0 | 3.1 | 3.2 | 3.6 | 3.4 | 2.7 | 0.8 | 1.5 | 1.6 | | |
| *Florilus* spp. | | | | | | | | | | | | | | | | | | | 1.2 | |
| *Fursenkoina fusiformis* | 4.8 | 1.9 | 0.8 | 25.2 | 0.6 | 19.3 | 23.1 | 10.0 | 0.9 | 34.9 | 9.6 | 2.5 | 4.0 | 6.5 | 2.3 | 1.2 | | 3.6 | | |
| *F. pauciloculata* | | | | | | | | | | | | | | | | | | | | |
| *F. pontoni* | | | | | | | | | | | | | | | | | | | | 2.4 |
| *Gavelinopsis lobatulus* | | | | | | | | | | | | 0.4 | | | | | | | | 3.6 |
| *G. translucens* | 1.0 | | | | 0.3 | | | | | | | | | | | 1.2 | | | | |
| G. cf. *prageri* | | | | | | | | | | | | | | | | | | | | |
| *Glabratella wrightii* | | | 0.4 | | | | | | | | | | | | | | | | | |
| *G.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Globobulimina auriculata* | | | | | | | | | | | | | | | | | | | | |
| *Gyroidina orbicularis* | | | | | | | | | | | 0.3 | | 0.8 | | | | | | | |

**Table 1 (continued).**

| Core, section: | 1H-1 | 1H-2 | 1H-3 | 1H-3 | 1H-4 | 1H-6 | 2H-2 | 2H-3 | 2H-3 | 2H-4 | 2H-4 | 3H-1 | 3H-2 | 3H-3 | 3H-4 | 3H-5 | 3H-6 | 4H-2 | 4H-3 | 4H-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 8–10 | 63–64 | 25–27 | 96–98 | 7–9 | 1–3 | 139–141 | 36–38 | 96–98 | 64–66 | 90–92 | 68–70 | 14–16 | 55–57 | 15–17 | 20–22 | 118–120 | 135–137 | 17–19 | 17–19 |
| Total individuals/10 $cm^3$: | 1947 | 2160 | 1312 | 1605 | 34,133 | 7389 | 11 | 100 | 14,080 | 3973 | 248 | 10,977 | 2000 | 1194 | 1740 | 29,324 | 699 | 1373 | 1787 | 2677 |
| *G. polius* | | | | | | | | | | | | | | | | | | | 2.7 | 0.4 |
| *G. soldanii* | 1.7 | 3.7 | | 1.7 | 0.6 | 3.1 | | 7.5 | 2.1 | 2.0 | 0.9 | 0.4 | 6.8 | 7.6 | 5.7 | 1.6 | 2.7 | 2.6 | | |
| *G.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Hanzawaia* spp. | | | | | | | | | | | | | | | | | | | | |
| *Haynesina orbiculare* | | | | | | | | | | | | | | | | | | | | |
| *Heronallenia crosbyi* | | | | | | | | | | | | | | | | | | | | |
| *Hoeglundina elegans* | | | | | | | | | 0.3 | | | | | | | | | | | |
| *Hopkinsina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Hyalinea balthica* | 0.7 | | | | 0.3 | | | | | | | | | | | | | | | |
| *Karreriella bradyi* | | | | | | | | | | | | | | | | | | | 0.6 | |
| *Lagena* spp. | 0.3 | 2.2 | | 0.3 | | | | 0.8 | | 0.3 | 3.7 | | | 1.7 | 0.4 | | 1.5 | 0.6 | | |
| *Lamarckina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Lenticulina* spp. | | | | | | | | | | | 0.3 | | | | 0.4 | | | | | |
| Miliolidae | | | | | | | | | | | | | | | | | | | | |
| *Neoconorbina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Nonion auriculata* | | | | | | | | | | | | | | | 0.8 | | | 0.3 | 2.7 | |
| *N. barleeanum* | 0.7 | 0.4 | 0.4 | | 0.9 | 0.4 | | | 7.0 | | | | 0.4 | 1.7 | 1.1 | | 0.8 | 1.3 | | |
| *N.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Nonionella atlantica* | | | | | | | | | | | | | | | | | | | | |
| *N. turigida* | 0.7 | | | 0.3 | | | | | | 3.0 | 0.3 | | | | | | | | 2.1 | 1.6 |
| *Nuttallides umbonifera* | 1.7 | 8.5 | | | 0.9 | 0.8 | | 0.8 | 2.1 | 7.7 | 0.9 | | 2.0 | 3.4 | 6.9 | | 11.5 | 4.2 | 0.3 | |
| *Oolina* spp. | | 0.4 | | | | | | 0.8 | 0.3 | 0.7 | 2.5 | 0.4 | | | 2.3 | | 0.4 | | | |
| *Opthalmidium pusillum* | | | | | | | | | | | 0.6 | | 0.4 | | | | | | 1.2 | |
| *Oridorsalis umbonatus* | 1.7 | 2.6 | 0.4 | 4.0 | | | | 12.5 | 4.2 | 7.0 | 26.3 | 1.1 | 1.6 | 14.1 | 7.7 | 0.8 | 4.2 | 2.3 | | |
| *Patellina corrugata* | | | | | | | | | | | | | | | | | | | | |
| *Planorbulina mediterreansis* | | | | | | | | | | | | | | | | | | | | |
| *Planulina ariminensis* | | | | | | | | | | | | | | | | | | | | |
| *Plerostomella* spp. | | | | | | | | | | | | | | | | | | | | |
| *Pseudopolymorphina novangliae* | 0.7 | | | 1.3 | | | | | | | | | | | | | | | 0.6 | |
| *Pullenia bulloides* | | | | | | | | | 1.5 | | | | | 1.4 | 1.5 | | | 1.6 | 9.0 | 0.4 |
| *P. subcarinata* | 5.1 | 8.9 | 1.6 | 2.0 | 0.9 | 4.7 | | 0.8 | 0.9 | 4.0 | 4.6 | 2.8 | 4.0 | 7.6 | 12.3 | 1.6 | 8.8 | 3.9 | | |
| *Pyrgo murrhyna* | | 0.7 | | | | | | | 0.6 | | | | 0.8 | | | | 0.4 | | 1.2 | |
| *P. williamsoni* | 1.0 | 0.7 | | 0.7 | 0.3 | 0.4 | | | | | 1.2 | | 1.6 | 2.7 | 0.4 | | | 0.3 | | |
| *Quinqueloculina agglutinans* | | | | | 0.3 | | | | | | | | | | | | | | 0.3 | |
| *Q. seminulum* | | 0.4 | | | 0.9 | 0.4 | | | 0.3 | 0.3 | 0.3 | 0.4 | | 2.7 | | | 3.1 | 1.6 | 1.8 | |
| *Q. stalkeri* | 2.4 | 2.6 | | 1.0 | | 0.4 | | | | 1.3 | 4.6 | | | | 1.1 | | | 2.9 | | |
| *Rosalina columbiensis* | | | | | | | | | | | | | | | | | | | | |
| *R. floridana* | | | | | 0.3 | | | | | | | | | | | | | | | |
| *Sigmoilina tenuis* | | | | | | | | | | | | | | | | | | | | |
| *Sigmoilopsis schlumbergeri* | | | | | | | | | 1.8 | | | | | | | | | | 2.1 | |
| *Siphotextularia rolshauseni* | 1.7 | 0.4 | | 0.7 | | 0.4 | | 6.7 | 0.3 | 0.7 | 3.1 | | 0.4 | 1.0 | 1.5 | | 1.1 | 1.0 | | |
| *Spiroloculina* spp. | | | | | | | | | | | | | | 0.3 | | | | | 1.5 | |
| *Stetsonia arctica* | 5.8 | 3.7 | | 26.2 | | 2.4 | | 3.3 | | 0.3 | 5.0 | | 6.8 | 7.9 | 3.4 | | | 1.9 | | |
| *Stilostomella antillea* | | | | | | | | | | | | | | | | | | | | |
| *S. bradyi* | | | | | | | | | 0.6 | | | | | | | | | | | |
| *S.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Textularia conica* | | | | | 0.3 | | | | | | | | | | | | | | | |
| *Tosaia hanzawai* | | 2.2 | | | 0.3 | | | | 1.2 | 0.3 | | | 2.0 | 1.7 | 0.4 | | 2.7 | 1.3 | | |
| *Trifarina angulosa* | | | | | | | | | | | | | | | | | | | | 1.2 |
| *T. fluens* | 2.1 | | 2.0 | 0.7 | 7.5 | 4.7 | 15.4 | | 10.3 | 1.0 | | 2.1 | 1.2 | | | 9.5 | 0.4 | | | |
| *Triloculina tricarinata* | 0.7 | | | | | 0.4 | | | | | | | | | | | | | | |
| *Turrila* spp. | | | | | | | | | | | | | | | | | | | | |
| *Uvigerina peregrina* | 1.4 | | | | 5.9 | 0.4 | | | 16.4 | | | | | | | 3.2 | | 0.3 | | |
| *U.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Valvulinera arctica* | | | | 2.7 | | 9.4 | | 1.7 | | | | 0.4 | | | | | | | | |
| *V. laevigata* | | | | | | 0.4 | | | | | | | | | | | | | | 4.4 |
| Reworked foraminifers | | | | | 0.6 | | | | 0.6 | | | | | | | | | | 4-3 | 4-4 |

Notes: Based on calcareous nannofossils (Liu et al., this volume; de Kaenel and Villa, this volume) the Pliocene/Pleistocene boundary occurs between Samples 149-898A-16X-1, 26-28 cm, and 16X-6, 5-7 cm, and the Miocene/Pliocene boundary occurs between Samples 149-898A-18X-3, 58-60 cm, and 18X-CC.

**Table 1 (continued).**

| Core, section: | 4H-5 | 4H-6 | 5H-1 | 5H-2 | 5H-3 | 5H-4 | 5H-5 | 5H-7 | 6H-2 | 6H-3 | 6H-3 | 6H-4 | 6H-5 | 6H-7 | 7H-4 | 7H6 | 7H-6 | 7H-7 | 8H-1 | 8H-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 95–97 | 44–46 | 35–37 | 113–115 | 53–55 | 31–33 | 90–92 | 35–37 | 83–85 | 131–133 | 134–136 | 84–86 | 62–64 | 12–14 | 80–82 | 27–29 | 108–110 | 22–24 | 44–46 | 105–107 |
| Total individuals/10 cm$^3$: | 2453 | 1429 | 18,480 | 1711 | 5440 | 5227 | 376 | 363 | 1787 | 798 | 293 | 4374 | 19,049 | 65 | 4706 | 38,684 | 3065 | 2837 | 34,844 | 2852 |
| *Ammobaculites agglutinans* | | | | | | | | | | | | | | | | 0.4 | | | | |
| *Ammodiscoides japonicus* | | | | | | | | | | | | | | | | | | | | |
| *Ammonia beccarii* | | | | | 3.5 | | | | | | | | | | | | | | | |
| *Anomalina globulosa* | 10.7 | 0.4 | 1.7 | 1.4 | | 3.3 | 0.3 | 1.1 | | 3.4 | 2.8 | 9.8 | | | | 0.7 | 1.2 | 9.4 | 0.4 | |
| *A.* spp. | | | | | | | | | | | | | | | 0.4 | | | | | |
| *Astrononion gallowayi* | | | 0.9 | | | | 0.3 | | | | | | | | | | | | | |
| *Bolivina arctica* | | | | | | | | | | | | | | | | | | | | |
| *B. decussata* | | | 4.3 | | 1.6 | | 1.3 | 0.4 | 3.0 | | | | 3.6 | | 12.0 | 15.1 | | | 11.0 | 0.3 |
| *B. inflata* | | | | | | | | | | | | | | | | | | | | |
| *B. pseudoplicata* | | | | | | | | | | | 0.4 | | | | | | | | | |
| *B. pygmaea* | | | 0.4 | | 0.4 | | 0.3 | | | | | | | | | 0.7 | | | 0.8 | |
| *B. subspinescens* | | | | | | | | | | | | | | | | | | | | |
| *Bolivinita trunctum* | | | | | | | | | | | | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Brizalina lowmani* | 2.0 | 0.4 | 10.8 | | 5.5 | | 3.7 | 0.7 | | | 0.8 | | 9.5 | 1.1 | 14.0 | | | | 13.9 | |
| *B. pseudopunctata* | | | 0.9 | | | | 1.0 | | | | | | | 1.1 | 4.8 | | | | 0.4 | 12.5 |
| *B. spathulata* | | | 1.3 | | 5.1 | | 5.0 | | 3.7 | | | 0.3 | 0.8 | | 0.8 | 19.1 | 0.4 | | 1.6 | 0.3 |
| *B. subaenariensis* | | | | | | | | | | | | | | | | | | | | |
| *Bulimina alazaensis* | | | | | | | | | | | | | | | | | | | | |
| *B. marginata* | 0.7 | | | | 0.8 | | | 0.4 | 1.1 | | | | 1.6 | | 0.4 | 0.4 | | | 0.8 | |
| *B. striata* | | | 0.4 | | | | | | | | | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Buliminella elegantissima* | | | | | | | | | | | | | | | | | | | | |
| *Cassidulina laevigata* | | | 8.7 | | 13.3 | | 0.7 | 1.5 | 15.7 | | | | 4.7 | | 2.0 | 2.2 | 0.4 | | 2.4 | 1.3 |
| *C. subglobosa* | 10.0 | | 35.9 | 1.8 | 25.5 | 4.1 | 14.0 | 0.7 | 29.1 | 8.8 | 1.2 | 7.9 | 43.1 | 7.7 | 6.4 | 18.8 | 12.4 | 13.9 | 11.4 | 8.9 |
| *C.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Cibicides lobatulus* | | | 4.3 | | 12.9 | | | 4.0 | 16.0 | | | | 6.7 | | | 8.1 | | | | |
| *C. wuellerstorfi* | 3.3 | 2.2 | 0.4 | 1.1 | 10.6 | 2.4 | 13.0 | 2.2 | 0.4 | 0.6 | 0.4 | 0.9 | | | 0.4 | 2.9 | 6.8 | 2.3 | 11.8 | 1.3 |
| *Cibicidoides mundulus* | | | | | | | | | | | | | | | | | | | | |
| *C. robertsonianus* | | | | | | | | | | | | | | | | | 0.4 | 0.8 | | |
| *Cyclogyra involvens* | | | | | | | | | | | | | | | | | | | | |
| *Dentalina* spp. | | 0.4 | | 0.4 | | | 0.7 | | 0.7 | | | | | | | | | | 0.4 | 0.3 |
| *Discorbinella* spp. | | | | | | | | | | | | | | | | | | | | |
| *Dentalina* spp. | | | | | 0.4 | | | | 3.0 | | | | 3.2 | | 1.6 | 0.7 | | | 1.2 | 0.7 |
| *Eggerella bradyi* | 0.3 | 0.4 | | | | | | | | 0.6 | | 0.6 | | | | | | | | |
| *Elphidium advenum* | | | | | 0.8 | | | | 2.2 | | | | 0.4 | | | | | | | |
| *E. crispum* | | | | | | | 0.3 | | | | | | | | | 2.2 | | | 0.8 | |
| *E. discoidale* | | | | | | | | | 1.1 | | | | 0.4 | | | | | | | |
| *E. excavatum* | | | | | | | | | 1.9 | | | | 2.4 | | 0.8 | | | | | |
| *E. galvestonense* | | | | | | | | | | | | | | | | | | | 2.9 | |
| *E. gunteri* | | | | | 0.4 | | 0.3 | | | | | | | | | 0.4 | | | 0.4 | |
| *E. margaritaceum* | | | | | | | | | | | | | | | | | | | | |
| *E. poeyanum* | | | 0.4 | | 4.7 | | | 0.7 | 0.4 | | | | | | | 1.5 | | | 6.5 | |
| *E.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Eoeponides pulchella* | | | | | | | | | | | | | | | | | | | 0.4 | |
| *Epistominella exigua* | 26.4 | 4.9 | 0.4 | | 0.8 | | 0.3 | | 1.9 | 20.7 | 14.6 | 22.6 | 0.4 | | 0.8 | | 21.7 | 24.1 | | 1.3 |
| *E. takayanagii* | | | | | 0.4 | | 0.3 | | | 0.6 | | | | | 2.4 | 0.4 | | | 0.8 | |
| *Eponides tumidulus* | 6.0 | 3.4 | | | | | | | | 3.1 | 1.2 | 5.5 | | 1.1 | 0.4 | | 4.0 | 3.0 | 0.4 | 0.3 |
| *E. weddellensis* | 6.4 | 65.3 | 1.3 | 11.9 | | 11.8 | | 26.5 | 4.5 | 31.3 | 33.7 | 25.9 | 1.6 | 8.8 | 1.6 | 0.4 | 8.4 | 13.5 | 1.2 | 9.2 |
| *Fissurina* spp. | 2.0 | 2.6 | | 0.4 | 1.2 | 0.8 | 2.3 | 3.3 | | 1.9 | 2.0 | 1.8 | 2.0 | 1.1 | 4.8 | 4.8 | 2.4 | 3.4 | 4.5 | 3.6 |
| *Florilus* spp. | | | | | | | | | | | | | | | | | | | | |
| *Fursenkoina fusiformis* | 3.7 | 3.0 | 11.7 | 6.5 | | 0.4 | 32.6 | 9.9 | | 0.3 | 8.0 | 1.2 | 10.3 | 40.7 | 22.8 | 1.8 | 0.8 | 0.8 | 5.7 | 42.6 |
| *F. paucileculata* | | | | 0.7 | | 0.4 | | 24.6 | | | | | | | | | | 0.4 | | |
| *F. pontoni* | | | | | | | | | | | | | | | | | | | | |
| *Gavelinopsis lobatulus* | | | | | 0.4 | | | | | | | | | | | 2.9 | | | 3.7 | |
| *G. translucens* | | | | | 2.4 | | 0.7 | | 5.2 | | | | 0.8 | | 2.4 | 11.8 | | | 3.7 | 0.3 |
| G. cf. *prageri* | | | | | | | | | | | | | | | | | | | | |
| *Glabratella wrightii* | | | | | | | | | | | | | | | 0.4 | | | | | |
| *G.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Globobulimina auriculata* | | 0.4 | 1.3 | 1.8 | | | | | | | | | | | | | | | | |
| *Gyroidina orbicularis* | | | | | | | | | | | 0.8 | | | | | | | | | 0.3 |
| *G. polius* | | | | | | | | | | | | | | | | | | | | |
| *G. soldanii* | 5.4 | 4.1 | 1.3 | 1.1 | 2.0 | | 0.7 | 1.1 | | 2.8 | 2.0 | 0.9 | 1.2 | | 0.8 | 0.7 | 4.8 | 4.5 | 0.4 | 1.7 |
| *G.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Hanzawaia* spp. | | | | | | | | | | | | | | | | | | | | |

**Table 1 (continued).**

| Core, section: | 4H-5 | 4H-6 | 5H-1 | 5H-2 | 5H-3 | 5H-4 | 5H-5 | 5H-7 | 6H-2 | 6H-3 | 6H-3 | 6H-4 | 6H-5 | 6H-7 | 7H-4 | 7H6 | 7H-6 | 7H-7 | 8H-1 | 8H-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 95–97 | 44–46 | 35–37 | 113–115 | 53–55 | 31–33 | 90–92 | 35–37 | 83–85 | 131–133 | 134–136 | 84–86 | 62–64 | 12–14 | 80–82 | 27–29 | 108–110 | 22–24 | 44–46 | 105–107 |
| Total individuals/10 cm$^3$: | 2453 | 1429 | 18,480 | 1711 | 5440 | 5227 | 376 | 363 | 1787 | 798 | 293 | 4374 | 19,049 | 65 | 4706 | 38,684 | 3065 | 2837 | 34,844 | 2852 |
| *Haynesina orbiculare* | | | | | | | | | | | | | | | | | | | | |
| *Heronallenia crosbyi* | | | | | | | | | | | | | | | | | | | | |
| *Hoeglundina elegans* | | | | | | | | | | | | | | | | | | | | |
| *Hopkinsina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Hyalinea balthica* | | | | | | | | | | | | | | | | | | | | |
| *Karreriella bradyi* | | 0.4 | | | | | | | | | | | | | | | | | | |
| *Lagena* spp. | 1.3 | 0.4 | | | | | 0.3 | 0.4 | | 0.9 | 1.2 | 0.3 | 0.4 | | | | 0.4 | | | 0.7 |
| *Lamarckina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Lenticulina* spp. | | | | | 0.4 | | | | 0.4 | | | | 0.4 | | | | 0.8 | | | |
| Miliolidae | | | | | | | | | | | | | | | | | | | | |
| *Neoconorbina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Nonion auriculata* | | | | | | | | | | | | | | | | | | | | |
| *N. barleeanum* | | | | 0.4 | 0.8 | | | 0.4 | 0.4 | 1.6 | | 0.6 | | | | | 1.6 | | 0.4 | |
| *N.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Nonionella atlantica* | | | | | | | | | | | | | | | 1.2 | | | | 0.4 | |
| *N. turigida* | | | 2.2 | | | | 1.3 | | | | | | 0.8 | | | 0.4 | | | | 5.3 |
| *Nuttallides umbonifera* | 4.7 | | | | | | | | | 4.1 | 0.8 | 7.0 | | 4.4 | | | 0.4 | 3.8 | 0.4 | |
| *Oolina* spp. | | | | | | 1.2 | | 1.8 | | | | 0.6 | | | | | 0.8 | 0.8 | 0.4 | |
| *Opthalmidium pusillum* | | | | | | | | | | 0.3 | 0.4 | | | | | | | | | |
| *Oridorsalis umbonatus* | 2.0 | 3.4 | 0.4 | 61.5 | 1.2 | 53.9 | | 7.0 | 5.6 | 1.6 | 1.6 | 7.6 | | | 0.4 | | 19.7 | 10.5 | 2.4 | 0.7 |
| *Patellina corrugata* | | | | | | | | | | | | | | | | | | | | |
| *Planorbulina mediterreansis* | | | | | | | | | | | | | | | | | | | 1.6 | |
| *Planulina ariminensis* | | | | | | | | | | | | | | | 0.4 | | | | | |
| *Plerostomella* spp. | | | | | | | | | | | | | | | | | | | | |
| *Pseudopolymorphina novangliae* | | | | | | | | | | | | | | | | 0.4 | | | | |
| *Pullenia bulloides* | 2.0 | | | | | | | | | 0.3 | | | | | | | | 0.8 | | |
| *P. subcarinata* | 7.0 | 3.7 | 5.6 | 2.5 | 0.4 | 1.6 | 1.3 | 2.6 | 2.2 | 5.0 | 3.6 | 2.4 | 2.0 | 3.3 | 0.8 | 0.4 | 5.6 | 1.9 | 0.4 | 2.3 |
| *Pyrgo murrhyna* | | | | | | | | | | 0.3 | | | | | | | | | | |
| *P. williamsoni* | 0.7 | | | | | 1.2 | | | | 1.6 | | 0.9 | | | | | | 0.4 | | |
| *Quinqueloculina agglutinans* | | | | | | | | | | | | | | | | | | | | |
| *Q. seminulum* | | | | 0.4 | 1.6 | 0.4 | | | | 0.6 | 0.4 | | | | 1.2 | | 2.4 | 0.8 | 0.8 | 0.3 |
| *Q. stalkeri* | 1.3 | 0.7 | | 1.4 | | | | 0.7 | | 1.3 | 0.8 | | | | | | 1.6 | 1.5 | | |
| *Rosalina columbiensis* | | | | | | | | | | | | | | | 0.4 | | | | | |
| *R. floridana* | | | | | | | | | | | | | | | | | | | | |
| *Sigmoilina tenuis* | | | | | | | | | | | | | | | | | | | | |
| *Sigmoilopsis schlumbergeri* | | | | | | | | | | | | | | | | | | | | |
| *Siphotextularia rolshauseni* | 2.0 | 0.7 | | | | 0.8 | | 2.6 | | 1.3 | | 0.9 | | 1.1 | 0.4 | | 0.4 | 0.8 | | |
| *Spiroloculina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Stetsonia arctica* | | 3.4 | 1.3 | 6.1 | | 17.6 | 12.6 | 6.6 | | 4.4 | 22.5 | | | 16.5 | 4.4 | 0.4 | | 0.4 | 0.8 | 3.6 |
| *Stilostomella antillea* | | | | | | | | | | | | | | | | | | | | |
| *S. bradyi* | | | | | 0.4 | | | | 0.4 | | | | 0.4 | | | | | | 0.4 | 1.0 |
| *S.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Textularia conica* | | | | | | | | | | | | | | | | | | | | |
| *Tosaia hanzawai* | 2.0 | | | 0.4 | | | | | | 1.9 | 0.4 | 2.1 | | | | 0.4 | 1.6 | 2.6 | | |
| *Trifarina angulosa* | | | | | | | | | | | | | | | | | | | | |
| *T. fluens* | | | 3.0 | | 2.7 | | 0.7 | 0.7 | 0.4 | | | | 3.2 | | 2.8 | 1.8 | 0.8 | | 4.1 | |
| *Triloculina tricarinata* | | | | | | | | | | | | | | | | | | | | |
| *Turrila* spp. | | | | | | | | | | | | | | | | | | | | |
| *Uvigerina peregrina* | | | | | | | | | | | | | 0.4 | | 0.8 | | | | | |
| *U.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Valvulinera arctica* | | | | 0.4 | | | 5.0 | | | 0.6 | 0.4 | | | 13.1 | 7.2 | 0.4 | | | | 1.0 |
| *V. laevigata* | | | 0.4 | | | | | | | | | | | | | | | | | |
| Reworked foraminifers | | | 0.4 | | | | 1.0 | | 0.7 | | | | | | | | | | | |

**Table 1 (continued).**

| Core, section: | 8H-5 | 8H-7 | 9H-5 | 9H-6 | 9H-7 | 10H-3 | 10H-5 | 11H-2 | 11H-3 | 11H-4 | 11H-5 | 12H-1 | 12H-3 | 12H-3 | 12H-4 | 12H-6 | 13H-1 | 13H-3 | 14H-5 | 15X-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 101–103 | 56–58 | 71–73 | 101–103 | 64–66 | 96–98 | 86–88 | 22–24 | 25–27 | 19–21 | 145–147 | 133–135 | 20–22 | 113–115 | 67–69 | 74–76 | 96–98 | 81–83 | 3–5 | 68–70 |
| Total individuals/10 cm$^3$: | 414 | 17,408 | 28,160 | 957 | 29,716 | 1526 | 1200 | 797 | 176 | 1835 | 608 | 4631 | 177 | 173 | 491 | 2942 | 5675 | 195 | 683 | 38,880 |
| *Ammobaculites agglutinans* | | | | | | | | | | | | | | | | | | | | |
| *Ammodiscoides japonicus* | | | | | | | | | | | | | | | | | | | | |
| *Ammonia beccarii* | | | | | | | | | | | | | | | | | | | | |
| *Anomalina globulosa* | 4.3 | | | 5.2 | 1.0 | | 0.8 | 2.5 | 4.3 | 7.4 | 8.2 | 1.6 | 11.0 | | 13.1 | 1.2 | | | 0.4 | |
| *A.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Astrononion gallowayi* | | | | | | | | | 0.7 | | | | 0.4 | | | | | | | |
| *Bolivina arctica* | | | | | | 2.8 | 0.8 | 3.3 | | | | | | | | | | 1.4 | | |
| *B. decussata* | 0.3 | 2.9 | 2.3 | | 9.5 | 4.8 | 10.6 | 0.8 | 1.7 | 0.4 | | 7.7 | | 1.8 | | | | 4.4 | | 5.3 |
| *B. inflata* | | | | | | | | | | | | | | | | | | | | |
| *B. pseudoplicata* | | | | | | | | | | | | | | | | | | | | |
| *B. pygmaea* | | | | | | | | | | | | | | | | | | | | 1.2 |
| *B. subspinescens* | | | | | | | | | | | | | | | | 0.3 | | | | |
| *Bolivinita trunctum* | | | | | | | | | | | | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Brizalina lowmani* | 0.3 | 2.2 | | | 13.2 | 5.2 | 0.8 | | 1.3 | | | 2.0 | | 5.4 | | 3.3 | | 6.1 | | |
| *B. pseudopunctata* | | | 0.3 | | | 3.2 | 1.2 | 2.5 | 1.3 | | | 5.7 | 0.4 | 5.8 | | 1.2 | 0.4 | 0.3 | | 4.5 |
| *B. spathulata* | | 15.1 | 21.1 | 2.4 | 10.5 | | 4.3 | | 1.3 | | 0.4 | 4.9 | 0.7 | | 0.3 | 12.7 | 5.3 | | 0.4 | 9.1 |
| *B. subaenariensis* | | | 0.6 | 0.3 | | | | | | | | | | | | | | | | |
| *Bulimina alazaensis* | | | | | | | | | | | | | | | | | | | | |
| *B. marginata* | | 1.1 | 4.5 | 0.7 | | | | | | 0.4 | | | | | | 0.3 | | | | 0.8 |
| *B. striata* | | | | | | | | | | | | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Buliminella elegantissima* | | | | | | | | 0.4 | | | | | | | | | | | | |
| *Cassidulina laevigata* | | 34.2 | 35.4 | 2.1 | 4.4 | | 8.2 | | | | | 6.5 | | 1.1 | | 2.7 | 2.6 | | | 2.5 |
| *C. subglobosa* | 0.3 | 16.5 | 17.2 | 15.7 | 17.9 | 9.3 | 0.4 | 11.7 | 4.7 | 6.2 | 12.8 | 21.1 | 2.8 | 1.4 | 2.9 | 9.4 | 20.3 | 4.1 | 7.1 | 18.9 |
| *C.* spp. | | | | | | | | | | | | | | 1.4 | | | | 1.7 | | |
| *Cibicides lobatulus* | | 10.7 | 1.6 | | 8.4 | | | | | 0.4 | | 1.6 | | | | | | | | |
| *C. wuellerstorfi* | 4.8 | | 2.6 | 2.4 | | 0.8 | 1.6 | 0.4 | 1.0 | 0.4 | 1.2 | 0.4 | 1.1 | | 2.9 | | 1.9 | 1.0 | 0.8 | 3.3 |
| *Cibicidoides mundulus* | | | | | | | | | | | | | | | | | 0.8 | | 0.8 | |
| *C. robertsonianus* | | | 0.3 | 0.3 | | | | | | | | | | | | | | | | |
| *Cyclogyra involvens* | | | | | 0.3 | | | | | | | | | | | | | | | |
| *Dentalina* spp. | | | | 0.3 | 0.7 | 0.4 | | 0.4 | | 0.4 | | 0.8 | | | | 0.6 | 0.4 | | 0.4 | 1.2 |
| *Discorbinella* spp. | | | | | | | | | | | | | | | | | | | | |
| *Dentalina* spp. | | 0.7 | 0.3 | | 5.1 | 0.4 | 1.6 | | | | | 0.8 | 0.4 | 2.2 | | | | 1.4 | | |
| *Eggerella bradyi* | | | | | | | | | | | | | | | 1.0 | | | | 1.7 | |
| *Elphidium advenum* | | 0.4 | 0.3 | | | | | | | | | | | | | | | | | |
| *E. crispum* | | | | | | | | | | | | | | | | | | | | |
| *E. discoidale* | | 1.5 | 0.6 | | | | | | | | | | | | | | | | | |
| *E. excavatum* | | | | | | | | | | | | | | | | | | | | |
| *E. galvestonense* | | | | | | | | | | | | | | | | | | | | |
| *E. gunteri* | | | | | | | | | | | | | | | | | | | | |
| *E. margaritaceum* | | | | | | | | | | | | | | | | | | | | |
| *E. poeyanum* | | 0.7 | | | 4.4 | | | | | | | | | | | | | | | |
| *E.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Eoeponides pulchella* | | | | | | | | | | | | | | | | | | | | |
| *Epistominella exigua* | 3.4 | | | | | 6.0 | | 2.5 | 0.7 | 1.2 | 5.3 | | 0.4 | | | 0.9 | 5.6 | | 14.2 | 0.4 |
| *E. takayanagii* | | | | | | 0.4 | 0.8 | 2.1 | | | | | | | | | | | | |
| *Eponides tumidulus* | 0.3 | | | 4.9 | | | 0.4 | | 0.3 | 4.7 | 2.5 | | 1.4 | | 1.9 | | 9.4 | | 8.8 | 1.6 |
| *E. weddellensis* | 65.9 | | | 7.7 | 1.4 | 5.6 | 3.9 | 11.7 | 22.4 | 25.2 | 21.4 | 3.3 | 15.2 | 1.1 | 31.3 | 7.6 | 16.9 | 4.8 | 18.0 | 11.5 |
| *Fissurina* spp. | 0.6 | 1.5 | 0.3 | 1.4 | 3.0 | 2.4 | 6.7 | 2.5 | 0.7 | 0.8 | 4.5 | 1.2 | 6.0 | 4.3 | 1.0 | 0.6 | 3.4 | 3.1 | 1.3 | 1.2 |
| *Florilus* spp. | | | | | | | | | | | | | | | | | | | | |
| *Fursenkoina fusiformis* | 0.9 | 1.1 | 1.0 | 1.7 | 8.4 | 27.4 | 38.4 | 28.9 | 35.8 | 3.9 | 1.6 | 19.9 | 10.2 | 49.6 | 6.4 | 40.2 | 6.4 | 53.6 | | 16.9 |
| *F. pauciloculata* | 0.6 | | | | | | | | 0.7 | | | | | | 7.7 | | | | | |
| *F. pontoni* | | | | | | | | | | | | | | | | | | | | |
| *Gavelinopsis lobatulus* | | 0.4 | 1.0 | | 1.4 | | | | | | | | | | | | | | | |
| *G. translucens* | | 2.9 | 1.0 | | 1.4 | | 0.4 | | | | | | | 0.4 | | | | | | |
| G. cf. *prageri* | | | | | | | | | | | | | | | | | | | | |
| *Glabratella wrightii* | | | | | | | | | | | | | | | | | | | | |
| *G.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Globobulimina auriculata* | | | | | | | | | | | | | | | | | | | | |
| *Gyroidina orbicularis* | 0.6 | | | | | | | 0.4 | | | | | | | | | 0.4 | | 2.9 | 4.9 |
| *G. polius* | | | | | | | | | | | | | | | | | | | | |
| *G. soldanii* | 0.6 | | | 4.2 | 2.4 | 2.0 | 3.5 | 1.7 | | 0.8 | 2.1 | 2.4 | 1.1 | 1.1 | 1.0 | 0.6 | 4.1 | | 10.0 | 2.1 |
| *G.* spp. | | | | | | | | | | | | | | | | | | | | |

**Table 1 (continued).**

| Core, section: | 8H-5 | 8H-7 | 9H-5 | 9H-6 | 9H-7 | 10H-3 | 10H-5 | 11H-2 | 11H-3 | 11H-4 | 11H-5 | 12H-1 | 12H-3 | 12H-3 | 12H-4 | 12H-6 | 13H-1 | 13H-3 | 14H-5 | 15X-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 101–103 | 56–58 | 71–73 | 101–103 | 64–66 | 96–98 | 86–88 | 22–24 | 25–27 | 19–21 | 145–147 | 133–135 | 20–22 | 113–115 | 67–69 | 74–76 | 96–98 | 81–83 | 3–5 | 68–70 |
| Total individuals/10 $cm^3$: | 414 | 17,408 | 28,160 | 957 | 29,716 | 1526 | 1200 | 797 | 176 | 1835 | 608 | 4631 | 177 | 173 | 491 | 2942 | 5675 | 195 | 683 | 38,880 |
| *Hanzawaia* spp. | | | | | | | | | | | | | | | | | | | | |
| *Haynesina orbiculare* | | | | | | | | | | | | | | | | | | | | |
| *Heronallenia crosbyi* | | | | | | | | | | | | | | | | | | | | |
| *Hoeglundina elegans* | | | | | | | | | | | | | | | | | | | | |
| *Hopkinsina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Hyalinea balthica* | | | | | | | | | | | | | | | | | | | | |
| *Karreriella bradyi* | | | 0.3 | | | | | | | | | | 0.7 | | | | | | | |
| *Lagena* spp. | 0.3 | | 0.3 | 1.0 | | 0.4 | 0.4 | | 0.7 | 1.6 | | | 0.7 | | 1.0 | | | 0.3 | 0.4 | |
| *Lamarckina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Lenticulina* spp. | | | 0.3 | | | | | | | | | | | | | | 0.4 | | 0.4 | 0.4 |
| Miliolidae | | | | | | | | | | | | | | | | | | | | |
| *Neoconorbina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Nonion auriculata* | | | | | | | | | | | | | | | | | 0.4 | | | |
| *N. barleeanum* | | | 1.0 | 1.0 | | | | | | | 4.9 | | | | | | 1.1 | | | |
| *N.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Nonionella atlantica* | | 0.4 | | | | | | | | | | 0.4 | | | | | | | | |
| *N. turigida* | | | | | | | | | | | | | | | | | | 4.1 | | |
| *Nuttallides umbonifera* | 14.2 | | 0.6 | 2.8 | | 0.4 | | | | 0.8 | 0.4 | | | | | | | | 18.8 | 0.4 |
| *Oolina* spp. | | | | | | 0.4 | | 0.4 | | | 0.4 | | 0.7 | | 0.3 | 0.3 | | | | |
| *Opthalmidium pusillum* | | | | 0.7 | | 0.8 | | 0.4 | | | | | | | | | | | | |
| *Oridorsalis umbonatus* | 0.6 | 0.7 | | 16.0 | | 6.9 | | 5.0 | 1.0 | 24.4 | 22.2 | 1.2 | 5.3 | | 6.4 | 6.0 | 5.3 | | 2.1 | |
| *Patellina corrugata* | | | | | 0.7 | 0.4 | | | | | | | | | | | | | | |
| *Planorbulina mediterreansis* | | | | | | | | | | | | | | | | | | | | |
| *Planulina ariminensis* | | | 0.6 | | | | | | | | | | | | | | | 0.3 | | |
| *Plerostomella* spp. | | | | | | | | | | | | | | | | | | | | |
| *Pseudopolymorphina novangliae* | | | | | | | | | | 0.4 | | | 0.4 | | | | | | | |
| *Pullenia bulloides* | | | | 3.5 | | | | | | 0.4 | | | 0.7 | | | | | | | |
| *P. subcarinata* | 1.4 | 0.4 | | 15.0 | 0.3 | 2.4 | 0.4 | 13.4 | 12.4 | 14.0 | 3.3 | 2.0 | 12.0 | 2.9 | 7.7 | 3.6 | 7.1 | 3.8 | 5.0 | 2.9 |
| *Pyrgo murrhyna* | | | | | | | | 0.4 | | | | | | | | | | | | |
| *P. williamsoni* | 0.3 | | | 0.7 | | 0.8 | | 2.5 | 0.7 | | 3.7 | | 1.8 | | 0.3 | | 0.8 | | | |
| *Quinqueloculina agglutinans* | | | | | | | | | | | | | | | | | | | | |
| *Q. seminulum* | | 0.7 | 0.3 | 0.3 | 2.4 | 0.4 | 0.8 | | | | | | | | | | | | | |
| *Q. stalkeri* | | | | 4.5 | | | | 1.7 | 1.0 | | 3.7 | 1.2 | 1.8 | 1.4 | 1.0 | | 1.1 | | | |
| *Rosalina columbiensis* | | | | | | | | | | | | | | | | | | | | |
| *R. floridana* | | | | | | | | | | | | | | | | | | | | |
| *Sigmoilina tenuis* | | | | | | | | | | | | | | | | | | | | |
| *Sigmoilopsis schlumbergeri* | | | | | | | | | | | | | | | | | | | | |
| *Siphotextularia rolshauseni* | 0.3 | 0.4 | | 1.0 | | | | 0.4 | 0.3 | 1.9 | 0.8 | | 3.9 | | 1.0 | 0.3 | 1.5 | | 0.4 | |
| *Spiroloculina* spp. | | | | | | | | | | | | | | | | | | | | |
| *Stetsonia arctica* | | 0.4 | | 3.1 | | 11.3 | 7.1 | 2.9 | 5.4 | 3.5 | | 8.1 | 20.1 | 7.2 | 12.8 | 0.3 | | 7.8 | 0.4 | 0.8 |
| *Stilostomella antillea* | | | | | | | | | | | | | | | | | | | | |
| *S. bradyi* | | 0.4 | | | | | 0.4 | | | 0.4 | | | | | | | | | | 0.4 |
| *S.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Textularia conica* | | | | | | | | | | | | | | | | | | | | |
| *Tosaia hanzawai* | | | | 0.3 | | | | 0.4 | | 0.4 | 0.4 | 0.4 | 0.4 | | 0.3 | | 2.6 | | 5.4 | 1.2 |
| *Trifarina angulosa* | | | | | | | | | | | | | | | | | | | | |
| *T. fluens* | | 3.3 | 1.9 | | 1.7 | 1.6 | 1.6 | 0.4 | 0.7 | 0.4 | | 2.0 | | | | 3.9 | 1.9 | 0.7 | | 5.8 |
| *Triloculina tricarinata* | | | | | | | | | | | | | | | | | | | | |
| *Turrila* spp. | | | | | | | | | | | | | | | | | | | | |
| *Uvigerina peregrina* | | 0.4 | 1.0 | | | | | | | | | | | | | | | | | |
| *U.* spp. | | | | | | | | | | | | | | | | | | | | |
| *Valvulinera arctica* | 0.3 | | | | | 3.2 | 5.1 | | 1.0 | | | 4.5 | 0.7 | 12.7 | | | | 1.0 | | 2.5 |
| *V. laevigata* | | | | | 0.3 | | | | | | | | | | | 3.9 | | | | |
| Reworked foraminifers | | 1.1 | 2.9 | 0.3 | 1.4 | | | | | | | | | | | | | | | |

**Table 1 (continued).**

| Core, section: | 16X-1 | 16X-5 | 17X-1 | 17X-2 | 17X-3 | 17X-5 | 17X-6 | 18X-1 | 18X-2 | 18X-3 | 18X-CC | 22X-4 | 23X-4 | 25X-2 | 28X-2 | 29X-5 | 30X-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 26–28 | 5–7 | 90–91 | 138–140 | 132–134 | 133–135 | 39–41 | 46–48 | 13–15 | 58–60 | 10–12 | 111–113 | 97–99 | 72–74 | 54–56 | 15–17 | 64–66 |
| Total individuals/10 cm$^3$: | 577 | 4080 | 1043 | 1976 | 1053 | 11,703 | 2504 | 319 | 2072 | 944 | 1964 | 738 | 31 | 111 | 103 | 267 | 41 |
| *Ammobaculites agglutinans* | | | | | | | | | | | | | | | | | |
| *Ammodiscoides japonicus* | | 0.4 | | | | | | | | | | | | | | | |
| *Ammonia beccarii* | | | | | | | | | | | | | | | | | |
| *Anomalina globulosa* | 5.8 | | 0.7 | 8.1 | | | | 0.8 | | | | | | | | | |
| *A.* spp. | | | | | | | | | | | | | | | | | |
| *Astrononion gallowayi* | | 0.8 | | | | | | 0.8 | | | | | | | | | |
| *Bolivina arctica* | | | | | | | | | | | | | | | | | |
| *B. decussata* | 0.7 | 2.4 | | | | 6.6 | | 13.8 | 2.0 | | | | | | | | |
| *B. inflata* | | | | | | | | | | | | | | | | 0.8 | |
| *B. pseudoplicata* | | | | | | | | | | | | | | | | 0.4 | 1.4 |
| *B. pygmaea* | | | | | | | | | | | | 0.4 | | | | | |
| *B. subspinescens* | | | | | | 0.8 | | 1.3 | | | | | | | | | |
| *Bolivinita trunctum* | | | | | | | | | | | | | | | | 3.8 | 1.4 |
| *B.* spp. | | | | | | | | | | | | 7.2 | | | 10.3 | 7.1 | |
| *Brizalina lowmani* | | | | | | | | 9.2 | | | | | | | | | |
| *B. pseudopunctata* | 0.7 | 0.4 | 0.3 | 0.4 | | | | | | | | | | | | | |
| *B. spathulata* | 0.4 | 10.2 | | | | 7.4 | | 0.8 | 1.2 | 0.4 | | | | | | 1.7 | |
| *B. subaenariensis* | | | | | | | | | | | | | | | | | |
| *Bulimina alazaensis* | | | | | | | | | | | | | | | | | 1.4 |
| *B. marginata* | | 5.9 | | | | 3.9 | | | 0.4 | | | | | | | | |
| *B. striata* | | | | | | | | | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | 12.7 | 1.2 | | | 0.6 | | |
| *Buliminella elegantissima* | | | | | | | | | | | | | | | | | |
| *Cassidulina laevigata* | | 15.3 | 0.3 | | | 6.3 | | | | | | | | | | | 1.4 |
| *C. subglobosa* | 5.1 | 8.6 | 12.7 | 7.7 | 5.5 | 10.2 | 10.9 | 5.4 | 6.1 | 9.3 | 5.9 | 28.9 | 11.3 | 13.0 | 20.6 | 27.9 | 13.7 |
| *C.* spp. | | | | | | | | | | | | | | | | | |
| *Cibicides lobatulus* | | 26.7 | | | | 25.8 | | | | | | | | | | | |
| *C. wuellerstorfi* | 2.9 | | 2.0 | 5.7 | | | 0.6 | 1.3 | 4.1 | 0.4 | | | | | | | |
| *Cibicidoides mundulus* | | 2.0 | 0.3 | 0.4 | | | 2.6 | | | | | | | 0.6 | | 0.8 | 2.7 |
| *C. robertsonianus* | | | | | 0.8 | | 0.6 | | | | 0.9 | 0.8 | 1.9 | | | | |
| *Cyclogyra involvens* | | | | | | | | | | | | | | | | | |
| *Dentalina* spp. | 0.7 | | 0.3 | | | 0.4 | | 0.4 | 0.4 | | | 0.8 | | 0.6 | 1.7 | | |
| *Discorbinella* spp. | | | | | | | | | | | | | | | 2.3 | 1.3 | |
| *Dentalina* spp. | | 2.0 | | | | 0.4 | | 3.8 | | | | | | | | | |
| *Eggerella bradyi* | | | 0.3 | | | | | | | 1.3 | | | | 1.7 | 0.6 | | 1.4 |
| *Elphidium advenum* | | | | | | | | | | | | | | | | | |
| *E. crispum* | | 0.8 | | | | 2.0 | | | | | | | | | | | |
| *E. discoidale* | | 7.5 | | | | | | | | | | | | | | | |
| *E. excavatum* | | | | | | 7.8 | | 0.4 | | | | | | | | | |
| *E. galvestonense* | | | | | | | | | | | | | | | | | |
| *E. gunteri* | | | | | | | | | | | | | | | | | |
| *E. margaritaceum* | | | | | | | | | | | | | | | | | |
| *E. poeyanum* | | | | | | | | | | | | | | | | | |
| *E.* spp. | | | | | | | | | | | | | | | | 0.8 | |
| *Eoeponides pulchella* | | | | | | | | | | | | | | | | | |
| *Epistominella exigua* | 1.5 | 0.4 | 4.0 | 2.0 | 3.0 | 1.2 | 14.1 | 0.4 | 4.5 | 0.8 | 4.5 | 17.7 | 3.8 | 11.3 | 10.3 | 4.2 | 6.8 |
| *E. takayanagii* | | 0.4 | | | | | | | | | | | | | | | |
| *Eponides tumidulus* | 1.8 | | 6.0 | 4.5 | 9.7 | | 2.6 | | 1.6 | 4.7 | 1.4 | | | | | | |
| *E. weddellensis* | 23.0 | 0.4 | 14.0 | 29.1 | 26.2 | 0.8 | 15.7 | 3.3 | 8.9 | 11.4 | 22.6 | 0.4 | 3.8 | | 4.0 | 2.1 | 1.4 |
| *Fissurina* spp. | 4.0 | 0.8 | 4.3 | 3.6 | 3.8 | 0.4 | 2.6 | 7.1 | 5.3 | 10.6 | 0.9 | | | 1.1 | 10.9 | 0.4 | 2.7 |
| *Florilus* spp. | | | | | | | | | | | | 2.0 | | | | | |
| *Fursenkoina fusiformis* | 4.4 | | 2.0 | 3.2 | 3.4 | | 1.6 | 30.1 | 0.8 | 3.4 | | 2.0 | 5.7 | | | | |
| *F. pauciloculata* | | | | | | | | | | | | | | | | | |
| *F. pontoni* | | | | | | | | | | | | | | 1.1 | | 0.8 | |
| *Gavelinopsis lobatulus* | | | | | | 2.7 | | | | | | | | | | | |
| *G. translucens* | | 8.6 | | | | 11.3 | | | 0.4 | | | | | | | | |
| G. cf. *prageri* | | | | | | | | | | | | 1.6 | | | 1.7 | 2.5 | 1.4 |
| *Glabratella wrightii* | | | | | | | | | | | | | | | | | |
| *G.* spp. | | | | | | 2.0 | | | | | | | | | | | |
| *Globobulimina auriculata* | | | | | | | | | | | 0.5 | | | | | | |
| *Gyroidina orbicularis* | | | 1.0 | 0.8 | | | 15.3 | 4.6 | 11.4 | 2.8 | | | | | | | |
| *G. polius* | | | | | | | | | | | | | 1.9 | | | | |
| *G. soldanii* | 0.7 | 1.2 | 10.3 | 4.9 | 3.0 | | 1.6 | 0.8 | 2.0 | 2.5 | 2.7 | 4.4 | 3.8 | 5.6 | 8.6 | 5.8 | 6.8 |
| *G.* spp. | | | | | | | | | | | | | | 2.3 | 1.1 | 1.3 | 1.4 |

**Table 1 (continued).**

| Core, section: | 16X-1 | 16X-5 | 17X-1 | 17X-2 | 17X-3 | 17X-5 | 17X-6 | 18X-1 | 18X-2 | 18X-3 | 18X-CC | 22X-4 | 23X-4 | 25X-2 | 28X-2 | 29X-5 | 30X-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 26–28 | 5–7 | 90–91 | 138–140 | 132–134 | 133–135 | 39–41 | 46–48 | 13–15 | 58–60 | 10–12 | 111–113 | 97–99 | 72–74 | 54–56 | 15–17 | 64–66 |
| Total individuals/10 cm$^3$: | 577 | 4080 | 1043 | 1976 | 1053 | 11,703 | 2504 | 319 | 2072 | 944 | 1964 | 738 | 31 | 111 | 103 | 267 | 41 |
| *Hanzawaia* spp. | | | | | | | | | | | | 12.0 | | | 7.4 | 8.3 | 5.5 |
| *Haynesina orbiculare* | | 0.4 | | | | | | | | | | | | | | | |
| *Heronallenia crosbyi* | | | | | | | | | | | | | | | | | 4.1 |
| *Hoeglundina elegans* | | | | | | | | | | | | | | | | | |
| *Hopkinsina* spp. | | | | | | | | | | | | | | 0.6 | | | |
| *Hyalinea balthica* | | | | | | | | | | | | | | | | | |
| *Karreriella bradyi* | | | | | | | | | | | | | | | | | |
| *Lagena* spp. | 1.1 | | 0.3 | | 0.4 | | | 0.4 | 2.0 | | | 0.4 | | 1.1 | 0.6 | | 1.4 |
| *Lamarckina* spp. | | | | | | | | | | | | | | | 0.6 | | |
| *Lenticulina* spp. | | | | | | | 0.3 | | 0.4 | 0.4 | | | | 0.6 | 0.6 | | |
| Miliolidae | | | | | | | | | | | | 0.4 | | | | | |
| *Neoconorbina* spp. | | | | | | | | | | | | | | | 1.1 | 1.7 | |
| *Nonion auriculata* | | | | | | | | | 0.4 | | | | | | | | |
| *N. barleeanum* | | | 1.0 | 0.4 | 7.2 | 0.4 | 2.2 | | 2.8 | | 1.4 | 0.4 | 3.8 | 1.7 | | | |
| *N.* spp. | | | | | | | | | | | 2.3 | 0.4 | | | 2.3 | 2.5 | |
| *Nonionella atlantica* | | | | | 0.8 | | | | | | | | | | | | |
| *N. turigida* | | | | | | | | | | | | | | | | | |
| *Nuttallides umbonifera* | 1.5 | | 18.0 | 3.2 | 10.5 | 0.4 | 11.8 | 2.1 | 8.9 | 6.4 | 19.9 | 1.2 | 34.0 | 15.8 | 1.1 | 9.2 | 19.2 |
| *Oolina* spp. | 0.7 | | | 0.4 | | 1.2 | 0.6 | | | 0.4 | | 0.4 | | | 0.6 | | |
| *Opthalmidium pusillum* | 0.4 | | | | | | | | | | | | | | | | |
| *Oridorsalis umbonatus* | 25.9 | 0.4 | 2.3 | 7.7 | 5.1 | 0.4 | 6.4 | 2.1 | 7.7 | 4.2 | 7.7 | 7.2 | 5.7 | 14.7 | 5.1 | 2.5 | 6.8 |
| *Patellina corrugata* | | | | | | | | 0.4 | | | | | | | | | |
| *Planorbulina mediterreansis* | | | | | | | | | | | | | | | | | |
| *Planulina ariminensis* | | | | | | | | | | | | | | | | | |
| *Plerostomella* spp. | | | | | | | | | | | | | | 1.1 | 0.6 | | |
| *Pseudopolymorphina novangliae* | | | | | | | | | | | | | | | | | |
| *Pullenia bulloides* | | 0.4 | | 0.4 | 0.4 | | 1.0 | | | 0.4 | 3.6 | | 16.9 | 4.0 | 0.6 | 3.8 | 2.7 |
| *P. subcarinata* | 6.9 | | 14.0 | 9.7 | 15.2 | 1.2 | 6.7 | 6.7 | 25.2 | 19.9 | 8.6 | 4.0 | 5.7 | 10.7 | 4.0 | 3.3 | 13.7 |
| *Pyrgo murrhyna* | | | | | | | | | | | | | | | | | |
| *P. williamsoni* | 1.5 | | 0.3 | 1.2 | | | | | 1.2 | 3.8 | | | | | | | |
| *Quinqueloculina agglutinans* | | | | | | | | | | | | | | | | | |
| *Q. seminulum* | 1.1 | 0.8 | | | | | 1.0 | | | | | | | 0.6 | | | |
| *Q. stalkeri* | 0.4 | | 0.3 | | 2.1 | | | | 0.4 | 1.7 | | | | | | | |
| *Rosalina columbiensis* | | | | | | | | | | | | | | | | | |
| *R. floridana* | | | | | | | | | | | | | | | | | |
| *Sigmoilina tenuis* | | | | | | | | | | | 0.5 | | | | | | |
| *Sigmoilopsis schlumbergeri* | | | | | | | | | | | | | | | | | |
| *Siphotextularia rolshauseni* | | | 0.7 | 2.8 | 0.8 | | 0.6 | | 0.8 | 2.1 | 0.5 | | | 0.6 | 0.6 | 1.3 | |
| *Spiroloculina* spp. | | | | 0.4 | | | | | | | | | | | | | |
| *Stetsonia arctica* | 8.0 | | 1.0 | | | | 0.3 | | 0.4 | 6.4 | | | | | | | |
| *Stilostomella antillea* | | | | | | | | | | | | | | 10.7 | 0.6 | 2.1 | 2.7 |
| *S. bradyi* | | 0.4 | | | | | | 0.4 | | 0.4 | | | | | | | |
| *S.* spp. | | | | | | | | | | | | 2.4 | | 0.6 | | 0.8 | |
| *Textularia conica* | | | | | | | | | | | | | | | | | |
| *Tosaia hanzawai* | 0.7 | | 2.3 | 3.2 | 2.1 | | 1.0 | | | 6.4 | 3.6 | 0.8 | 1.9 | | | 0.4 | |
| *Trifarina angulosa* | | | | | | | | | | | | 2.4 | | | 1.7 | 2.1 | |
| *T. fluens* | | 3.1 | 0.3 | | | 5.9 | | 0.4 | 0.4 | | | | | | | | |
| *Triloculina tricarinata* | | | | | | | | | | | | | | | | | |
| *Turrila* spp. | | | | | | | | | | | | | | | | 0.4 | |
| *Uvigerina peregrina* | | | | | | | | | | | | | | | | | |
| *U.* spp. | | | | | | | | | | | | 0.4 | | | | | |
| *Valvulinera arctica* | | | 0.7 | | | | | 2.9 | | | | | | | | | |
| *V. laevigata* | | | | | | | | | | | | | | | | | |
| Reworked foraminifers | | | | | | 0.8 | | | | | | | | | | | |

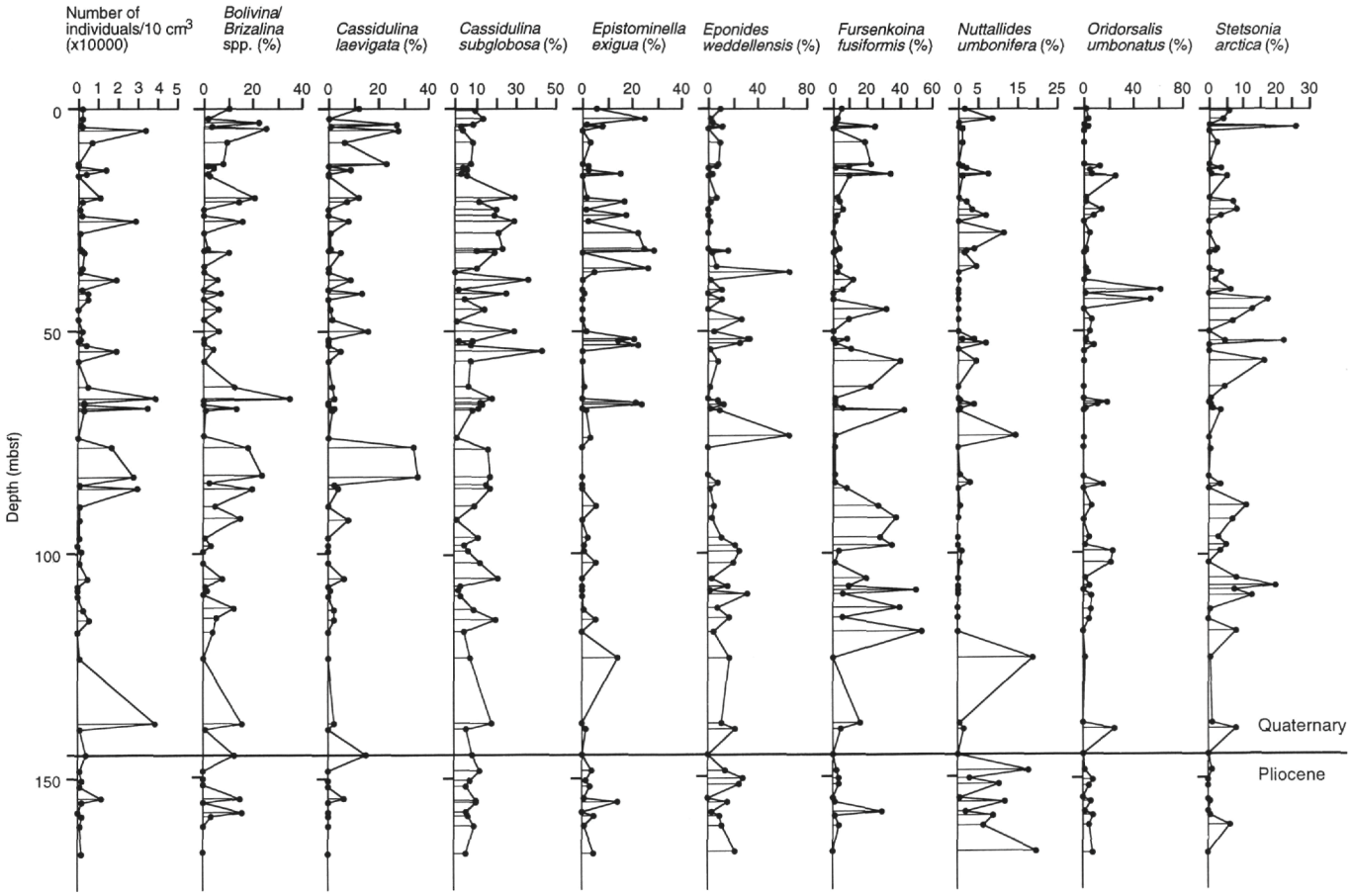


Figure 2. Distribution of selected species of benthic foraminifers in Quaternary and upper Pliocene sediments from Hole 898A.

**Table 2. Percentage occurrences of benthic foraminifers in sediments from Hole 898B.**

| Core, section: | 1H-1 | 1H-1 | 1H-1 | 1H-1 | 1H-2 | 1H-2 | 1H-2 | 1H-3 | 1H-3 | 1H-3 | 1H-4 | 1H-4 | 1H-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 0–1 | 24–26 | 45–47 | 72–74 | 3–5 | 46–48 | 77–79 | 25–27 | 53–55 | 92–94 | 18–20 | 52–54 | 116–118 |
| Total individuals/10 cm$^3$ | 9248 | 3157 | 544 | 1547 | 7920 | 584 | 19,200 | 3372 | 36,480 | 1168 | 2640 | 2810 | 2424 |
| *Adercotryma glomerata* | | 0.7 | | | | | | | | | | | |
| *Ammobaculites agglutinans* | | 0.7 | | | | | | | | | | | |
| *Anomalina globulosa* | 2.4 | | | | 0.7 | 1.9 | 0.7 | 12.4 | 1.1 | 4.5 | | | |
| *Astrononion gallowayi* | 3.1 | 0.7 | 1.3 | 1.4 | 1.3 | | 0.7 | 1.1 | 3.2 | 0.3 | | | |
| *Bolivina decussata* | 5.5 | 3.0 | | 0.7 | 6.1 | 1.6 | 2.0 | | 4.2 | 1.7 | | | |
| *B. pygmaea* | | | | | | | 2.3 | | 1.4 | | | | |
| *Brizalina pseudopunctata* | | 1.0 | 0.3 | 1.0 | 0.3 | 0.3 | 1.0 | | 3.5 | 0.7 | 1.0 | | |
| *B. spathulata* | 13.1 | 2.0 | 6.0 | 5.5 | 11.4 | 3.7 | 12.0 | 1.5 | 9.5 | 1.0 | 0.3 | 1.1 | 4.0 |
| *B. subaenariensis* | 4.8 | | | | 3.0 | | 0.7 | | | | | | |
| *B.* spp. | | | 1.3 | | | | | | | | | | |
| *Bulimina exilis* | | | 1.3 | 0.3 | | | | | | | | | |
| *B. marginata* | 3.5 | 0.3 | | | 0.3 | 0.9 | 2.3 | | 1.8 | | | | |
| *B. striata* | 0.3 | | | 0.3 | | | | | 0.4 | | | | |
| *Cassidulina laevigata* | 18.3 | 1.4 | 4.7 | 3.4 | 19.9 | 0.9 | 22.0 | 1.5 | 13.3 | 2.1 | 1.0 | 1.1 | 4.0 |
| *C. subglobosa* | 13.1 | 10.5 | 8.7 | 5.2 | 17.5 | 4.7 | 18.7 | 4.0 | 17.9 | 6.8 | 8.4 | 8.5 | 17.2 |
| *C.* spp. | | | | | 0.3 | | | | | | | | |
| *Cibicides wuellerstorfi* | 12.5 | 2.7 | 2.7 | 2.8 | 5.4 | 2.8 | 4.0 | 1.5 | 4.9 | 1.7 | 2.0 | 3.2 | 1.7 |
| *Cibicidoides robertsonianus* | | | | | | | | 0.4 | | | | | |
| *Dentalina* spp. | | | 1.0 | | | | 0.7 | | 0.4 | 0.3 | | | 0.3 |
| *Dentalina* spp. | 2.1 | 0.7 | | | 0.7 | | 0.3 | | | | | | 0.3 |
| *Eggerella bradyi* | | | | | | 0.3 | | | | 4.1 | 0.4 | | |
| *Elphidium crispum* | | | | | | | 0.7 | | | | | | |
| *E. excavatum* | 4.2 | | | 0.3 | 0.7 | 1.2 | 3.7 | | 0.7 | | 0.7 | | |
| *E.* spp. | | | | | | 0.3 | | | | | | | |
| *Epistominella exigua* | 0.3 | 24.0 | 4.7 | | 0.7 | 14.6 | 1.7 | 9.5 | 2.53 | 6.01 | 4.81 | 6.0 | 2.0 |
| *E. takayanagii* | | | 1.3 | | 1.0 | | 0.7 | | | | | | |
| *Eponides tumidulus* | 0.7 | 3.4 | 7.7 | 4.1 | | 9.0 | 2.0 | 8.0 | 1.1 | 9.21 | 5.51 | 6.4 | 10.2 |
| *E. weddellensis* | 2.8 | 20.9 | 7.4 | 11.4 | 9.4 | 19.0 | 3.7 | 20.1 | 10.2 | 3.8 | 2.0 | 1.8 | 16.8 |
| *Fissurina* spp. | | 1.0 | 1.3 | 0.3 | 1.3 | 2.2 | 0.7 | 2.2 | 0.4 | 2.1 | 2.7 | 5.3 | 2.6 |
| *Fursenkoina fusiformis* | 0.7 | 2.0 | 7.4 | 20.7 | 4.0 | 1.6 | 3.3 | 1.8 | 7.0 | 8.2 | 1.3 | 2.5 | 6.6 |
| *Gavelinopsis translucens* | | | | | 0.3 | | | | | | | | |
| *Glabratella wrightii* | | | | | | | 0.3 | | 0.3 | | | | |
| *Globobulimina auriculata* | | | | | 0.3 | | | | | | | | |
| *Gyroidina soldanii* | | 1.0 | 2.7 | 0.3 | 1.3 | | 0.3 | 0.4 | 0.4 | 1.0 | 2.7 | 2.1 | 2.0 |
| *Hapolophragmoides* spp. | | 1.0 | | | | | | | | | | | |
| *Karreriella bradyi* | | 0.3 | | | | | | | 0.4 | | | | |
| *Lagena* spp. | | | 3.0 | 0.7 | | 0.9 | | 0.4 | 0.7 | 1.0 | 0.3 | 1.1 | 0.3 |
| *Lenticulina* spp. | | | | 0.3 | | | | | | | 0.3 | 0.7 | |
| Miliolidae | | | 1.7 | | | | | | | | 0.3 | | |
| *Nonion auriculata* | | | | | | | 0.3 | 0.4 | | 0.3 | | | |
| *N. barleeanum* | 0.7 | 0.3 | | | | 0.3 | 1.0 | | | | 2.0 | 1.1 | 1.0 |
| *Nonionella atlantica* | | | | | | | | | 1.4 | | | | |
| *N. turigida* | | | 0.7 | 1.7 | 2.7 | | 0.3 | | | | 0.4 | | |
| *Nuttallides umbonifera* | 4.5 | 7.1 | 1.3 | | | 0.6 | | 1.1 | 0.7 | 2.4 | 4.6 | | 15.5 |
| *Oolina* spp. | | 0.3 | | | 0.3 | 0.9 | 0.3 | 0.7 | | 2.1 | 0.7 | | |
| *Oridorsalis umbonatus* | 1.4 | 3.7 | 3.3 | 1.4 | 0.7 | 4.0 | 1.3 | 3.6 | 8.9 | 12.5 | 3.2 | | 1.7 |
| *Patellina corrugata* | | | 0.3 | | | | | | | | | | |
| *Planulina ariminensis* | | 0.3 | | | | 0.3 | 0.3 | | | | | | |
| *Psammosphaera* spp. | | | 12.0 | | | | | | | | | | |
| *Pullenia bulloides* | | | 2.3 | | 1.3 | 2.8 | | | | | 2.0 | 1.4 | |
| *P. subcarinata* | 0.3 | 3.4 | 5.4 | 2.8 | 0.7 | 3.1 | 1.3 | 2.2 | 3.5 | 1.0 | 4.4 | 8.2 | 3.3 |
| *Pyrgo williamsoni* | | 0.3 | 0.7 | 1.0 | | 0.6 | | 1.1 | | | | 0.4 | 1.0 |
| *Quinqueloculina seminulum* | | 2.4 | | 0.3 | 1.0 | | | | | | | 0.7 | 1.0 |
| *Q. stalkeri* | | 1.7 | | 0.3 | 1.0 | 3.1 | | 1.8 | | | 3.4 | 3.6 | 3.3 |
| *Reophax nodulosus* | | 0.3 | | | | | | | | | | | |
| *Reusella* spp. | | | | | | | | | 0.4 | | | | |
| *Robertinoides* spp. | | | | | | | 1.0 | | 0.4 | | | | |
| *Siphotextularia rolshauseni* | | | 1.0 | 1.4 | | 2.2 | | 0.4 | 1.7 | 0.3 | 0.4 | 0.3 | |
| *Sphaeroidina bulloides* | | | 0.7 | | | | | | | | | | |
| *Spiroloculina* spp. | | | | | | 0.3 | | | | | | | |
| *Stetsonia arctica* | | 0.7 | 5.4 | 30.3 | | 15.3 | 0.7 | 24.5 | 1.1 | 3.1 | 17.8 | 11.4 | |
| *Stilostomella antillea* | 0.3 | 0.3 | | | | | 0.7 | | | | | | |
| *S. bradyi* | 0.3 | | | | | | | | | | | | |
| *Tosaia hanzawai* | | 1.0 | 0.7 | | | | 0.7 | | | 0.3 | 1.0 | 2.1 | 2.0 |
| *Trifarina fluens* | 1.7 | 0.7 | | | 2.0 | 0.3 | 4.3 | | 7.7 | 0.3 | 0.3 | 1.1 | |
| *Uvigerina peregrina* | | | 1.7 | 1.7 | 4.0 | | 2.3 | | 0.4 | 0.4 | | | |
| *Valvulinera laevigata* | | | | | | | 0.3 | | 0.4 | | | | |
| Reworked Tertiary | 3.1 | | | | | | 0.7 | | 0.4 | | | | |

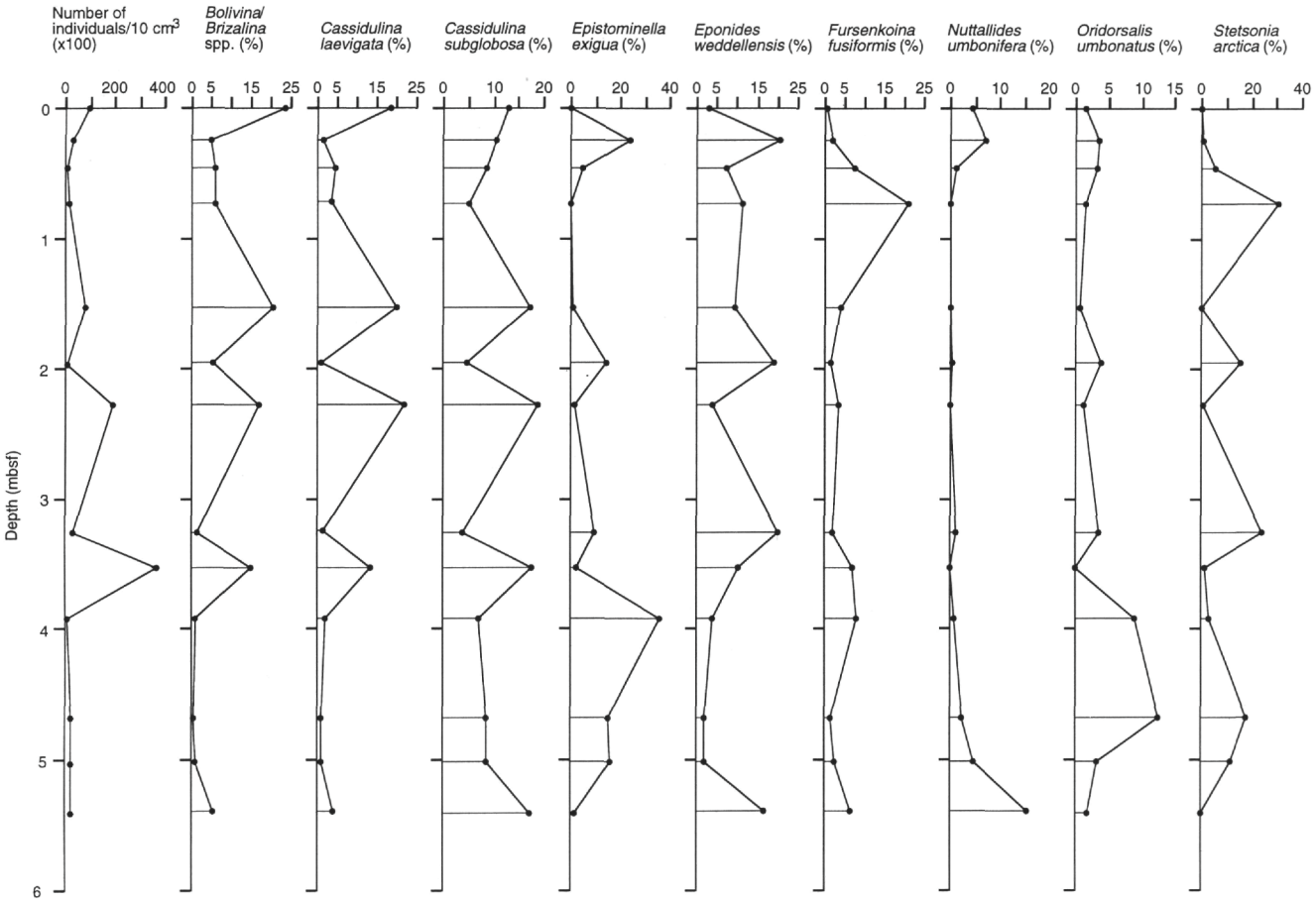


Figure 3. Distribution of selected species of benthic foraminifers in Quaternary sediments from Hole 898B.

**Table 3. Percentage occurrences of benthic foraminifers in sediments from Hole 900A.**

| Core, section: | 1R-1 | 2R-1 | 3R-1 | 4R-1 | 4R-4 | 5R-1 | 5R-3 | 6R-4 | 7R-3 | 8R-3 | 9R-2 | 10R-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interval (cm): | 26–28 | 31–33 | 9–11 | 107–109 | 21–23 | 120–122 | 113–115 | 64–66 | 111–113 | 36–38 | 26–28 | 97–99 |
| Total individuals/10 cm$^3$ | 5055 | 1873 | 3187 | 3825 | 3 | 5163 | 88 | 3564 | 2249 | 2810 | 2860 | 3188 |
| *Ammobaculites agglutinans* | 0.3 | | | | | | | | 0.4 | | | |
| *Ammonia beccarii* | | | | | | | | | | | | |
| *Anomalina globulosa* | 0.3 | 0.7 | | | | 0.4 | 0.7 | 3.2 | | 4.3 | 1.7 | 3.1 |
| *Astrononion gallowayi* | | 0.4 | 0.4 | | | 0.4 | | | | 0.4 | | |
| *Bolivina arctica* | | | | | | | | | | 17.4 | | |
| *B. decussata* | 0.6 | | | 0.4 | | 1.7 | | 1.1 | 2.1 | | | |
| *B. inflata* | | | | | | | | | | | | |
| *B. pseudoplictata* | | | | | | | | | | | | |
| *B. pygmaea* | | | | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | | |
| *Bolivinita trunctum* | | | | | | | | | | | | |
| *Brizalina lowmani* | | | | | | | | | | | | |
| *B. pseudopunctata* | 0.6 | | 0.8 | | | 0.8 | 1.3 | 0.4 | 5.9 | 3.6 | | |
| *B. spathulata* | 2.3 | 0.4 | 4.2 | 1.5 | | 8.3 | 1.3 | 6.3 | | 1.8 | 1.7 | 0.4 |
| *Bulimina aculeata* | | | | | | | | | 1.3 | | | |
| *B. alazaensis* | | | | | | | | | | | | |
| *B. marginata* | | | 0.4 | | | 0.4 | | 1.4 | 0.4 | 0.4 | | |
| *B. striata* | | | 0.8 | | | | | | | | | |
| *B.* spp. | | | | | | | | | | | | |
| *Cassidulina laevigata* | 2.3 | 0.7 | 5.4 | 1.5 | | 5.0 | | 1.8 | 0.4 | 5.3 | | |
| *C. reniforme* | | | | | | | | | | | | |
| *C. subglobosa* | 8.1 | 11.4 | 16.7 | 12.5 | | 24.8 | | 10.2 | 6.3 | 7.8 | 7.0 | 5.0 |
| *C.* spp. | | 0.4 | 0.4 | | | | | | | | | |
| *Cibicides wuellerstorfi* | 0.6 | 0.7 | 2.9 | 5.3 | | 1.7 | 2.7 | 3.5 | | 4.3 | 1.0 | 1.2 |
| *Cibicidoides mundulus* | | | | | | | | | | | | |
| *C. robertsonianus* | | | | 0.4 | | | | 0.4 | | 0.7 | | |
| *C.* spp. | | | | | | | | | | | | |
| *Dentalina* spp. | | | | | | 0.4 | | 0.7 | | 0.4 | | 0.8 |
| *Discorbis* spp. | 0.6 | 0.4 | | | | | | | 0.4 | | | |
| *Eggerella bradyi* | | 0.7 | | 0.4 | | 0.4 | 0.7 | | | | | |
| *Elphidium excavatum* | | 0.4 | | | | | | | | | | |
| *E. crispum* | | | | | | | | | | | | |
| *Epistominella exigua* | 31.2 | 33.1 | 17.2 | 10.6 | | 1.7 | 9.4 | 12.3 | 6.7 | 1.8 | 10.5 | 18.9 |
| *E. takayanagii* | | | | 0.8 | | | | | | | 0.3 | |
| *Eponides tumidulus* | 5.2 | 9.3 | 2.5 | 6.5 | | 4.1 | 3.4 | 3.9 | 2.9 | 4.6 | 4.5 | 2.7 |
| *E. weddellensis* | 16.2 | 2.8 | 3.8 | 5.7 | | 8.7 | 4.7 | 4.6 | 20.1 | 8.9 | 27.6 | 23.2 |
| *Fissurina* spp. | 1.0 | 6.0 | 2.1 | 3.8 | | 2.1 | 1.3 | 3.2 | 3.3 | 0.4 | 2.4 | 0.4 |
| *Florilus* spp. | | | | | | | | | | | | |
| *Fursenkoina fusiformis* | 1.6 | 1.4 | 5.9 | 3.8 | | 2.5 | 2.0 | 3.5 | 9.2 | 6.0 | 1.7 | |
| *F. pauciloculata* | | | | | | | 0.7 | | | | | 0.8 |
| *F. pontoni* | | | | | | | | | | | | |
| *Gavelinopsis* cf. *prageri* | | | | | | | | | | | | |
| *Glandulina* spp. | | | | | | | | | | | | |
| *Gyroidina polius* | | | | | | | | | | | | |
| *G. soldanii* | 2.6 | 4.6 | 6.7 | 8.4 | 66.7 | 6.2 | 2.7 | 4.6 | 2.9 | 2.1 | 5.6 | 6.2 |
| *G.* spp. | | | | | | | | | | | | |
| *Hanzawaia* spp. | | | | | | | | | | | | |
| *Heronallenia crosbyi* | | | | | | | | | | | | |
| *Hopkinsina* spp. | | | | | | | | | | | | |
| *Hyalinea balthica* | | | | | | | | | | | | |
| *Islandiella teretis* | | | | | | | | 0.7 | | | | |
| *Lagena* spp. | 1.3 | 3.6 | 2.5 | 1.9 | | 1.2 | 1.3 | 1.8 | 0.8 | 1.8 | 0.3 | 0.4 |
| *Laticarinina halophora* | | | | | | | | | | | | |
| *L. pauperata* | | | | | | | | | | | | |
| *Lenticulina* spp. | | | | | | | 0.7 | | | | | |
| Miliolidae | | | | | | | | | 1.7 | 0.4 | | |
| *Nonion auriculata* | 0.3 | 1.1 | | | | | | | | | | |
| *N. barleeanum* | | | 0.8 | 2.3 | | 2.1 | 5.4 | 4.9 | 2.1 | 3.6 | 1.0 | 3.9 |
| *N.* spp. | | | | | | | | | | | | |
| *Nonionella atlantica* | | | 0.4 | 1.1 | | 0.8 | | 0.4 | 4.2 | 0.4 | | 1.9 |
| *N.* spp. | | | | | | | | | | | | |
| *Nuttallides umbonifera* | 14.0 | 4.6 | 6.3 | 7.2 | 33.3 | 3.3 | 45.6 | 15.1 | 7.9 | 4.3 | 9.1 | 11.2 |
| *Oolina* spp. | | 0.4 | | | | | | 0.4 | 0.4 | | 0.3 | 0.4 |
| *Oridorsalis umbonatus* | 3.2 | 5.3 | 5.4 | 3.8 | | 6.6 | 0.7 | 1.4 | 4.2 | 7.5 | 7.0 | 8.9 |
| *Plerostomella* spp. | | | | | | | | | | | | |
| *Psammosphaera fusca* | 0.3 | | | | | | | | | | | |
| *Pullenia bulloides* | 1.0 | 0.4 | 2.9 | | | 2.5 | 4.0 | 2.5 | 1.3 | 3.9 | | 3.1 |
| *P. subcarinata* | 1.0 | 5.7 | 1.3 | 9.5 | | 3.7 | 4.0 | 5.3 | 10.5 | 1.8 | 11.9 | 6.6 |
| *Pyrgo williamsoni* | | 1.1 | 1.7 | 1.5 | | 0.4 | | | 0.4 | 1.1 | 0.3 | |
| *Quinqueloculina seminulum* | 0.3 | | | 0.4 | | 0.8 | | | | 0.7 | | |
| *Q. stalkeri* | 1.9 | 3.6 | | 3.0 | | 0.8 | | 0.7 | | | 1.4 | 0.4 |
| *Rosalina* spp. | | | | | | | | | | | | |
| *Seebrooki* spp. | | | | | | | | | | | | |
| *Siphotextularia rolshauseni* | 0.6 | 0.7 | 2.1 | 1.5 | | 0.4 | 2.7 | 0.4 | 1.3 | 0.7 | 0.3 | 0.8 |
| *Spiroloculina* spp. | | | 1.3 | 0.4 | | 0.4 | | 0.4 | | | | |
| *Spiorplectammina* spp. | | | | | | | | | | | | |
| *Stilostominella antillea* | | | | | | | | | | | | |
| *S.* spp. | | | | | | | | | | | | |
| *Stetsonia arctica* | 1.0 | 0.4 | 1.3 | 1.5 | | 2.9 | 1.3 | 2.5 | 0.4 | 0.4 | | |
| *Tosaia hanzawai* | 1.0 | | 2.1 | 3.0 | | 1.7 | 3.4 | 1.1 | 2.1 | 0.7 | 1.4 | |
| *Trifarina angulosa* | | | | | | | | | | | | |
| *T. fluens* | 0.3 | | 1.7 | 1.1 | | 2.9 | | 1.4 | 0.4 | 0.7 | 2.1 | |
| *Turrila* spp. | | | | | | | | | | | | |
| *Uvigerina auberiana* | | | | | | | | | | | | |
| *U. peregrina* | | | | | | | | | | | | |
| *U.* spp. | | | | | | | | | | | | |
| *Valvulinera laevigata* | | | | | | | | 0.4 | | 2.1 | 0.3 | |

Notes: Based on calcareous nannofossils (Liu et al., this volume; de Kaenel and Villa, this volume) the Pliocene/Pleistocene boundary occurs between Samples 5R-3, 113-115 cm, and 6R-4, 64-66 cm, and the Miocene/Pliocene boundary occurs between Samples 11R-4, 97-99 cm, and 12R-4, 16-18 cm.

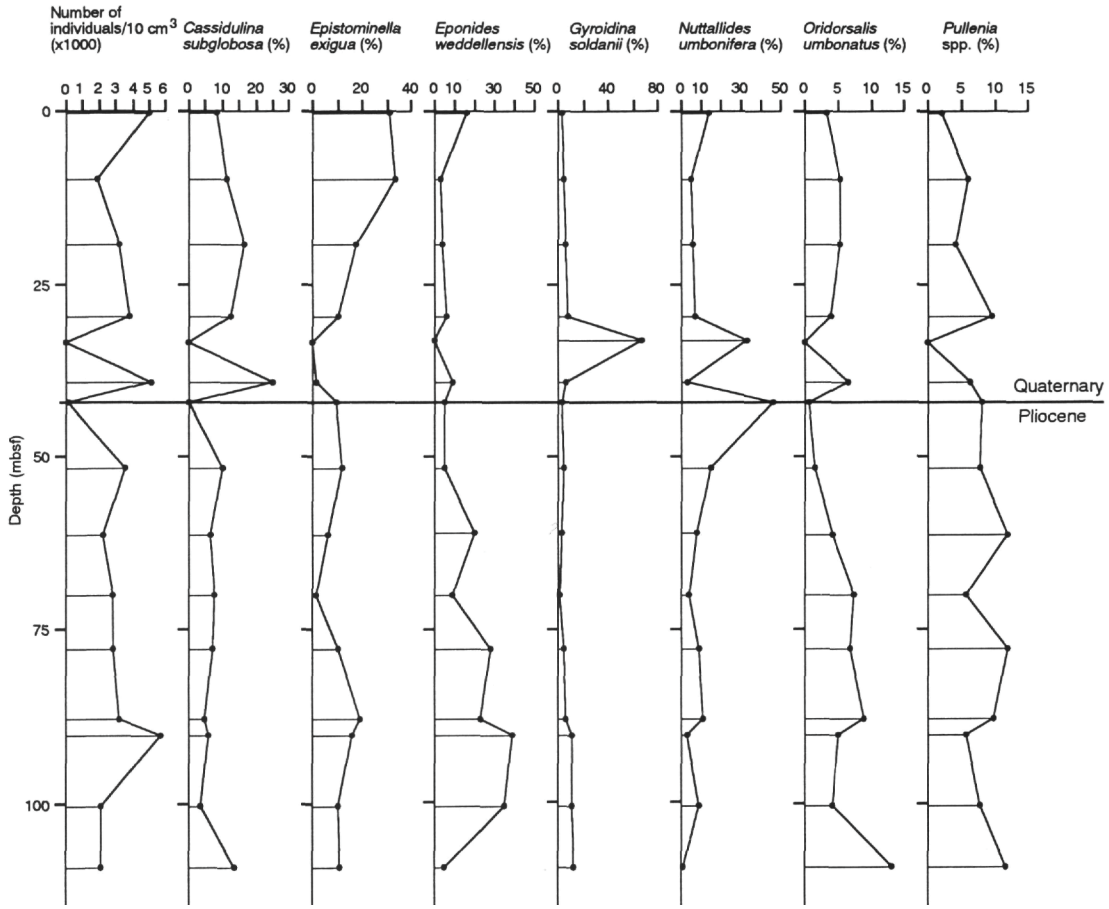


Figure 4. Distribution of selected species of benthic foraminifers in Quaternary and Pliocene sediments from Hole 900A.

**TAXONOMIC APPENDIX**

*Adercotryma glomerata* (Brady)
*Lituola glomerata* Brady, 1878, p. 433, pl. 20, figs. la-c.

*Ammobaculites agglutinans* (d'Orbigny)
*Spirolina agglutinans* d'Orbigny, 1846, p. 137, pl. 7, figs. 10-12.

*Ammodiscoides japonicus* Asano
*Ammodiscoides japonicus* Asano, 1952, p. 3, figs. 9—11.

*Ammonia beccarii* (Linné)
*Nautilus beccarii* Linné, 1758, p. 710.

*Anomalina globulosa* Chapman and Parr
*Anomalina globulosa* Chapman and Parr, 1937, p. 117.

*Astrononion gallowayi* Loeblich and Tappan
*Astrononion gallowayi* Loeblich and Tappan, 1953, p. 90, pl. 17, figs. 4-7.

*Bolivina arctica* Herman
*Bolivina arctica* Herman, 1973, p. 140, pl. 1, figs. 1-7, text fig. 3.

*Bolivina decussata* Brady
*Bolivina decussata* Brady, 1881a, p. 58.

*Bolivina inflata* Heron-Allen and Earland
*Bolivina inflata* Heron-Allen and Earland, 1913; after: McLaughlin and Sen Gupta, 1994, pl. 2, fig. 3.

*Bolivina pseudoplictata* Heron-Allen and Earland
*Bolivina pseudoplictata* Heron-Allen and Earland, 1930, p. 81, pl. 3, figs. 36-40.

*Bolivina pygmaea* Brady
*Bolivina pygmaea* Brady, 1881b, p. 406.

*Bolivina subspinscens* Cushman
*Bolivina subspinscens* Cushman, 1922a, p. 48, pl. 7, fig. 5.

*Bolivinita truncatum* (Phleger)
*Loxostomum truncatum* Phleger, 1951, p. 17, pl. 7, figs. 15-19.

*Brizalina lowmani* (Phleger and Parker)
*Bolivina lowmani* Phleger and Parker, 1951, p. 13, pl. 6, figs. 20, 21.

*Brizalina pseudopunctata* (Höglund)
*Bolivina pseudopunctata* Höglund, 1947, p. 273, pl. 24, fig. 5, pl. 32, figs. 23,24.

*Brizalina spathulata* (Williamson)
*Textularia variabilis* Williamson var. *spathulata* Williamson, 1858, p. 76, pl. 6, figs. 164, 165.

*Brizalina subaenariensis* (Cushman)
*Bolivina subaenariensis* Cushman, 1922a, p. 46, pl. 7, fig. 6.

*Bulimina aculeata* d'Orbigny
*Bulimina aculeata* d'Orbigny, 1826, p. 269, no. 7.

*Bulimina alazaensis* Cushman
*Bulimina alazaensis* Cushman, 1927a, p. 161, pl. 25, fig. 4

*Bulimina exilis* Brady
*Bulimina elegans* d'Orbigny var. *exilis* Brady, 1884, p. 339, pl. 50, figs. 5, 6.

*Bulimina marginata* d'Orbigny
*Bulimina marginata* d'Orbigny, 1826, p. 269, pl. 12, figs. 10, 12.

*Bulimina striata* d'Orbigny
*Bulimina striata* d'Orbigny, 1826, p. 269.

*Buliminella elegantissima* (d'Orbigny)
*Bulimina elegantissima* d'Orbigny, 1839b, p. 51, pl. 7, figs. 13, 14.

*Cassidulina laevigata* d'Orbigny
*Cassidulina laevigata* d'Orbigny, 1826, p. 282, pl. 15, figs. 4, 5.

*Cassidulina reniforme* Norvang, 1945
*Cassidulina crassa* var. *reniforme* NORVANG, 1945, p. 41, text figs. 6c-h.

*Cassidulina subglobosa* Brady
*Cassidulina subglobosa* Brady, 1881a, p. 60.

*Cibicides lobatulus* (Walker and Jacob)
*Nautilus lobatulus* Walker and Jacob in Kanmacher, 1798, p. 642, pl. 14, fig. 36.

*Cibicides wuellerstorfi* (Schwager)
*Anomalina wuellerstorfi* Schwager, 1866, p. 258, pl. 7, figs. 105, 107.

*Cibicidoides mundulus* (Brady, Parker and Jones)
*Truncatulina mundula* Brady, Parker and Jones, 1890, p. 228.

*Cibicidoides robertsonianus* (Brady)
*Truncatulina robertsoniana* Brady, 1881a, p. 65.

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

*Eggerella bradyi* (Cushman)
*Verneuilina bradyi* Cushman, 1911, p. 54, pl. 6, fig. 4.

*Elphidium advenum* (Cushman)
*Polystominella advena* Cushman, 1922b, p. 56, pl. 9, figs. 11, 12.

*Elphidium crispum* (Linné)
*Nautilus crispus* Linné, 1758, p. 709.

*Elphidium discoidale* (d'Orbigny)
*Polystominella discoidalis* d'Orbigny, 1839a, p. 56, pl. 6, figs. 23, 24.

*Elphidium excavatum* (Terquem)
*Polystominella excavata* Terquem, 1876, p. 429.

*Elphidium galvestonense* Kornfeld
*Elphidium gunteri* Cole var. *galvestonensis* Kornfeld, 1931, p. 87, pl. 15, fig. 1.

*Elphidium gunteri* Cole
*Elphidium gunteri* Cole, 1931, p. 34, pl. 4, figs. 9, 10.

*Elphidium margaritaceum* Cushman
*Elphidium advenum* (Cushman) var. *margaritaceum* Cushman, 1930, p. 25, pl. 10, fig. 3.

*Elphidium poeyanum* (d'Orbigny)
*Polystomella poeyana* d'Orbigny, 1839a, p. 55, pl. 6, figs. 25, 26.

*Eoeponides pulchella* (Parker)
*Pninaella*? *pulchella* Parker, 1952, p. 420, pl. 6, figs. 18-20.

*Epistominella exigua* (Brady)
*Pulvinulina exigua* Brady, 1884, p. 696, pl. 103, figs. 13, 14.

*Epistominella takayanagii* Iwasa
*Epistominella takayanagii* Iwasa, 1955, p. 16, 17, text figs. 4a—c.

*Eponides tumidulus* (Brady)
*Truncatulina tumidula* Brady, 1884, p. 666, pl. 95, figs. 8a-d.

*Eponides weddellensis* Earland
*Eponides weddellensis* Earland, 1936, p. 57, pl. 1, figs. 65-67.

*Fursenkoina fusiformis* (Williamson)

*Bulimina pupoides* d'Orbigny var *fusiformis* Williamson, 1858, p. 64, pl. 5, figs. 129, 130.

*Fursenkoina pauciloculata* (Brady)
*Virgulina pauciloculata* Brady, 1884, p. 414, pl. 52, figs. 4, 5.

*Fursenkoina pontoni* (Cushman)
*Virgulina pontoni* Cushman, 1932, p. 17, pl. 3, fig. 7.

*Gavelinopsis lobatulus* (Parr)
*Discorbis lobatulus* Parr, 1950, p. 354.

*Gavelinopsis translucens* (Phleger and Parker)
"*Rotalia*" *translucens* Phleger and Parker, 1951, p. 24, pl. 12, figs, 11a, b, 12a, b.

*Glabratella wrightii* (Brady)
*Discorbina wrightii* Brady, 188 1b, p. 413, pl. 21, fig. 6.

*Globobulimina auriculata* (Bailey)
*Bulimina auriculata* Bailey, 1851, p. 12, pl. 1, figs. 25-27.

*Gyroidina orbicularis* d'Orbigny
*Gyroidina orbicularis* d'Orbigny, 1826, p. 278.

*Gyroidina polius* (Phleger and Parker)
*Eponides polius* Phleger and Parker, 1951, p. 11, figs. 1,2.

*Gyroidina soldanii* (d'Orbigny)
*Rotalia soldanii* d'Orbigny, 1826, p. 278, fig. 36.

*Haynesina orbiculare* (Brady)
*Nonionia orbiculare* Brady, 1881b, p. 415, pl. 21, fig. 5.

*Heronallenia crosbyi* McCulloch
*Heronallenia crosbyi* McCulloch, 1977; after: Loeblich and Tappan, 1988, p. 569, pl. 623, figs. 13-15.

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

*Hyalinea balthica* (Schröter)
*Nautilus balthicus* Schröter, 1783, p. 20, pl. 1, fig. 2.

*Islandiella teretis* (Tappan)
*Cassidulina teretis* Tappan, 1951, p. 7, pl. 1, figs. 30a-c.

*Karreriella bradyi* (Cushman)
*Gaudryina bradyi* Cushman, 1911, p. 67, fig. 107.

*Laticarinina halophora* (Stache)
*Robulina halophora* Stache, 1864, in Finlay, 1940, p. 467-468.

*Laticarinina pauperata* (Parker and Jones)
*Pulvinulina repanda* var. *menardii* subvar. *pauperata* Parker and Jones, 1865, p. 395, pl. 16, figs. 50, 51.

*Nonion auriculata* (Heron-Allen and Earland)
*Nonionella auriculata* Heron-Allen and Earland, 1930, p. 192, pl. 5, figs. 68-70.

*Nonion barleeanum* (Williamson)
*Nonionina barleena* Williamson, 1858, p. 32, pl. 4, figs. 68, 69.

*Nonionella atlantica* Cushman
*Nonionella atlantica* Cushman, 1947, p. 90, pl. 20, figs. 4, 5.

*Nonionella turigida* (Williamson)
*Rotalina turigida* Williamson, 1858, p. 50, pl. 4, figs. 95-97.

*Nuttallides umbonifera* (Cushman)
*Pulvinulinella umbonifera* Cushman, 1933, p. 90, pl. 9, figs. 9a-c.

*Opthalmidium pusillum* (Earland)
*Spiroloculina pusilla* Earland, 1934, p. 47.

*Oridorsalis umbonatus* (Reuss)
*Rotalina umbonata* Reuss, 1851, p. 75, pl. 5, figs. 35a-c.

*Patellina corrugata* Williamson
*Patellina corrugata* Williamson, 1858, p. 46, pl. 3, figs. 86-89.

*Planorbulina mediterreansis* d'Orbigny

*Planorbulina mediterranensis* d'Orbigny, 1826, p. 280, pl. 14, figs. 4-6.

*Planulina ariminensis* d'Orbigny
*Planulina ariminensis* d'Orbigny, 1826, p. 280, pl. 14, figs. 1-3.

*Psammosphaera fusca* Schulze
*Psammosphaera fusca* Schulze, 1875, p. 111, pl. 2, fig. 8.

*Pseudopolymorphina novangliae* (Cushman)
*Polymorphina lactea* (Walker and Jacob) var. *novangliae* Cushman, 1923, p. 146, pl. 39, figs. 6-8.

*Pullenia bulloides* (d'Orbigny)
*Nonionina bulloides* d'Orbigny, 1826, p. 293.

*Pullenia subcarinata* (d'Orbigny)
*Nonionina subcarinata* d'Orbigny, 1839b, p. 28, pl. 5, figs. 23, 24.

*Pyrgo murrhyna* (Schwager)
*Biloculina murrhyna* Schwager, 1866, p. 203, pl. 4, figs. 15a-c.

*Pyrgo williamsoni* (Silvestri)
*Biloculina williamsoni* Silvestri, 1923, p. 73.

*Quinqueloculina agglutinans* d'Orbigny
*Quinqueloculina agglutinans* d'Orbigny, 1839b, p. 168, pl. 12, figs. 11-13.

*Quinqueloculina seminulum* (Linné)
*Serpula seminulum* Linné, 1758, p. 786.

*Quinqueloculina stalkeri* Loeblich and Tappan
*Quinqueloculina stalkeri* Loeblich and Tappan, 1953, p. 40, pl. 5, figs. 5-9.

*Reophax, nodulosus* Brady
*Reophax nodulosus* Brady, 1879, p. 52, pl. 4, figs. 7, 8.

*Rosalina columbiensis* (Cushman)
*Discorbis columbiensis* Cushman, 1925, p. 43, pl. 6, fig. 13.

*Rosalina floridana* (Cushman)
*Discorbis floridana* Cushman, 1922b, p. 39, pl. 5, figs. 11, 12.

*Sigmoilina tenuis* (Czjzek)
*Quinqueloculina tenuis* Czjzek, 1848, p. 149, pl. 13, figs. 31-34.

*Sigmoilopsis schlumbergeri* (Silvestri)
*Sigmoilina schlumbergeri* Silvestri, 1904, p. 267, 269.

*Siphotextularia rolshauseni* Phleger and Parker
*Siphotextularia rolshauseni* Phleger and Parker, 1951, p. 4, pl. 1, figs, 23, 24a, b.

*Sphaeroidina bulloides* d'Orbigny
*Sphaeroidina bulloides* d'Orbigny, 1826, p. 267, no. 1.

*Stetsonia arctica* (Green)
*Epistominella arctica* Green, 1960, p. 71, pl. 1, figs. 4a, b.

*Stilostomella antillea* (Cushman)
*Nodosaria antillea* Cushman, 1923, p. 91.

*Stilostomella bradyi* (Cushman)
*Nodogenerina bradyi* Cushman, 1927b, p. 79.

*Textularia conica* d'Orbigny
*Textularia conica* d'Orbigny, 1839b, p. 135, pl. 1, figs. 19, 20.

*Tosaia hanzawai* Takayanagi
*Tosaia hanzawai* Takayanagi, 1953, p. 30, pl. 40, fig. 7.

*Trifarina angulosa* (Williamson)
*Uvigerina angulosa* Williamson, 1858, p. 67.

*Trifarina fluens* (Todd)
*Anglogerina fluens* Todd in Cushman and Todd, 1947, p. 67, pl. 16, figs. 6, 7.

*Triloculina tricarinata* d'Orbigny
*Triloculina tricarinata* d'Orbigny, 1826, p. 299, no. 7, mod. no. 94.

*Uvigerina auberiana* d'Orbigny
*Uvigerina auberiana* d'Orbigny, 1839a, p. 106, pl. 2, figs. 23, 24.

*Uvigerina peregrina* Cushman
*Uvigerina peregrina* Cushman, 1923, p. 166, pl. 42, figs. 7-10.

*Valvulinera arctica* Green
*Valvulinera arctica* Green, 1960, p. 77, pl. 1, figs. 3a-c.

*Valvulinera laevigata* Phleger and Parker
*Valvulinera laevigata* Phleger and Parker, 1951, p. 28, pl. 13, figs. 11. 12.

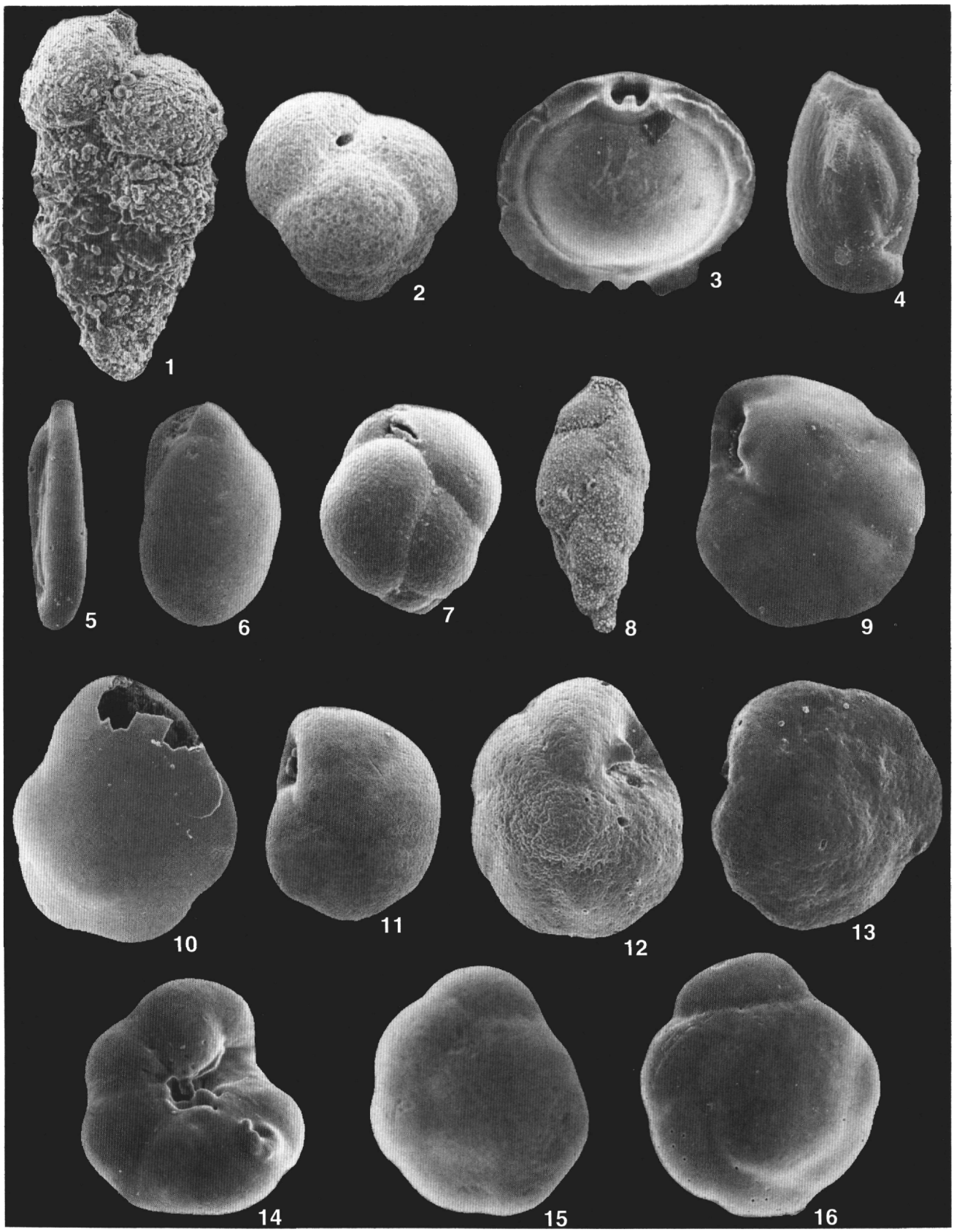


Plate 1. Benthic foraminifers common in hemipelagic deposits. **1.** *Siphotextularia rolshauseni* ×148. **2.** *Eggerella bradyi* ×72. **3.** *Pyrgo murryhina* ×59. **4.** *Quinqueloculina seminulum* ×138. **5.** *Quinqueloculina stalkeri* ×123. **6.** *Cassidulinoides* sp. ×126. **7.** *Tosaia hanzawai* ×240. **8.** *Hopkinsina* sp. ×221. **9.** *Epistominella exigua* ×137. **10.** *Epistominella exigua* ×182. **11.** *Epistominella takayanagii* ×239. **12.** *Nuttallides umbonifera* ×153.**13.** *Nuttallides umbonifera* ×116. **14.** *Eponides tumidulus* ×223. **15.** *Eponides tumidulus* ×262. **16.** *Eponides weddellensis* ×286.

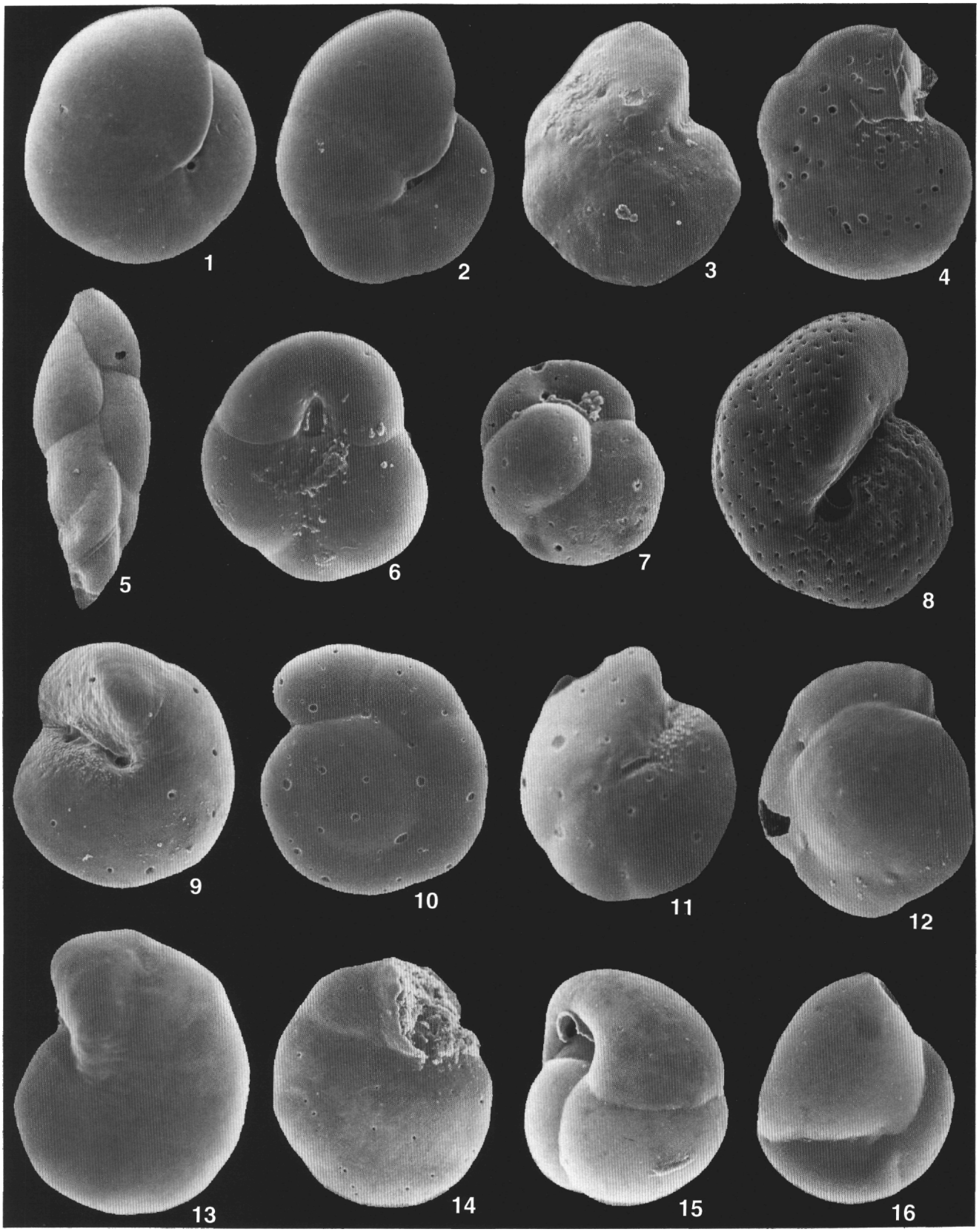


Plate 2. Benthic foraminifers common in hemipelagic/pelagic deposits. **1.** *Pullenia bulloides* ×137. **2.** *Pullenia subcarinata* ×130. **3.** *Cibicides wuellerstorfi* ×172. **4.** *Cibicides wuellerstorfi* ×125. **5.** *Fursenkoina fusiformis* ×162. **6.** *Cassidulina subglobosa* ×189. **7.** *Cassidulina reniforme* ×242. **8.** *Nonion barleeanum* ×71. **9.** *Gyroidina soldani ×99.* **10.** *Gyroidina soldani ×123.* **11.** *Oridorsalis umbonatus* ×156. **12.** *Oridorsalis umbonatus* ×148. **13.** *Anomalinaglobulosa ×336.* **14.** *Anomalina globulosa* ×262. **15.** *Stetsonia arctica* ×239. **16.** *Stetsonia arctica* ×258.

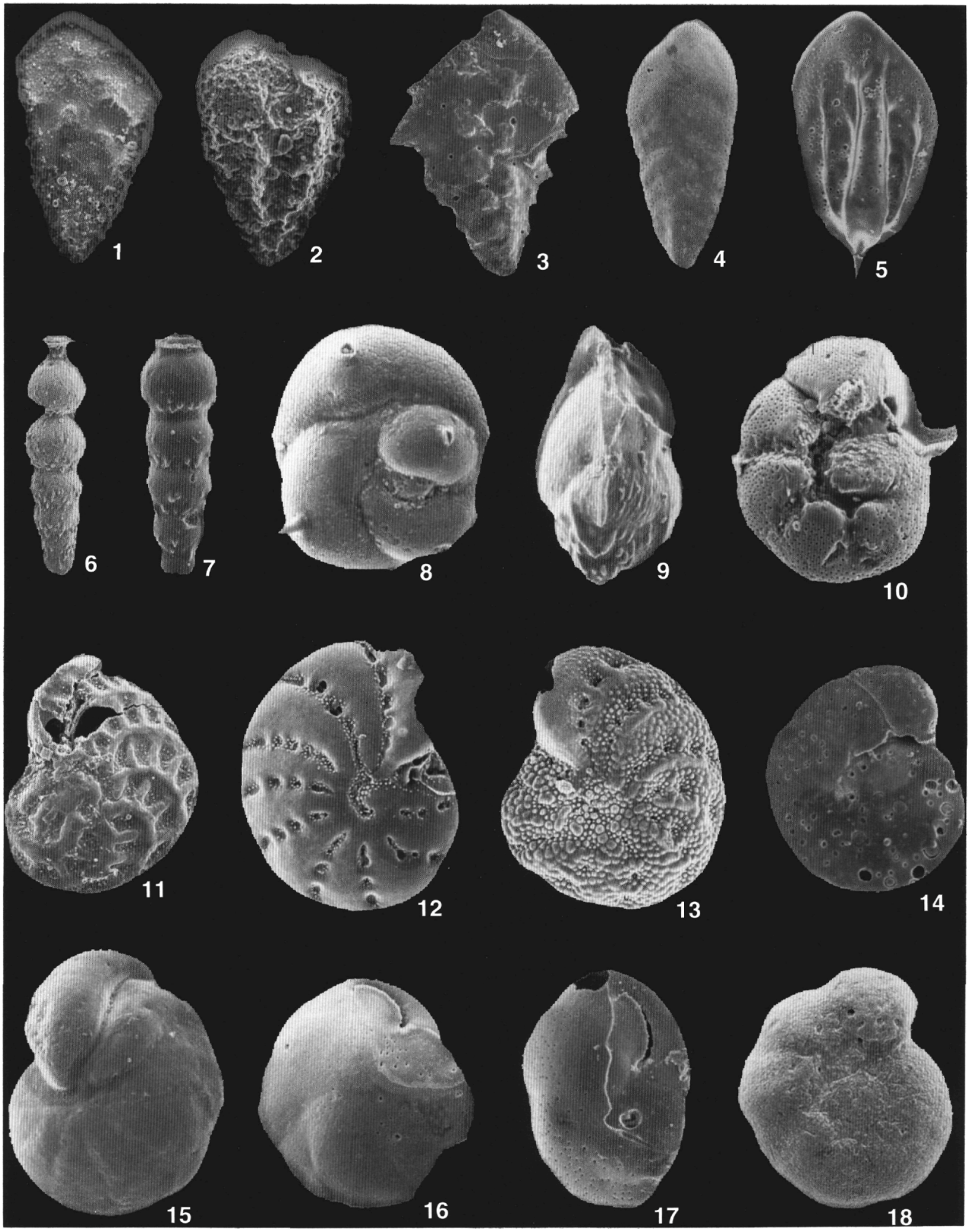


Plate 3. Benthic foraminifers common in turbidite deposits. **1.** *Bolivinita truncatum* ×225. **2.** *Bolivina pseudoplictata* ×193. **3.** *Bolivina pygmae* ×143. **4.** *Brizalina spathulata* ×94. **5.** *Brizalina subaenariensis* ×130. **6.** *Stilostominella antillea* ×96. **7.** *Stilostominella bradyi* × *25.* **8.** *Glabratella arctica* ×333. **9.** *Trifarina fluens* ×161. **10.** *Ammonia beccarii* ×262. **11.** *Elphidium crispum* ×104. **12.** *Elphidium excavatum* ×171. **13.** *Elphidium margaritaceum* ×166. **14.** *Cibicides lobatulus* × 116. **15.** *Cibicides lobatulus* ×87. **16.** *Cassidulina laevigata* ×145. **17.** *Cassidulina laevigata* ×132. **18.** *Cibicidoides robertsoniansis* × 113.