24. LATE PALEOGENE AND EARLY NEOGENE FORAMINIFERS OF DEEP SEA DRILLING PROJECT SITE 270, ROSS SEA, ANTARCTICA[1]

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ABSTRACT

Foraminifers from the upper Oligocene, lower Miocene, and Pleistocene at Site 270 in the southern Ross Sea, Antarctica, are discussed and illustrated. The total fauna comprises 74 genera and 163 species. A small number of taxa are recycled from Cretaceous and older Paleogene sediments. Four assemblage zones are proposed, the age of informal lithologic units discussed, and potentially important hiatuses identified. Microfaunas reflect a mixing of biogeographic affinities with one element exhibiting similarities to temperate late Paleogene assemblages in New Zealand, and another representing the early cold-water assemblages of the antarctic Neogene.

INTRODUCTION

Rich foraminiferal faunas have long been known from the Quaternary of the Ross Sea and other parts of Antarctica (Chapman, 1916; Heron-Allen and Earland, 1922; McKnight, 1962; Pflum, 1966; Kennett, 1968; Fillon, 1974; Anderson, 1975; Osterman and Kellogg, 1979; and Ward, 1979). Studies of Tertiary microfaunas have been hampered by lack of exposures on land and paucity of stratigraphic drill holes in the Ross Sea and coastal areas near the Transantarctic Mountains. However, in the last decade, drill cores provided by such projects as the Deep Sea Drilling Project (Leg 28), Dry Valley Drilling Project, Ross Ice Shelf Project, and the McMurdo Sound Sediment and Tectonic Studies have facilitated the study of late Neogene (D'Agostino, 1980; Webb and Wrenn, 1982) and Paleogene foraminifers (Webb, 1982a, b; Webb et al., 1982, in press). Microfaunas from very limited land outcrops of upper Neogene sediments have also been investigated (Webb, 1972, 1974; Webb et al., 1984). Only at Site 270 has the upper Paleogene and lower Neogene transition been recovered. This time interval is particularly significant in that it marks the intensification of cooling in the Ross Sea (Leckie and Webb, 1983). The present study documents the faunas of this transition, from cosmopolitan and temperate Paleogene faunas to more restricted polar assemblages of the Neogene. Another important objective of this paper is to establish the foraminiferal biostratigraphy at Site 270 with an emphasis on the problems of southern high-latitude biostratigraphic control during the mid-Tertiary and lack of reliable correlation beyond Antarctica. A companion paper (Leckie and Webb, 1983) addresses our paleoenvironmental interpretations of the upper Oligocene–lower Miocene sedimentary sequence at Site 270.

LITHOSTRATIGRAPHIC FRAMEWORK

DSDP Site 270 is located in the south-central Ross Sea on the western flank of a broad sedimentary basin on the eastern Ross Sea continental shelf (Figs. 1, 2). The *Glomar Challenger* penetrated a total section of 422.5 m at Site 270. Details of the drilling operations and a coring summary are published in Volume 28 of the *Initial Reports* (Hayes, Frakes, et al., 1975).

A sedimentary succession of 412 m overlies a metasedimentary basement complex (marble and calc-silicate gneiss) that is tentatively correlated with the early Paleozoic Koettlitz Marble of the Transantarctic Mountains (Ford, 1975) (Fig. 2). The lowermost sedimentary unit, Unit 5, rests unconformably on the basement and is a subaerial breccia of supposed Tertiary age. Two thin, upper Oligocene shallow marine sandstones, a carbonaceous quartz sand (Unit 4), and a glauconitic greensand

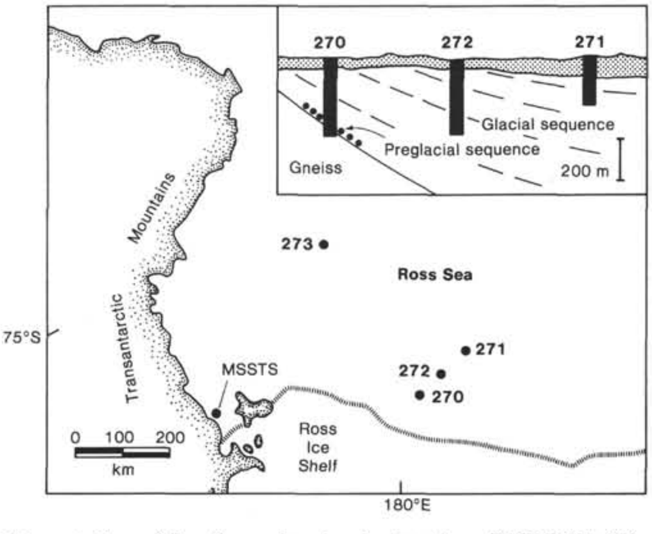

Figure 1. Map of Ross Sea region showing location of DSDP Site 270, adjacent DSDP holes, and drillhole MSSTS. Note suprajacent position of Site 272 relative to Site 270.

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[1] Kennett, J. P., von der Borch, C. C., et al., *Init. Repts. DSDP*, 90: Washington (U.S. Govt. Printing Office).

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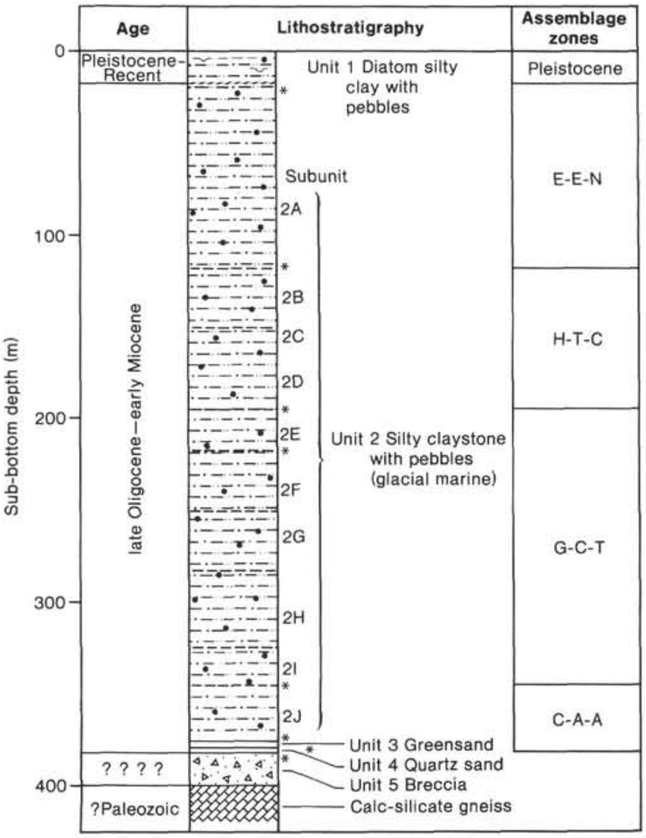

Figure 2. Stratigraphic column at Site 270, showing foraminiferal assemblage zones. Asterisks mark position of suspected diastems or minor hiatuses as discussed in text. See Figure 3 for assemblage zones.

(Unit 3) overlie this breccia. These sands may represent the thin marginal facies of an extensive late Mesozoic—early Cenozoic preglacial basin (Fig. 1). Above the sandstone units lie the thick (365 m) upper Oligocene–lower Miocene glaciomarine sediments of Unit 2, composed of silty claystones with granules and pebbles distributed throughout. Unit 2 is divided into 10 subunits, each delineated by subtle bedding features and clast abundance (Barrett, 1975). Unit 1, also of glaciomarine origin, caps the sequence at Site 270. A lower Miocene to Pliocene–Pleistocene angular unconformity separates Unit 2 from Unit 1 above.

Paleontologic, magnetostratigraphic, and radiometric dating has suggested that the late Oligocene–early Miocene marine phase of sedimentation at Site 270 spans a 9-m.y. interval, from 26 to 17 Ma (Allis and others, 1975; McDougall, 1977). According to Savage and Ciesielski's (1983) reinvestigation of diatom biostratigraphy at nearby suprajacent Site 272, the age of the uppermost Miocene sediments at Site 270 could be no younger than 19 Ma.

AGE OF UNITS FOUR THROUGH TWO AT SITE 270

Preliminary comments on the paleontology and biostratigraphy of Site 270 yielded a broad late Oligocene-early Miocene age for Units 4 through 2 (Hayes, Frakes et al., 1975). Burns (1975) noted small calcareous nannoplankton floras in Subunits 2C–2D and suggested an Oligocene or Miocene age. Ten samples from Unit 2 were recently examined for calcareous nannofossils by Marie-Pierre Aubry (WHOI). Samples from Subunits 2A, 2B, 2D, and 2F yielded low-diversity assemblages that concur with an early Miocene age for the upper part of Unit 2. A fairly diverse and well-preserved flora is recorded in Sample 270-18-2, 66–68 cm (Subunit 2B); it includes *Cyclococcolithus macintyrei, C. floridanus, Helicosphaera* cf. *H. carterii, Coccolithus pelagicus, Reticulofenestra* cf. *R. pseudoumbilica, Sphenolithus moriformis/neoabies, Umbilicosphaera* sp., *R. bisecta*, and *R. hesslandi*. The last two taxa are probably reworked from Paleogene deposits.

Webb (in Hayes, Frakes, et al., 1975, p. 227) assigned an Oligocene–early Miocene age to the diverse benthic foraminiferal taxa of Units 2, 3, and 4, citing their affinities with the New Zealand mid-Tertiary in the lower part of the succession but noting the development of a strong polar endemism in the middle and upper parts of Unit 2. Chen (1975) reported fragmented radiolarians in Unit 1 and Subunit 2B but these did not provide useful ages. McCollum (1975) noted Brunhes-age diatoms in Unit 1 and no diatoms in Units 2, 3, or 4. However, Subunits 2A, 2B, and 2C originally contained abundant diatoms, as is suggested by the persistent occurrence of cristobalite (Hayes, Frakes, et al., 1975, p. 216; Cook et al., 1975).

Kemp (1975) and Kemp and Barrett (1975) reported abundant wood fragments in the carbonaceous sandstone (Unit 4) and a sparse dinoflagellate cyst assemblage in the glauconitic sandstone (Unit 3). Unit 3 was assigned a "mid" to late Oligocene age based on the presence of *Selenopemphix nephroides*. This taxon also occurs in the lowermost sample of the overlying glaciomarine sequence (Subunit 2J). However, there may be a synonymous form, *Protoperidinium subinera*, which ranges into the Pleistocene and would render the biostratigraphic utility of "*S. nephroides*" tenuous (J. H. Wrenn, pers. comm., 1984).

Preglacial Units 4 and 3 contain no pollen or spores, but all samples from the glaciomarine strata contain these palynomorphs (Kemp, 1975; Kemp and Barrett, 1975). The basal Subunit 2J contains the richest assemblages. These assemblages are interpreted as *in situ* because there are no forms which are obviously recycled. The sparse assemblages of Subunits 2E and 2F (Cores 270-24, 270-25, and 270-29) contain Eocene–early Oligocene dinoflagellate cysts, suggesting that reworking is more common in the upper parts of the glaciomarine sequence of Unit 2 (Kemp, 1975; Kemp and Barrett, 1975). Most of the spore and pollen species are known to have relatively long stratigraphic ranges and therefore have limited biostratigraphic value. A mid-Tertiary age is, however, consistent with other dating techniques.

A potassium/argon date of 26.0 ± 0.5 Ma was determined from glauconite in the calcareous greensand of Unit 3, immediately beneath the basal glaciomarine sediments of Unit 2 (McDougall, 1977; Fig. 2). McDougall noted that glauconite commonly yields K-Ar ages that are too young, but he concluded that the 26 Ma age is probably a reliable minimum. Revised decay constants would put this age at about 26.7 Ma.

Allis et al. (1975) conducted a paleomagnetic study of the thick glaciomarine sequence of Unit 2. The reversal stratigraphy for 30 to 240 m sub-bottom compares closely with the early Miocene part of the Heirtzler et al. (1968) seafloor anomaly scale. This interval includes magnetic anomaly numbers 5C through the upper part of 6A of LaBrecque et al. (1977), which, according to a revised Neogene geochronology by Berggren et al. (in press), represents an absolute age of about 16 to 21 Ma (Fig. 5, later). This translates into an average sediment accumulation rate of about 42 m/m.y. for the upper 210 m of Unit 2. The linear relationship between the Site 270 reversal stratigraphy and the seafloor anomaly record implies that the sedimentation rate was constant (fig. 6 of Allis et al., 1975). Although Unit 2 is nearly homogeneous and composed mainly of poorly sorted silty claystone with granules and pebbles throughout, there are several distinct stratigraphic intervals with very different average clast densities: Subunit 2A = 13.7 pebbles/m; Subunits 2B–2E = 2.2 pebbles/m; Subunits 2F–2I = 14 pebbles/m; Subunit 2J = 3.2 pebbles/m (from fig. 9 of Barrett, 1975). These variations in clast abundance perhaps could be interpreted to indicate changes in intensity of ice-rafting and therefore presumably changes in sedimentation rate. Foraminiferal trends through Unit 2 also suggest changing rather than static paleoenvironmental conditions (Leckie and Webb, 1983). Barrett (1975) attributes the changes in pebble density to differences in size distribution caused by erosional processes. This remains an unresolved problem and therefore biases our confidence in the paleomagnetic record.

The interval from 240–370 m sub-bottom is entirely normally magnetized (Allis et al., 1975). Three reversals are present from 370–384 m but cannot be uniquely correlated to the Heirtzler et al. seafloor anomaly scale. Allis et al. (1975) attribute the long interval of normal magnetization to growth of authigenic minerals with unstable magnetization. If, however, a constant sedimentation rate of 42 m/m.y. is assumed for the lower 144 m of Unit 2, the extrapolated age of the base of the glacial sequence is about 24 to 25 Ma, which is in good agreement with the glauconite age of Unit 3. Are these results fortuitous or are they substantiating evidence of a reliable paleomagnetic record?

In lieu of high-resolution biostratigraphy at DSDP Site 270, we must assume that the age control provided by the paleomagnetic stratigraphy of Unit 2 and the 26 Ma K-Ar date of Unit 3 represents the best first approximation to the age of the glaciomarine sequence at Site 270. This latest Oligocene–early Miocene age is corroborated by benthic and planktonic foraminifers (discussed in a later section). Diatoms, foraminifers, palynomorphs, and microplankton appear to hold the greatest promise for future biostratigraphic refinement in the antarctic Cenozoic, although a reevaluation of calcareous nannofossil biostratigraphy at Site 270 may also prove valuable.

AGE OF THE LOWER GLACIOMARINE SECTION AT SITE 272

Savage and Ciesielski (1983) used diatoms and silicoflagellates in determining a date of 19.2 Ma (early Miocene) for the lower glaciomarine section of Site 272, located close to Site 270 and at a slightly higher stratigraphic level than Subunit 2A of Site 270 (Figs. 1, 2). The lower 296 m of Site 272 (Subunits 2B and 2C) contain rare diatoms indicative of the *Coscinodiscus rhombicus* Zone (18.34–19.23 Ma) and perhaps the lower *Nitzschia maleinterpretaria* Zone (18.19–18.34 Ma) according to Savage and Ciesielski (1983). At Site 272, the top of the *C. rhombicus* Zone is tentatively placed at the last occurrence of *Coscinodiscus* sp. 1 (of McCollum, 1975), a datum recognized by Weaver and Gombos (1981) in the original definition of this zone. Although *C. rhombicus* and *N. maleinterpretaria* were not recorded in the Site 272 sequence, the presence of the silicoflagellate *Mesocena apiculata* concurs with the *C. rhombicus* Zone assignment. Where originally defined at DSDP Site 266, the top of the *C. rhombicus* Zone (Section 266-18-1; Weaver and Gombos, 1981) is coincident with an overlap between the last occurrence of *Catapsydrax* spp. and the first appearance of *Globorotalia zealandica* (Kaneps, 1975). This suggests foraminiferal zones N6 or N7 (about 19.0 to 16.6 Ma, according to Berggren et al., in press). Nannofossil data from the same interval at Site 266 are in close agreement with the foraminifer age assignment (i.e., NN4 or 17.5 to 16.0 Ma) based on the last occurrence of *Sphenolithus belemnos* in Section 266-19-2 (top of NN3) and the first occurrence of *S. heteromorphus* in Core 266-17-1 (NN4–NN5; Burns, 1975). The last occurrence of the silicoflagellate *M. apiculata* is just above the top of the *C. rhombicus* Zone at Site 266 (Section 266-17-4; Ciesielski, 1975) and therefore may lend support to the reliability of the *Coscinodiscus* sp. 1 datum at Site 272. From this information we can infer that Subunits 2B and 2C of Site 272 are probably at least 16–17 Ma in age if *Coscinodiscus* sp. 1 and *M. apiculata* are indeed *in situ* and if our reassessment of the age of the upper *C. rhombicus* Zone applies to the antarctic region.

Savage and Ciesielski (1983) assume that the basal sediments of Site 272 (Subunit 2C) correspond with the *C. rhombicus* Zone although no age-diagnostic species were recorded. They note that the diatom assemblage of Subunit 2C is very similar to that of Subunit 2B and therefore assume an early Miocene age. However, the age-diagnostic species of Subunit 2B, *Coscinodiscus* sp. 1 and *M. apiculata*, may be useful in defining the top of the *C. rhombicus* Zone but not necessarily its base: *Coscinodiscus* sp. 1 has an unspecified first occurrence and *M. apiculata* first appears in the middle Eocene (Bukry, 1981). All we can say with reasonable confidence is that Subunits 2B and 2C of Site 272 (145 to 441 m sub-bottom) are probably older than about 16 Ma. Acoustic reflection profiles across Sites 270 and 272 indicate that there probably is only a slight stratigraphic overlap, if any, between the two sites (Hayes, Frakes, et al., 1975).

Indeed, Subunit 2C of Site 272 (365 to 441 m sub-bottom) bears strong resemblance to Subunits 2A through 2C of Site 270 (20 to 177 m sub-bottom), based on sedimentology, bulk x-ray mineralogy, and persistence of cristobalite (Hayes, Frakes, et al., 1975; Cook et al., 1975).

Conflicting age assignments apparently exist between the lower two-thirds of Site 272 and the top of Unit 2 at Site 270. Subunits 2B and 2C of Site 272 are probably older than about 16 Ma and represent a sedimentary section of nearly 300 m. If the top of Subunit 2B is 16 Ma, estimates of the basal age of Site 272 could range from about 23 Ma (based on a sedimentation rate of 42 m/m.y.) to 17 Ma (based on a rate of 275 m/m.y., proposed by Savage and Ciesielski, 1983). These figures do not agree with the paleomagnetic stratigraphy of Site 270, which puts the age of the top of Unit 2 at about 16 Ma (Allis et al., 1975). What do we believe? If we assume that the paleomagnetic record of Site 270 is indeed correct, what might account for the "old" age for Subunits 2B and 2C of Site 272? Perhaps there is more stratigraphic overlap between Sites 270 and 272 than interpreted from the reflection profiles. This is doubtful because there is no lithologic equivalent of Subunit 2B (of Site 272) at Site 270. Perhaps *Coscinodiscus* sp. 1 and *M. apiculata*, the siliceous species used by Savage and Ciesielski (1983) to define the early Miocene *C. rhombicus* Zone at Site 272, have different stratigraphic ranges in antarctic compared with subantarctic or temperate areas. This is a potential problem with other southern high-latitude siliceous microfossils and calcareous groups as well. Future drilling in the Antarctic is necessary in order to refine polar late Paleogene and Neogene microfossil zonations. At present, too few antarctic drill sites have penetrated strata below the upper Miocene, and as is often the case in Antarctica, incomplete sedimentary sequences, reworking and poor microfossil abundance or preservation have hindered our ability to establish high-resolution biostratigraphy. Recycling of microfaunas and floras could also be responsible for an older apparent age, particularly if the background species are all long-ranging. A case may be made for this interpretation at Site 272. The absence of age-diagnostic diatoms in Subunit 2C and strong lithologic similarity to the upper part of Unit 2 at Site 270 contrasts with Subunit 2B at Site 272, which contains only two "age-diagnostic" species in a lithology much different from any at Site 270. Perhaps there is an unconformity between diatom-rich Subunit 2B and diatom-poor, cristobalite-rich Subunit 2C at Site 272.

FORAMINIFERAL TRENDS AND ZONATION AT SITE 270

Foraminifers were found to be moderately abundant in the thin preglacial strata (Unit 4), the thick glaciomarine succession of Unit 2, and the overlying and much younger Unit 1 (Fig. 2; Leckie and Webb, 1980, 1983). One hundred and ten samples from Units 2 and 4 were examined for foraminifers (Table 1). Twenty-six samples containing the greatest number of specimens were used to delineate four late Oligocene–early Miocene assemblage zones (Leckie and Webb, 1980; 1983) (Fig. 3). Throughout Unit 2 there are numerous intervals that contain deformed soft-sediment clasts suggesting bottom-current scour or slump of semilithified claystone. Twenty-five of the 26 representative samples, however, are not from such intervals and therefore may contain truly autochthonous faunas. Assemblage zones are based on generic abundance, species diversity, and the composition of individual assemblages (Fig. 3; Leckie and Webb, 1983, fig. 4).

Cyclammina-Ammoscalaria-Anomalinoides Assemblage Zone

Definition. The C-A-A Assemblage Zone is 36 m thick. The base of the zone is placed at the lithologic contact between Unit 4 and the sedimentary breccia of Unit 5, 388 m sub-bottom (1022 m below present sea level). The top of the zone is coincident with the sharp lithologic contact between Subunits 2J and 2I, at 352 m sub-bottom (986 m below sea level) (Fig. 2).

Faunal content. The C-A-A Assemblage Zone contains 44 genera and 77 species (Table 1). Distribution of genera is 18 agglutinated, 24 calcareous benthic, and 2 planktonic; of species is 32 agglutinated, 43 calcareous benthic, and 2 planktonic. Sixty percent of C-A-A taxa range into the suprajacent G-C-T Assemblage Zone. The proportion of calcareous benthic to agglutinated species increases from the lower to higher levels of the zone. Planktonic taxa occur in the uppermost part of the C-A-A Assemblage Zone (Samples 270-39-6, 24–36 cm and 270-40-3, 123–131 cm).

Species of *Cyclammina, Anomalinoides*, and *Ammoscalaria pseudospiralis* are prominent taxa throughout the C-A-A Assemblage Zone (Figs. 3, 4). Unit 4 contains only 11 species. Most are large specimens. The four agglutinated species dominate the assemblage in Section 270-44-1 (Table 1). Large specimens of *Globobulimina* sp. are also common in this fauna. Although all 11 species in Unit 4 are also present in the more diverse faunas of Subunit 2J, the presence of hiatuses between Units 4, 3, and 2J (Leckie and Webb, 1983, fig. 2) might require further subdivision of the C-A-A Assemblage Zone. The upper part is characterized by much more diverse assemblages of calcareous benthic taxa, including species of *Astacolus, Lenticulina, Dentalina, Nodosaria*, and the small and delicate *Fissurina, Oolina*, and *Parafissurina* (Table 1). Planktonic foraminifers appear in the uppermost strata of the C-A-A Assemblage Zone (Subunit 2J), *Candeina antarctica* in Sample 270-40-3, 123–131 cm, and *Globorotalia* cf. *G. siakensis* in Sample 270-39-6, 24–26 cm.

Globocassidulina-Cassidulinoides-Trochoelphidiella Assemblage Zone

Definition. The G-C-T Assemblage Zone encompasses Subunits 2I through 2E, a stratigraphic thickness of 156 m. The base is marked by the sharp paraconformable contact between Subunits 2J and 2I at 352 m sub-bottom (986 m below sea level). The top of the G-C-T Assemblage Zone is arbitrarily placed between Subunits 2E and 2D by foraminiferal and sedimentary characteristics. The contact between these two subunits was not recovered. The top of the zone corresponds to 196 m sub-bottom or 830 m below present sea level (Fig. 2).

Faunal Content. The G-C-T Assemblage Zone contains 50 genera and 77 species (Table 1). Distribution of genera is 11 agglutinated, 34 calcareous benthic, and 6 planktonic; of species is 11 agglutinated, 70 calcareous benthic, and 6 planktonic. About 53% of these species also occur in the underlying *Cyclammina-Ammoscalaria-Anomalinoides* Assemblage Zone and 52% continue into the succeeding *Haplophragmoides-Trifarina-Cibicides* Assemblage Zone.

Globocassidulina subglobosa is the most common and persistent calcareous benthic in the G-C-T Assemblage Zone (Figs. 3, 4). *Cassidulinoides* is also a characteristic genus, being represented by *C. bradyi, C. braziliensis*, and *C. parkerianus*. These taxa disappear just below the G-C-T/H-T-C Assemblage Zone boundary. Another key taxon of the G-C-T Assemblage Zone is *Trochoelphidiella*, the genotype of which occurs in the Pliocene Pecten gravels of Wright Valley (Webb, 1974). The earliest known species of this genus, *T. pustulosa* n. sp. appears near the base of the G-C-T Assemblage Zone (Subunit 2I) in Sample 270-38-3, 86–93 cm. A second species, *T. uniforamina* D'Agostino n. sp. appears slightly higher in the succession, in Sample 270-35-3, 112–121 cm (Subunit 2H). Several variants of these species are also present in the G-C-T Assemblage Zone. Both *T. pustulosa* and *T. uniforamina* continue up into the H-T-C Assemblage Zone and the latter species is also found in the E-E-N Assemblage Zone and the Miocene of Site 273 (D'Agostino, 1980). *Trochoelphidiella* appears to be endemic to Antarctica and provides a potentially useful lineage. Other members of the Elphididae are also persistent throughout the G-C-T Assemblage Zone. The first appearance of *Elphidium magellanicum* s.l. in Sample 270-38,CC (Subunit 2I) just above the C-A-A/G-C-T Assemblage Zone boundary may also provide a useful regional biostratigraphic datum.

The planktonic *Candeina antarctica* has a first appearance near the top of the C-A-A Assemblage Zone and occurs persistently throughout the G-C-T Assemblage Zone. Other occurrences of planktonic species are confined to single or a few specimens. These include *Chiloguembelina cubensis, Globorotalia* cf. *G. gemma, Globigerina* cf. *G. ouachitaensis, Globigerinita* cf. *G. glutinata*, and *Globigerinoides trilobus*. These will be discussed below.

A wide diversity exists among the small and fragile taxa such as *Fissurina, Oolina*, and *Parafissurina*. Although the G-C-T Assemblage Zone exhibits the highest diversity among the five assemblage zones, the occurrence of individual species is sporadic (Table 1). In Figure 3 it is apparent that species diversity declines steadily towards the top of the G-C-T Assemblage Zone. Low-diversity agglutinated fauna occur in the basal and uppermost G-C-T Assemblage Zone sediments (Subunits 2I and 2E, respectively).

Haplophragmoides–Trifarina–Cibicides Assemblage Zone

Definition. The H-T-C Assemblage Zone embraces Subunits 2D through 2B, a stratigraphic thickness of 75 m (Fig. 2). The base of the zone is placed between Subunits 2E and 2D, 196 m sub-bottom (830 m below present sea level). The top of the H-T-C Assemblage Zone is placed at the lithologic boundary between Subunit 2B and the thick, unstratified glaciomarine sediments of Subunit 2A (121 m sub-bottom, 755 m below sea level; Fig. 2).

Faunal content. The H-T-C Assemblage Zone contains 47 genera and 84 species (Table 1). Distribution of genera is 16 agglutinated, 28 calcareous benthic, and 3 planktonic; of species is 24 agglutinated, 57 calcareous benthic, and 3 planktonic. Of the H-T-C Assemblage Zone taxa, 55% are common to the underlying G-C-T Assemblage Zone whereas only 25% continue up into Zone E-E-N.

The agglutinated fauna of the H-T-C Assemblage Zone differs markedly from the faunas rich in agglutinated species in the lower part of the C-A-A Assemblage Zone (Figs. 3, 4). The conspicuous occurrence of *Haplophragmoides* sp. in the H-T-C Assemblage Zone may be used to distinguish the two assemblages. *Ammoscalaria pseudospiralis* is present in the C-A-A Assemblage Zone but absent in the H-T-C Assemblage Zone. *Cyclammina incisa* remains a common member of the H-T-C assemblages. Calcareous benthics are also an important element in this zone. Although *Trifarina fueguina* ranges through all zones it is particularly common here. Species of *Cibicides*, long-ranging in most cases, are also represented in high numbers. Of the H-T-C calcareous benthics, 64% are also common to the G-C-T Assemblage Zone. As noted above, species of *Globocassidulina* and *Cassidulinoides* disappear below the G-T-C/H-T-C Assemblage Zone boundary. The influx of new agglutinated taxa in the H-T-C Assemblage Zone and loss of certain calcareous taxa in the uppermost G-C-T Assemblage Zone may signify the presence of an hiatus. The most diverse assemblage encountered in this study is present in Sample 270-19-5, 113–122 cm (Subunit 2C), near the middle of the zone.

Epistominella–Elphidium–Nonionella Assemblage Zone

Definition. The E-E-N Assemblage Zone is represented by the 101-m-thick succession of unstratified glaciomarine sediments of Subunit 2A (Fig. 2). This is the youngest Neogene assemblage zone documented at Site 270. It is bounded at its base by what has been described as a gradational contact with Subunit 2B at 121 m sub-bottom (755 m below present sea level) and at its top by a major disconformity which separates lower Miocene Subunit 2A from Pleistocene Subunit 1B at 20 m sub-bottom, or 654 m below present sea level.

Faunal content. The E-E-N Assemblage Zone contains 19 genera and 29 species (Table 1), a sharp drop from the much more diverse assemblages of the underlying zone (Fig. 2; Leckie and Webb, 1983, fig. 4). Distribution of genera is 0 agglutinated, 18 calcareous benthic, and 1 planktonic; of species is 0 agglutinated, 28 calcareous benthic, 1 planktonic. Of these species, 72% are found in the H-T-C Assemblage Zone while 86% are present in the three underlying zones.

The most obvious aspect of the E-E-N Assemblage Zone is the very low diversity and absence of agglutinated taxa (Figs. 3, 4). The few taxa present in significant

Table 1. Distribution of foraminifers at Site 270.

Lithologic unit	Core-Section (interval in cm)	*Ammodiscus* cf. *A. glabratus*	*Ammobaculites* cf. *A. coprolithiformis*	*Ammoscalaria pseudospiralis*	*Cyclammina incisa*	*Parafissurina groenlandica*	*Parafissurina lateralis*	*Elphidium* sp.	*Gyroidina zelandica*	*Anomalinoides globulosa*	*Melonis barleeanus*	*Globobulimina* sp.	*Cyclammina* cf. *C. complanata*	*Hyperammina cylindrica*	*Rhizammina algaeformis*	*Trifarina* aff. *T. fueguina*	*Cibicides lobatulus*	*Cibicides temperata* s.l.	*Pullenia subcarinata*	*Astacolus crepidulus*	*Cassidulinoides bradyi*	*Epistominella vitrea*	*Nonionella magnalingua*	*Melonis affinis*	*Oolina apiculata*	*Elphidium* cf. *E. nitidum*	*Cyclammina rotundata*	*Pullenia bulloides*	?*Bathysiphon* sp. 1	*Haplophragmoides* sp.	?*Gaudryina* spp.	*Fissurina laevigata*	*Globocassidulina subglobosa*	*Anomalinoides* cf. *A. macraglabra*	*Cibicides pseudoungerianus*	*Bathysiphon* aff. *B. cylindrica*
1	1-2, 52-54																																			
	1,CC																																x			
	2,CC																					x														
	3-1, 123-125																																			
	3,CC																x					x											x			
2A	4,CC																																			
	5-2, 122-132																																			
	6-1, 113-123																																			
	6-2, 123-126																																			
	7-3, 135-150																																			
	8-3, 113-128								x		x						?					x														
	9-3, 134-142																																			
	9,CC																		x		x	x		x											x	
	10-2, 110-120																																			
	10,CC																?		x			x											?			
	11-2, 112-122																	x																	x	
	12-1 (top of section)																					x		x											?	
	12-4, 123-134																																			
	13-3, 114-125										x						x	x				x		x											x	
	13,CC																	x	x			x		x												
	14-3										x						x		x			x														
	14,CC																x	x				x		x												
	15-1 (top of section)																																			
2B	15-3, 50-57				x													x	x			x							x	x						
	15-3, 97-110		x		x							x		x		x		x				x						x	x						x	x
	15,CC										x					x		x										x							x	
	16-4, 123-135																													x						
	17-5, 130-140				x							x				x	x	x	x											x						
	17,CC		?		?						x	x		x		x		x										x	x	x						
2C	18-5, 129-139	x			x																															
	19-5, 113-122		x			x	x		x	x	x	x				x		x	x					x				x				?			x	
	20-6, 85-95	x			x					x	x			x		x		x											x	x						x
2D	21-5, 102-112	x			x											x		x				x		x												
	22-6, 135-145	x																x	x			x			x											
2E	23-4, 72-82				x												x				x	x											x			
	24-3, 110-120																					x		x	?								x			
	24,CC																					x											x			
2F	25-2, 50-60	x			x						x							x				x		x	x								x		x	
	26-4, 100-114								x												x												x			
	26,CC																	x			x												x			
	27-4, 108-118															x				x	x	x											x		x	
	28-3, 54-56																																			
	28-6 (bottom of section)										x					x		x	x		x	x		x									x			
	28,CC				?																x	x											x			
	29-1, 3-5																																			
	29-1, 21-23																																			
	29-2, 52-54																																			
	29-3, 50-52																																			
	29-4, 48-50																																			
2G	29-6, 8-18								x		x							x			x	x		x								x	x		x	
	29-6, 50-52																																			
	30-2, 50-52																																			
	30-4, 24-35										x											x											x			
	31-3, 59-67																				x	x		x	x								x		x	
	31-5, 58-60																																			

Note: Most samples are too poor in foraminifers to yield realistic abundance data. Relative abundance data for 27 of the richest samples are presented in Figure 4. Note that the samples representing 2-3 cm intervals are very poor in foraminifers. Species from *Ceratobulimina* to *Uvigerina* sp. not present in Samples 270-31,CC to 270-44-2, 5-7 cm.

Table 1. (Continued).

Reophax sp. 2	*Rosalina globularis*	*Fissurina marginata*	*Cassidulinoides braziliensis*	*Lagena striata*	*Nodosaria calomorpha*	*Anomalinoides pinguiglabra*	*Bathysiphon discreta*	*Textularia* cf. *T. plummerae*	*Karreriella obscura*	*Nodosaria* sp. 3	*Fissurina bisulcata*	*Sphaeroidina bulloides*	*Fissurina agassizi*	*Astrorhiza* cf. *A. granulosa*	*Protobotellina cylindrica*	*Hormosina globulifera*	*Reophax scorpiurus*	*Ammobaculites* cf. *A. expansus*	*Textularia* sp. 2	*Psammosphaera fusca*	*Bathysiphon* cf. *B. alba*	*Rhabdammina* cf. *R. abyssorum*	*Oolina apiopleura*	*Oolina globosa*	?*Bathysiphon* sp. 2	*Marsipella* sp.	*Reophax* sp. 1	*Ammodiscus* cf. *A. incertus*	*Dentalina* cf. *D. advena*	*Lenticulina lenticula*	*Gyroidina* cf. *G. obicularis*	*Reophax* cf. *R. nodulosus*	*Eponides* cf. *E. weddellensis*	*Fursenkoina schriebersiana*	*Nonionella iridea*	*Fissurina lucida*	*Lagena laevis*	*Candeina antarctica*	*Globorotalia* cf. *G. siakensis*	*Textularia* sp. 1	*Fissurina annectens*	*Fissurina* sp. 4	*Oridorsalis tenera*	*Elphidium magellanicum* s.l.
																																												x
																																			?									
																																			x									
																																			x									
	x																																		x									x
																																			x									x
																								x																				
	x																																											x
																																			x									x
																																			x									x
	x										x																								x			x						x
																								x											x									x
	x																																					x						x
												x																							x									x
																																												x
x																		x		x															x									x
x																	x	x		x			x	x			x				x	x					x							x
																																			x	x		x						x
																													x															x
																																						x						x
	x						x										x	x								x											x							x
				x																				x																				x
	x	x									x	x	x	x			x	x					x	x							x													x
x																	x																		?			x						
				x							x	x			x								x										x					x			x			
	x																						x												x			x						x
	x		x																																			?						
	x		x									x																										x				x		x
			x																					x														x						
																																												x
	x		x																															x			x			x			x
	x			?																		x												x		x					x		x
			x																																									x
																																												x
			x																																			x			?			x
	x																																					x			x			x
	?					x																																					x

Table 1. (Continued).

Lithologic unit	Core-Section (interval in cm)	*Articulina* sp.	*Pyrgo* cf. *P. vespertilio*	*Quinqueloculina seminula*	*Trochoelphidiella pustulosa* n.sp.	*Quinqueloculina triangularis*	*Trochoelphidiella* sp.	*Jaculella* cf. *J. acuta*	*Vaginulina* cf. *V. rheophagica*	*Cassidulinoides* cf. *C. parkerianus*	*Globigerinita* cf. *G. glutinata*	*Gyroidina parva*	*Cibicides* cf. *C. mediocris*	*Nonionella bradii*	*Trochoelphidiella uniforamina*	*Saracenaria kellumi*	*Saracenaria* sp.	*Fissurina* sp. 3	*Triloculina rotundata*	*Chiloguembelina cubensis*	*Globigerina* cf. *G. ouachitaensis*	*Cassidulinoides* cf. *C. chapmani*	*Lagena* cf. *L. laevigata*	*Nodosaria* sp. 2	?*Astacolus* sp.	*Flintina* cf. *F. droogeri*	*Parafissurina subcarinata*	*Eponides bradyi*	*Uvigerina* cf. *U. miozea*	*Globigerinoides trilobus*	*Globocassidulina crassa*	*Parafissurina curta*	*Globorotalia* cf. *G. gemma*	*Globorotaloides* cf. *G. suteri*	*Lenticulina* cf. *L. punctata*	*Robertina tasmanica*
1	1-2, 52-54																														x					
	1,CC																																			
	2,CC																																			
	3-1, 123-125																																			
	3,CC										x																									
2A	4,CC																																			
	5-2, 122-132														x																					
	6-1, 113-123						x																													
	6-2, 123-126																																			
	7-3, 135-150																																			
	8-3, 113-128						x			x				x													x									
	9-3, 134-142																																			
	9,CC																																			
	10-2, 110-120																																			
	10,CC											?																								
	11-2, 112-122																																			
	12-1 (top of section)																																			
	12-4, 123-134																																			
	13-3, 114-125											?																								
	13,CC													x																						
	14-3																																			
	14,CC			x																																
	15-1 (top of section)																																			
2B	15-3, 50-57																																			
	15-3, 97-110		x					x					x										x													
	15,CC														x																					
	16-4, 123-135																																			
	17-5, 130-140				x																															
	17,CC							x																				x								
2C	18-5, 129-139																																			
	19-5, 113-122													x													?	x				x				
	20-6, 85-95												?					x																		
2D	21-5, 102-112																																			
	22-6, 135-145			x																																
2E	23-4, 72-82			x		x				x																										x
	24-3, 110-120														x	x																			x	
	24,CC																																x	x		
2F	25-2, 50-60					x												x	x																	
	26-4, 100-114																								x											
	26,CC									?																										
	27-4, 108-118				x	x						x							x																	
	28-3, 54-56																																			
	28-6 (bottom of section)				x										x																x	x				
	28,CC				x										?														x	x						
	29-1, 3-5																																			
	29-1, 21-23																																			
	29-2, 52-54																																			
	29-3, 50-52																																			
	29-4, 48-50																																			
2G	29-6, 8-18				x		x					x											x				x									
	29-6, 50-52																																			
	30-2, 50-52																											x								
	30-4, 24-35		x		x																		x				x									
	31-3, 59-67				x																					x										
	31-5, 58-60																								x											

Table 1. (Continued).

Ceratobulimina spp.	*Lagena gracilis*	*Cancris laevinflatus*	*Rhabdammina linearis*	*Reophax* cf. *R. cushmani*	*Arenodosaria antipoda*	*Cibicides* cf. *C. thiara*	*Gaudryina reussi*	*Marginulina tumida*	*Lagena sequenziana*	*Lenticulina callifera*	*Nodosaria* sp. 1	*Vaginulina awamoana*	*Fissurina danica*	*Cibicides refulgens*	*Cibicides vortex*	?*Rhizammina* sp.	*Siphonia* spp.	*Marginulina* cf. *M. cocoaensis*	*Lagena elongata*	*Lenticulina* sp.	*Fissurina fimbricata*	*Globigerina* cf. *G. angiporoides*	*Parafissurina* cf. *P. tasmanica*	*Lagena nebulosa*	*Marginulinopsis* cf. *M. pedum*	*Lagena sulcata*	*Fissurina kerguelenensis*	*Islandiella norcrossi*	*Islandiella teretis*	*Eponides tumidulus*	*Ehrenbergina glabra*	*Globocassidulina biora*	*Astrononion echolsi*	*Globorotalia* sp.	*Globigerina* sp.	*Globigerina megastoma*	*Neogloboquadrina pachyderma*	*Trifarina earlandi*	*Miliammina lata*	*Trochammina* sp.	*Trifarina pauperata*	*Uvigerina* sp.
																																							x	x	x	x
																																		x								
																																	x									
														x											x	x	x	x	x	x	x	x	x	x	x	x	x	x				
																							x																			
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x																					x																					
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					x								x				x	x	x	x	x																					
						x											x																									
																x																										
	x			x		x	x	x	x	x	x	x	x	x	x																											
			x	x	x	x																																				
		x																																								
	x																																									
x																																										

Table 1. (Continued).

Lithologic unit	Core-Section (interval in cm)	*Ammodiscus* cf. *A. glabratus*	*Ammobaculites* cf. *A. coprolithiformis*	*Ammoscalaria pseudospiralis*	*Cyclammina incisa*	*Parafissurina groenlandica*	*Parafissurina lateralis*	*Elphidium* sp.	*Gyroidina zelandica*	*Anomalinoides globulosa*	*Melonis barleeanus*	*Globobulimina* sp.	*Cyclammina* cf. *C. complanata*	*Hyperammina cylindrica*	*Rhizammina algaeformis*	*Trifarina* aff. *T. fueguina*	*Cibicides lobatulus*	*Cibicides temperata* s.l.	*Pullenia subcarinata*	*Astacolus crepidulus*	*Cassidulinoides bradyi*	*Epistominella vitrea*	*Nonionella magnalingua*	*Melonis affinis*	*Oolina apiculata*	*Elphidium* cf. *E. nitidum*	*Cyclammina rotundata*	*Pullenia bulloides*	?*Bathysiphon* sp. 1	*Haplophragmoides* sp.	?*Gaudryina* spp.	*Fissurina laevigata*	*Globocassidulina subglobosa*	*Anomalinoides* cf. *A. macraglabra*	*Cibicides pseudoungerianus*	*Bathysiphon* aff. *B. cylindrica*
2G	31,CC								?								x		x		x	x	x	x									x			
	32-2, 53-55			x																																
	32-3, 114-123										x					x	x				x	x											x		x	
	32,CC										x							x			x	x											x			
2H	33-1, 50-52																																			
	33-3, 102-110															x	x		x			x		x									x		x	
	33-5, 52-54																																			
	34-2, 70-72																																			
	34-3, 28-38								?	x	x					x	?		x				?	x								x	x			
	34-5, 59-61																																			
	34,CC																x					x		x								x	x			
	35-1, 49-51																																			
	35-3, 112-121				?				x	x	x					x	x	x			x	x		x				x					x		x	
	35-5, 53-55																																			
	35,CC										x					x	x	x			x			x								x	x		x	
	36-2, 53-55																																			
	36-3, 97-104						x										x	x						x											x	
	36-5, 100-102				x																															
	36-6, 115-123		?	?	x		x				x			x	x				x		x			x					x				x			
	37-2, 58-60																x																			
	37-2, 123-132																																			
2I	37-4, 133-142									x	x					x	?	x			x			x	x			x					x		x	
	38-3, 87-96								x	x	x					x	x	x	x		x		x	x												
	38-6, 114-124				?				x	x							x	x			x							x							x	
	38,CC		x		x						x	x				x	x	x	x		x	x	x	x				x		?			x		x	
	39-3, 133-144				x						x							x				x								x						
2J	39-5 (top of section)	x			x												x	x												?					?	
	39-6, 24-36				x					x	x							x				x		x			x			?				x	x	
	40-3, 123-131		?		x					x	x	x				x	x		x									x		?		x		x	x	
	40-5 (top of section)	x		x	x	x											?					x						x		x				x		
	40-5, 70-79	x			x						?	?		x				x																		
	41-2, 0-10			x	x						x			x		?		?	x		x			x			x			x				x	x	x
	41-3, 36-40			x	x									x										?						x						
	41-3, 134-142			x	x								x					x									x			x	x					x
	41,CC	x		x	x									x				x			x									x			x			?
	42-2, 21-31			x	x						x			x		?		x											x	x				x	x	
	42-2, 131-141			x	x					x	x	?			x	x		x	x								x	x		?		x	?	x	x	
	42-3, 19-29	x		x	x						x	x		x		x		x												x	x		x	?	x	
	42-3, 94-107			x	x			x						x		x		x									x		x							
	42-4, 13-23				x			x								?		x																	?	x
	42-4, 93-103			x	x			?								x		x												x				x		
	43-1, 130-140	x		x	x				x	x						x	x	x	?						x					x					x	x
	43-2, 46-56	x		x	x					x				x		x	x	?				x												x		x
	43-2, 120-133				x						x	x				x		x	?		x												x	x	?	
	43-3, 29-39			x	x					x	x	?	x			x		x						x				x	x	x	x	x				
	43-3, 90-100																																			
	43-4, 20-30				x																						x	?								
	43-4, 90-100																																			
	43-5, 18-31																									x										
	43-5, 50-52																																			
	43-5, 70-72			x																																
	43-5, 121-132				x						x	x				x			x		x	x	x	x	?											
	43-6, 65-79		x	x	x			x	x	x		x	x	x	x	x	x	x	x	?																
3	43-6, 129-132																		Barren																	
	43,CC																																			
4	44-1	x	x	x	x	x	x	x	x	x	x	x																								
	44-1, 130-140																																			
	44-1, 142-150																																			
	44-2, 5-7																																			

Table 1. (Continued).

Reophax sp. 2	*Rosalina globularis*	*Fissurina marginata*	*Cassidulinoides braziliensis*	*Lagena striata*	*Nodosaria calomorpha*	*Anomalinoides pinguiglabra*	*Bathysiphon discreta*	*Textularia* cf. *T. plummerae*	*Karreriella obscura*	*Nodosaria* sp. 3	*Fissurina bisulcata*	*Sphaeroidina bulloides*	*Fissurina agassizi*	*Astrorhiza* cf. *A. granulosa*	*Protobotellina cylindrica*	*Hormosina globulifera*	*Reophax scorpiurus*	*Ammobaculites* cf. *A. expansus*	*Textularia* sp. 2	*Psammosphaera fusca*	*Bathysiphon* cf. *B. alba*	*Rhabdammina* cf. *R. abyssorum*	*Oolina apiopleura*	*Oolina globosa*	?*Bathysiphon* sp. 2	*Marsipella* sp.	*Reophax* sp. 1	*Ammodiscus* cf. *A. incertus*	*Dentalina* cf. *D. advena*	*Lenticulina lenticula*	*Gyroidina* cf. *G. obicularis*	*Reophax* cf. *R. nodulosus*	*Eponides* cf. *E. weddellensis*	*Fursenkoina schriebersiana*	*Nonionella iridea*	*Fissurina lucida*	*Lagena laevis*	*Candeina antarctica*	*Globorotalia* cf. *G. siakensis*	*Textularia* sp. 1	*Fissurina annectens*	*Fissurina* sp. 4	*Oridorsalis tenera*	*Elphidium magellanicum* s.l.
	x										x												x												x			x				x		x
			x			?					x													x														x			x			x
	x		x																																								x	x
	x																																					x						x
	x		x		x	x					x																								x			x			x			x
	x											x																																x
	x		x									x																							x			x				x	x	x
											x																																	
	x	x				x						x																									x	x						x
						x																																						
			x		x													?					x			x									?		x				x			
																																			x									
	x		x		x	x				x	x	x																		x								x					x	x
	x		x							x	x	x											x																		x		x	x
		x	x			x		x				x																										x			x			x
	x	x	x									x	x										x												x			x			x	x	x	x
																	x																		x			x	x	x				
		x	x		x	x						x	x		x								x													x	x	x						
			x			x												x															x	x	x	x								
																	x									x						x												
			x															?					x			x					x													
			x			?												x												x														
							x											x		x						x																		
	x		x				x							x	x		x	x																										
					x								x					x							x			x	x															
							x					x		x				x							x	x	x																	
			x	x		?	x					x	x	x						x	x	x	x	x																				
							x							x	x	x	x	x	x	x																								
		x				?	x	x	x	x	x	x	?																															
				x	x	x																																						
x		x	x																																									
x	x																																					?						
									?																																			
																						Barren																						

Table 1. (Continued).

Lithologic unit	Core-Section (interval in cm)	*Articulina* sp.	*Pyrgo* cf. *P. vespertilio*	*Quinqueloculina seminula*	*Trochoelphidiella pustulosa* n.sp.	*Quinqueloculina triangularis*	*Trochoelphidiella* sp.	*Jaculella* cf. *J. acuta*	*Vaginulina* cf. *V. rheophagica*	*Cassidulinoides* cf. *C. parkerianus*	*Globigerinita* cf. *G. glutinata*	*Gyroidina parva*	*Cibicides* cf. *C. mediocris*	*Nonionella bradii*	*Trochoelphidiella uniforamina*	*Saracenaria kellumi*	*Saracenaria* sp.	*Fissurina* sp. 3	*Triloculina rotundata*	*Chiloguembelina cubensis*	*Globigerina* cf. *G. ouachitaensis*	*Cassidulinoides* cf. *C. chapmani*	*Lagena* cf. *L. laevigata*	*Nodosaria* sp. 2	?*Astacolus* sp.	*Flintina* cf. *F. droogeri*	*Parafissurina subcarinata*	*Eponides bradyi*	*Uvigerina* cf. *U. miozea*	*Globigerinoides trilobus*	*Globocassidulina crassa*	*Parafissurina curta*	*Globorotalia* cf. *G. gemma*	*Globorotaloides* cf. *G. suteri*	*Lenticulina* cf. *L. punctata*	*Robertina tasmanica*
2G	31,CC				x										?								x	x												
	32-2, 53–55																																			
	32-3, 114–123				x		x								?																					
	32,CC				x																															
2H	33-1, 50–52																																			
	33-3, 102–110			x	x												x		x			x														
	33-5, 52–54																																			
	34-2, 70–72																																			
	34-3, 28–38			x	x									x																						
	34-5, 59–61																				x															
	34,CC			x	x										x				x	x																
	35-1, 49–51																																			
	35-3, 112–121			x	x										x	x	x	x																		
	35-5, 53–55																																			
	35,CC			x	x					x		x	x	?	?																					
	36-2, 53–55																																			
	36-3, 97–104																																			
	36-5, 100–102																																			
	36-6, 115–123			x		x		x	x	x	x																									
	37-2, 58–60																																			
	37-2, 123–132																																			
2I	37-4, 133–142			x		x	x																													
	38-3, 87–96		x	x	x																															
	38-6, 114–124	x																																		
	38,CC																																			
	39-3, 133–144																																			
2J	39-5 (top of section)																																			
	39-6, 24–36																																			
	40-3, 123–131																																			
	40-5 (top of section)																																			
	40-5, 70–79																																			
	41-2, 0–10																																			
	41-3, 36–40																																			
	41-3, 134–142																																			
	41,CC																																			
	42-2, 21–31																																			
	42-2, 131–141																																			
	42-3, 19–29																																			
	42-3, 94–107																																			
	42-4, 13–23																																			
	42-4, 93–103																																			
	43-1, 130–140																																			
	43-2, 46–56																																			
	43-2, 120–133																																			
	43-3, 29–39																																			
	43-3, 90–100																																			
	43-4, 20–30																																			
	43-4, 90–100																																			
	43-5, 18–31																																			
	43-5, 50–52																																			
	43-5, 70–72																																			
	43-5, 121–132																																			
	43-6, 65–79																																			
3	43-6, 129–132	Barren																																		
	43,CC																																			
4	44-1																																			
	44-1, 130–140																																			
	44-1, 142–150																																			
	44-2, 5–7																																			

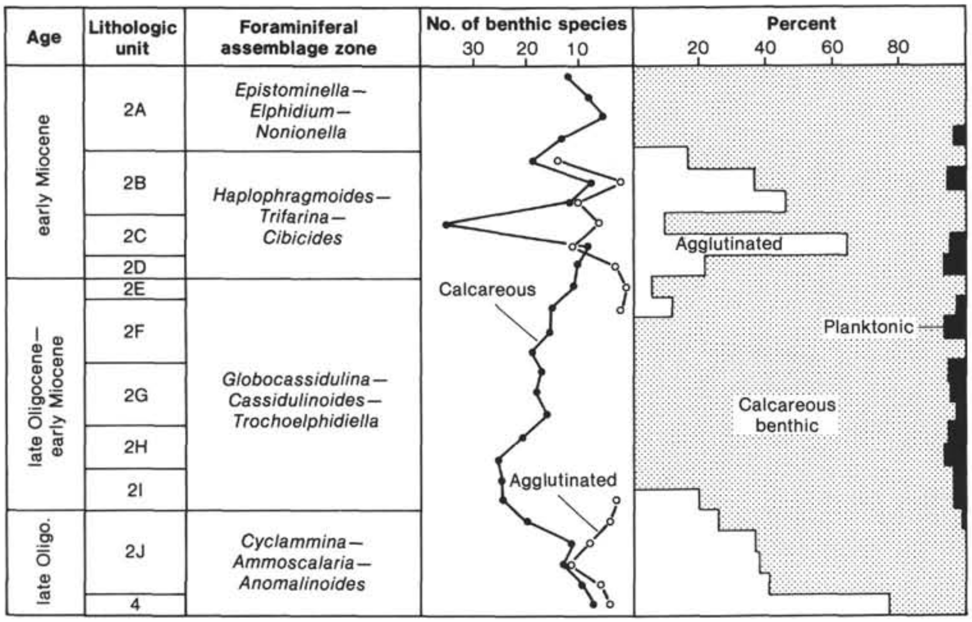

Figure 3. Diversity trends of agglutinated and calcareous benthic species and proportions of agglutinated, calcareous benthic, and planktonic taxa expressed as percentages. Based on 26 of 110 samples investigated in Units 2–4 at Site 270. Selection determined by size of population and stratigraphic distribution. Thin (1 m) glauconitic sand of Unit 3 (between 2J and 4) is apparently devoid of foraminifers.

numbers include *Epistominella vitrea, Elphidium magellanicum* s.l., and *Nonionella iridea* as well as *Melonis* spp. and *Cibicides* spp. Although the Subunit 2B/2A contact is regarded as gradational, the sudden loss of agglutinated taxa and drop in diversity and test numbers at the H-T-C/E-E-N Assemblage Zone boundary is striking and points to a possible hiatus.

Pleistocene Foraminifers (Unit 1)

The floor of the Ross Sea is capped by a widespread cover of Pliocene–Pleistocene diamictons. These sediments have been labeled Subunits 1A and 1B and vary in thickness across the Ross Sea. Unit 1A, at Site 270 only 20 cm thick, has not been studied here. Unit 1B is approximately 20 cm thick.

Unit 1 has been studied extensively both sedimentologically and paleontologically. Paleontological studies have revealed that the composition of the population is very sensitive to depth, salinity, temperature, and oxygen and carbon dioxide concentration (e.g., Kennett, 1968; Osterman and Kellogg, 1979). Unit 1 clearly does not have a consistent lateral microfossil composition and also contains an appreciable component of recycled taxa. (Many of the factors affecting the microfaunas of Unit 1 also apply, of course, to those of Unit 2.)

Faunal content. At Site 270 Unit 1B contains 21 genera and 26 species (Table 1). Distribution of genera is 2 agglutinated, 14 calcareous benthic, 5 planktonic; of species is 2 agglutinated, 19 calcareous benthic, 5 planktonic. Only 29% of these species are common to Unit 2 assemblages. Some of these may be recycled. Assemblages are marked by a near absence of agglutinated forms. Taxa common in Unit 1 but not represented in the late Oligocene–early Miocene assemblage zones include *Islandiella norcrossi, I. teretis, Trifarina earlandi, T. pauperata, Eponides tumidulus, Ehrenbergina glabra, Globocassidulina biora, Astrononion echolsi, Globigerina megastoma*, and *Neogloboquadrina pachyderma*. Specimens of the late Oligocene–Miocene–Pliocene *Trochoelphidiella* species complex and late Oligocene–Miocene *Candeina antarctica* do not occur in Pleistocene assemblages.

FORAMINIFER AGE DETERMINATIONS AND FAUNAL AFFINITIES

Although foraminifers have proven useful in delineating paleoecological and basin history trends, their usefulness in providing high-resolution biostratigraphy in the Ross Sea, with a potential for correlation northward to calibrated temperate zonations, is limited (Leckie and Webb, 1983). The predominantly neritic nature of the benthic assemblages and the paucity of planktonic taxa greatly restricts correlation to periantarctic deep-sea zonations. The nearest neritic benthic zonations are located in New Zealand, which by late Oligocene–early Miocene times lay beneath temperate water masses, whereas the Ross Sea lay within much cooler water masses. The Site 270 assemblages exhibit, within a span of about 7 to 10 m.y., an important high-latitude late Paleogene–early Neogene transition. The C-A-A Assemblage Zone is cool-temperate in character, whereas the G-C-T, H-T-C, and E-E-N Assemblage Zones demonstrate a distinctive polar aspect (Leckie and Webb, 1983). Many of the Site 270 benthic taxa with known extra-antarctic records have ranges of Eocene–Oligocene, Eocene–Miocene, and Oligocene–Miocene. Benthic taxa known to be confined to the high southern latitudes have long ranges which span the late Oligocene–Miocene or Miocene. Pliocene and Pleistocene benthic taxa are significantly different from those of the Miocene. Planktonic taxa found in Site 270

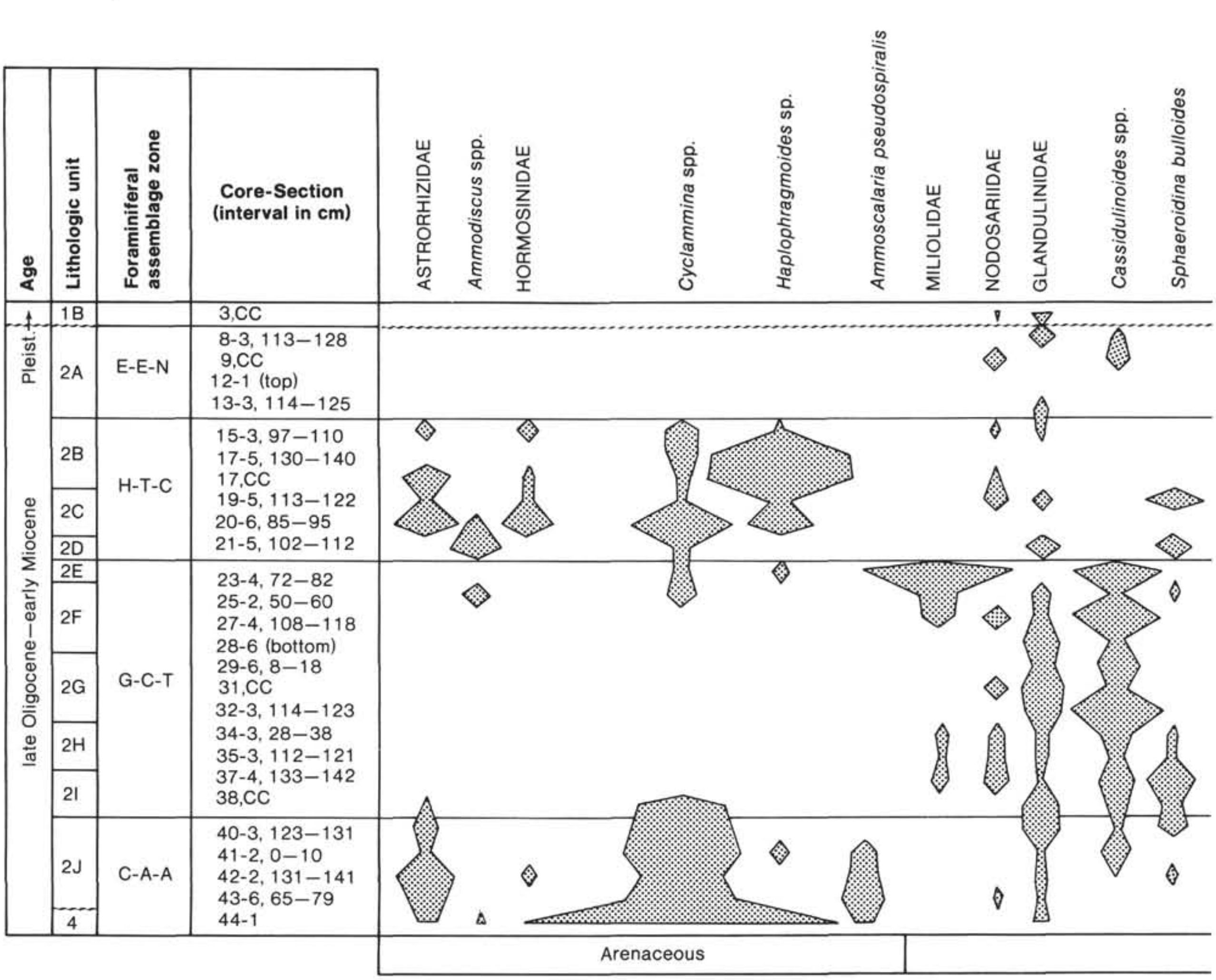

Figure 4. Percentage occurrences of the key taxa or faunal groups in the 27 representative samples of Site 270.

appear to be of very limited use. Late Paleogene–Neogene planktonic assemblages never achieved a diversity greater than one to three species, and apparently temperate planktonics only made sporadic appearances in the southern high latitudes. Their extreme rarity in these glaciomarine sediments reduces their importance owing to the possibility of recycling into younger sediments.

C-A-A Assemblage Zone (Unit 4, Subunit 2J)

Globorotalia cf. *G. siakensis* is present in the upper part of Subunit 2J (270-39-6, 24–26 cm). In lower-latitude zonations this taxon ranges from the base of Zone P22 (late Oligocene) to the top of Zone N14 (middle Miocene, about 11 Ma; Kennett and Srinivasan, 1983; Fig. 5). The only other planktonic, *Candeina antarctica*, is apparently endemic to antarctic areas in the Pacific Ocean and is the only persistent planktonic taxon in upper Oligocene–mid Miocene strata of the Ross Sea (Leckie and Webb, 1985). *Cyclammina incisa* has a New Zealand range of Eocene through Oligocene (Arnold and Landon Series; Hornibrook, 1961, 1971) and is reported to range into the early Miocene in Australia (Ludbrook, 1977). *Gyroidinoides zelandica*, common in the C-A-A Assemblage Zone, appears in the New Zealand late Oligocene (Waitakian) but ranges to the Pleistocene (Hornibrook, 1961). *Anomalinoides pinguiglabra* ranges from the early Oligocene to mid-Miocene (Whaingaroan–upper Southland Series), while *A. macraglabra* spans the New Zealand late Eocene to mid-Miocene (Runangan–Waiauan). The general compositional aspects of the C-A-A Assemblage Zone suggest an affinity with the relatively shallow water late Oligocene assemblages of the Oamaru district of New Zealand (Hornibrook, 1961), a relationship not so obvious in the overlying G-C-T Assemblage Zone.

G-C-T Assemblage Zone (Subunits 2I to 2E)

Six planktonic species are recorded within this interval (Fig. 5). With the exception of *Candeina antarctica*, all are well known in the lower latitudes. Because of their extreme paucity, recycling must be considered a possibility. *Chiloguembelina cubensis* (270-34,CC, Subunit 2H) ranges from the middle Eocene to late Oligocene (*Globigerina euapertura* Zone) in New Zealand (Jenkins, 1971), but according to Blow (1969, p. 222), *Chiloguembelina* spp. ex-group *cubensis* ranges "throughout most, if not all, of N3 (= P22)" and also "has been noted to occur with *Globigerinoides primordius* and,

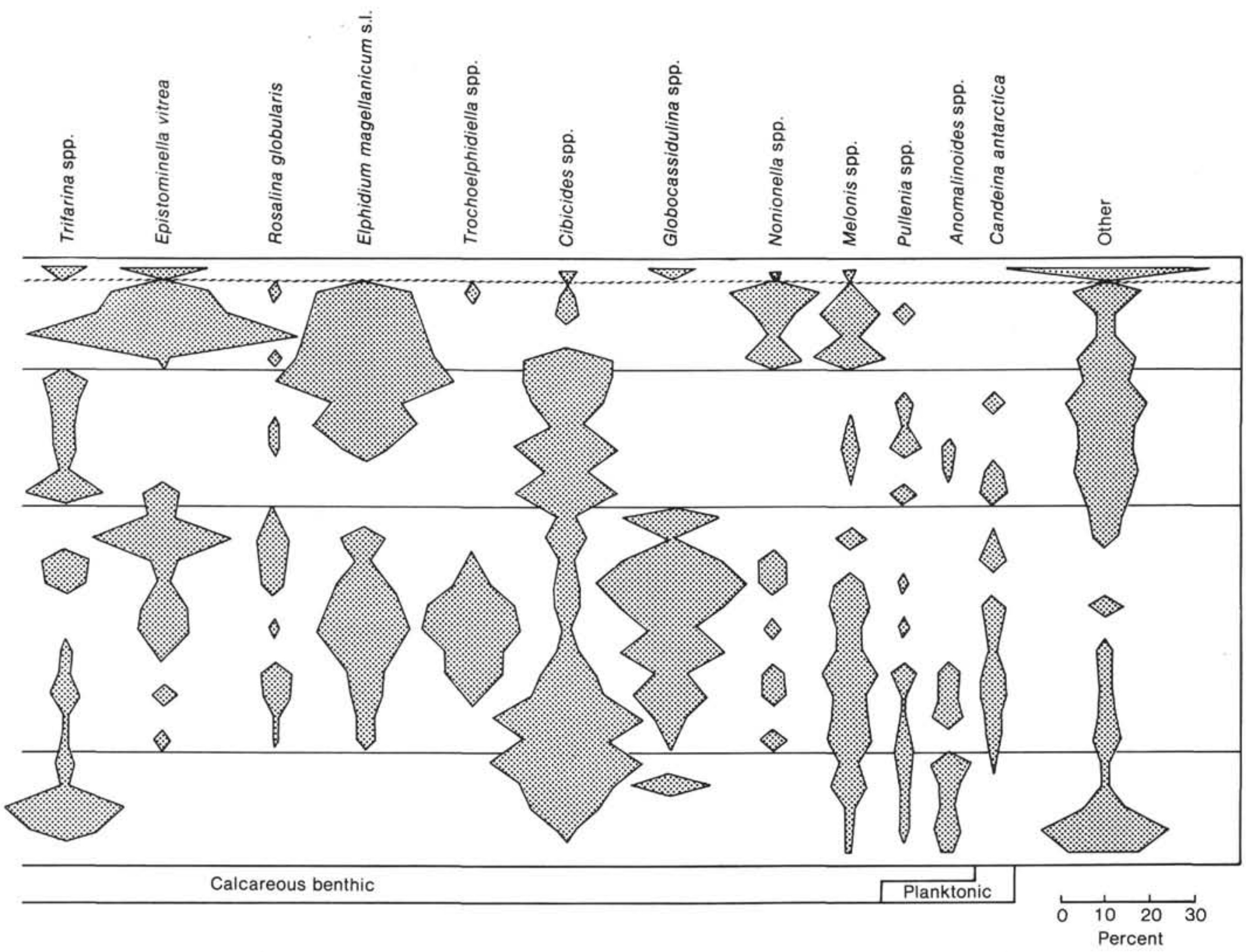

Figure 4. (Continued).

thus, to range into the early part of Zone N4" (latest Oligocene–earliest Miocene). *Globigerina ouachitaensis* (270-34-5, 59–61 cm, Subunit 2H) ranges from the middle Eocene (*Globigerapsis index index* Zone) to early Miocene (*Globigerinoides trilobus trilobus* Zone) in New Zealand (Jenkins, 1971). *Globigerinita* cf. *G. glutinata* is also present in Subunit 2H (270-36-6, 115–123 cm) and ranges in New Zealand (as *G. juvenilis*) from early Oligocene (*Globigerina angiporoides angiporoides* Zone) to Pleistocene (Jenkins, 1974). Kennett and Srinivasan (1983) state a range for *Globigerinita glutinata* as late Oligocene (Zone P22) to Recent. A single specimen of *Globigerinoides trilobus* occurs in 270-28,CC (Subunit 2F). This species first appears in early Miocene Zone N4B (about 23 Ma; Kennett and Srinivasan, 1983). *Globigerina* cf. *G. angiporoides* (270-15-3, 50–57 cm; Subunit 2B) and *Globorotalia* cf. *G. gemma* (270-24,CC, Subunit 2E) have New Zealand ranges of late Eocene–early Oligocene (Jenkins, 1971). These occurrences in Site 270 are clearly recycled. If we assume that *Chiloguembelina cubensis* and *Globigerinoides trilobus* are not recycled, the Oligocene–Miocene boundary would lie between 270-34,CC (Subunit 2H) and 270-28,CC (Subunit 2F).

Calcareous benthic taxa characterize the G-C-T Assemblage Zone and a number of these species also occur in the lower member of the Carmen Silva Formation of Tierra Del Fuego (lower to middle Miocene, local Gaviotian Stage; Codignotto and Malumian, 1981; Malumian, 1982). These taxa include *Trifarina fueguina, Globobulimina* sp., *"Buccella"* sp., and *Pullenia* spp. (see Malumian, 1982).

H-T-C Assemblage Zone (Subunits 2D to 2B)

Although some of the taxa are also documented in New Zealand, most are long-ranging late Paleogene–Neogene forms. *Cyclammina incisa* probably ranges no younger than the early Miocene (Ludbrook, 1977), as does *Gaudryina reussi* (Hornibrook, 1961, 1971).

E-E-N Assemblage Zone (Subunit 2A)

No age-definitive taxa are present. The zone contains what is regarded here as typical Miocene polar assemblages.

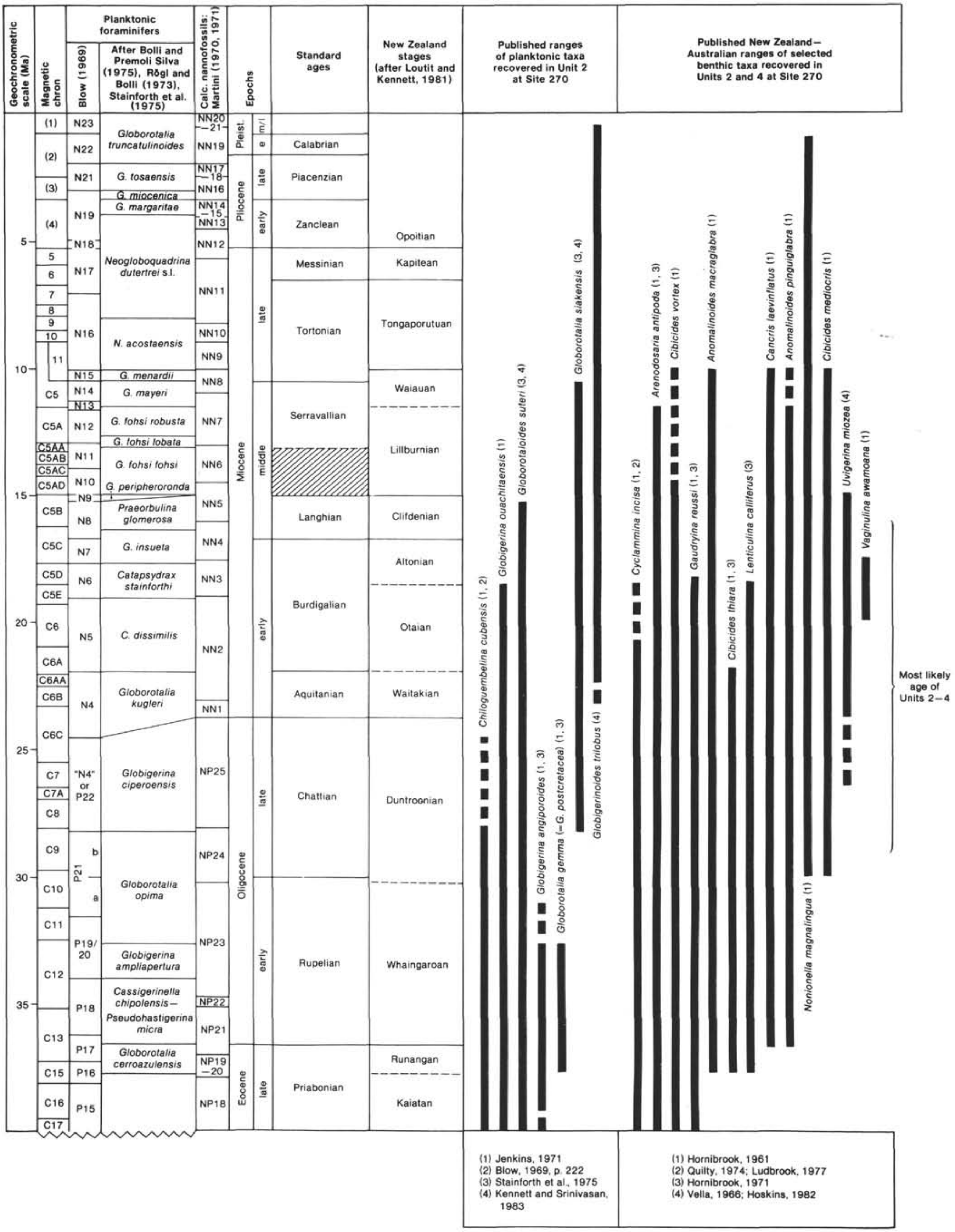

Figure 5. Published ranges of planktonic and selected benthic taxa that occur in Units 2 and 4 of Site 270. Time scale, magnetic chrons, and planktonic biostratigraphy after Berggren et al. (in press). Correlation of New Zealand stages is approximate (based on Loutit and Kennett, 1981).

Pleistocene (Subunit 1B)

Contains typical polar Quaternary assemblages (e.g., McKnight, 1962; Pflum, 1966; Kennett, 1968; Fillon, 1974; Anderson, 1975; Osterman and Kellogg, 1979). These assemblages differ significantly from Pliocene assemblages (Webb, 1974; Webb and Wrenn, 1982) and are markedly different from the late Oligocene–early Miocene assemblages discussed earlier.

SYSTEMATIC NOTES

This investigation of upper Oligocene–lower Miocene and Quaternary sediments from Site 270 results in the identification and description of 74 genera and 163 species of foraminifers. This includes 22 genera and 40 species of agglutinated taxa, 43 genera and 109 species of calcareous benthic taxa and 9 genera and 14 species of planktonic taxa. Of the 163 species, 144 are present in the upper Oligocene–lower Miocene sediments (Units 4 and 2) whereas 27 species are present in the Quaternary sediments (Unit 1). Eight of the taxa in Unit 1 are also found in Unit 2. Some of these may be recycled from Unit 2.

Among the agglutinated taxa, members of the Astrorhizidae, Hormosinidae, and Lituolidae were found to be dominant. Astrorhizidae are the most diverse, with 8 genera and 14 species. Species diversity is highest in *Bathysiphon*. Hormosinidae are also prominent with 6 species (5 species of *Reophax*). The Lituolidae (7 species) are dominated by *Cyclammina* (3 species). *Textularidae* are poorly represented by 3 species of *Textularia*.

Prominent calcareous benthic families include the Nodosariidae, Glandulinidae, Islandiellidae, Uvigerinidae, Elphidiidae, Cibicididae, and Nonionidae. Nodosariidae are the most diverse, with 8 genera and 26 species (8 species of *Lagena*). Glandulinidae are also prominent with 3 genera and 21 species—*Fissurina* (13 species), *Parafissurina* (5 species), and *Oolina* (3 species). The Islandiellidae are represented by 2 genera (*Cassidulinoides* and *Islandiella*) and 6 species. The Uvigerinidae are represented by 2 genera (*Trifarina* and *Uvigerina*) and 4 species. The family Elphidiidae is represented by 2 genera (*Elphidium* and *Trochoelphidiella*) and 6 species. The Cibicididae include 1 genus (*Cibicides*) and 7 species. Three genera (*Astrononion, Nonionella*, and *Pullenia*) and 6 species from the Nonionidae are documented.

The planktonic fauna contains 9 genera and 14 species and includes members of the Globorotalidae, Globigerinidae, Heterohelicidae, Candeinidae, and Planomalinidae. The Globigerinidae are the most diverse, with 5 genera and 8 species, and include species of *Globigerina, Globigerinita, Globigerinoides, Globorotaloides*, and *Neogloboquadrina*. The Family Globorotalidae is represented by 3 species of *Globorotalia*. Four species are possibly recycled into Unit 2 from other Cenozoic sediments. One is recycled from Cretaceous sediments.

Classification and Identification

The family and generic classification of Loeblich and Tappan (1964) is followed here. For taxa with Paleogene benthic affinities we have relied on the New Zealand works of Hornibrook (1961, 1971). Jenkins's (1971) treatment of New Zealand Cenozoic planktonic foraminifers was also an important source of comparative information. Many of the taxa identified here were compared with primary type and other materials held in the collections of the New Zealand Geological Survey, Lower Hutt, New Zealand. For identification of many of the cool-water polar Neogene taxa, we have relied on studies of Recent assemblages published by Brady, Parr, Heron-Allen and Earland, and others.

Astrorhiza cf. *A. granulosa* Brady
(P. 1, Fig. 8)

Astrorhiza granulosa Brady, 1884, pl. 20, figs. 14–23.

Bathysiphon cf. *B. alba* (Heron-Allen and Earland)
(Pl. 1, Fig. 3)

Hippocrepinella alba Heron-Allen and Earland, 1932, p. 259, pl. 1, figs. 16–18.

Bathysiphon aff. *B. cylindrica* (Glaessner)
(Pl. 1, Figs. 1–2)

Rhabdammina cylindrica Glaessner, 1937, pl. 1, fig. 1
Bathysiphon cylindrica (Glaessner). Webb, 1975, p. 834, pl. 1, fig. 4.

Bathysiphon discreta (Brady)
(Pl. 1, Fig. 4)

Rhabdammina discreta Brady. Brady, 1884, pl. 22, figs. 7–10.

Bathysiphon sp. 1
(Pl. 1, Fig. 5)

Description. Test an elongate narrow tube, coarsely arenaceous with carbonate cement, open at both ends in most instances.

Discussion. This form is narrower and more coarsely agglutinated than *B. discreta* of this study. These specimens resemble *Rhabdammina linearis* Brady except that they possess a central, subglobular chamber. Because these forms are obviously fragments, generic classification is uncertain. This species occurs in Subunits 2J, 2H, 2C, and 2B.

Bathysiphon sp. 2

Description. Test an elongate tube with a thick wall constructed of well-sorted, silt-sized quartz grains in a milky white clay matrix; exterior smoothly finished, both ends of tube open.

Hyperammina cylindrica Parr
(Pl. 1, Fig. 7)

Hyperammina elongata Brady, 1878, p. 433, pl. 20, fig. 2.
Hyperammina cylindrica Parr, 1950, p. 254, pl. 3, fig. 5. Anderson, 1975, p. 88, pl. 1, fig. 6.

Jacuella cf. *J. acuta* Brady
(Pl. 1, Fig. 11)

Jacuella acuta Brady, 1884, pl. 22, figs. 14–18.

Marsipella sp.
(Pl. 1, Fig. 13)

Description. Test a single undivided chamber, elongate-fusiform, slightly compressed and twisted, wall smooth and consisting of very fine agglutinated quartz grains in a micritic cement. Most specimens are white but a few are iron-stained.

Protobotellina cylindrica Heron-Allen and Earland
(Pl. 1, Fig. 14)

Protobotellina cylindrica Heron-Allen and Earland, 1929, p. 326, pl. 2, figs. 9–13.

Rhabdammina cf. *R. abyssorum* M. Sars

Rhabdammina abyssorum M. Sars, 1868, p. 248 (nomen nudum) *in* Carpenter, 1869, p. 288.

Rhabdammina linearis Brady
(Pl. 1, Fig. 9)

Rhabdammina linearis Brady, 1879, p. 37, pl. 3, figs. 10–11.

Rhizammina algaeformis Brady
(Pl. 1, Fig. 12)

Rhizammina algaeformis Brady, 1879.

Psammosphaera fusca Schulze
(Pl. 1, Fig. 10)

Psammosphaera fusca Schulze, 1875, p. 113. McKnight, 1962, p. 99, pl. 9, fig. 3.

Ammodiscus cf. *A. glabratus* Cushman and Jarvis
(Pl. 2, Fig. 13)

Ammodiscus glabratus Cushman and Jarvis, 1928, p. 86, pl. 12, fig. 6.

Ammodiscus cf. *A. incertus* (d'Orbigny)

Ammodiscus cf. *incertus* (d'Orbigny). Cushman and Stainforth, 1945, p. 14, pl. 1, figs. 10–11.

Hormosina cf. *H. globulifera* Brady

Hormosina globulifera Brady, 1879, p. 60, pl. 4, figs. 4–5.

Reophax cf. *R. cushmani* Heron-Allen and Earland
(Pl. 2, Fig. 5)

Reophax cushmani Heron-Allen and Earland, 1932, p. 339, pl. 7, figs. 22–24.

Reophax cf. *R. nodulosus* Brady
(Pl. 2, Fig. 6)

Reophax nodulosus Brady, 1884, p. 295, pl. 31, figs. 1-9. McKnight, 1962, p. 100, pl. 9, fig. 11. Anderson, 1975, p. 92, pl. 1, fig. 19.

Reophax scorpiurus Montfort
(Pl. 2, Fig. 7)

Reophax scorpiurus Montfort, 1808, p. 331. Anderson, 1975, p. 92, pl. 2, fig. 2.

Miliammina lata Heron-Allen and Earland

Miliammina lata Heron-Allen and Earland, 1930, p. 43, pl. 1, figs. 13–17.

Ammobaculites cf. *A. coprolithiformis* (Schwager)
(Pl. 2, Fig. 8)

Ammobaculites coprolithiformis (Schwager). Cushman, 1946, p. 22, pl. 3, figs. 7–9.

Ammobaculites cf. *A. expansus* Plummer
(Pl. 2, Figs. 9–10)

Ammobaculites expansus Plummer. Cushman, 1951, p. 4, pl. 1, figs. 5–7.

Ammoscalaria pseudospiralis (Williamson)
(Pl. 2, Figs. 11–12)

Proteonina pseudospiralis Williamson, 1858, p. 2, pl. 1, figs. 2–3.
Ammoscalaria pseudospiralis (Williamson). Parker et al., 1953, p. 6, pl. 1, figs. 29, 35. Murray, 1971, p. 29, pl. 7, fig. 105.

Cyclammina cf. *C. complanata* Chapman

Cyclammina complanata Chapman, 1904, p. 228, pl. 22, fig. 7.
Haplophragmoides complanata (Chapman). Taylor, 1965, p. 148, fig. 3.
Cyclammina complanata Chapman. Ludbrook, 1977, p. 187, pl. 2, figs. 28–30; pl. 4, figs. 41–44.

Discussion. These specimens resemble *Cyclammina incisa* (Stache) but are larger in diameter and have sinuous sutures which join at the umbilicus at a greater angle. *C.* cf. *complanata* also has 13–14 chambers in its final whorl instead of the 10–11 characteristic of *C. incisa*. Taylor (1965) believes that *C. incisa* developed from *C. complanata*.

Cyclammina incisa (Stache)
(Pl. 3, Figs. 1–5)

Haplophragmium incisum Stache, 1864, p. 165, pl. 21, fig. 1.
Cyclammina incisa (Stache). Chapman, 1926, p. 29, pl. 2, fig. 1. Crespin, 1950, p. 72, pl. 10, fig. 3. Asano, 1950, p. 77, pl. 12, figs. 8–9. Hornibrook, 1961, p. 30.
Haplophragmoides cf. *incisa* (Stache). Taylor, 1965, p. 150, figs. 2A–3.
Cyclammina incisa (Stache). Hornibrook, 1971, p. 34, pl. 6, figs. 1–3.
Cyclammina cf. *incisa* (Stache). Quilty, 1974, p. 33, pl. 1, figs. 1–3.
Cyclammina incisa (Stache). Ludbrook, 1977, p. 188, pl. 1, figs. 5–8; pl. 3, figs. 31–35; pl. 5, figs. 45–46; pl. 6, figs. 47–49; pl. 7, figs. 50–51; pl. 8, figs. 52–53.

Discussion. Crespin (1950) recognized that this species is widespread in the Oligocene and Miocene. Asano (1950) also assigned the occurrence of *C. incisa* to the Oligocene and Miocene in Japan. Hornibrook (1961) doubted Asano's identification of *C. incisa* and restricted the range of this species to the Eocene–Oligocene (Arnold to Landon Series; Hornibrook, 1971). Quilty (1974) extended the range into the Tasmanian Early Miocene. Likewise, Ludbrook (1977) notes the widespread occurrence of *C. incisa* in southern Australia and New Zealand from Late Paleocene to Early Miocene. Common in Unit 4 and Subunits 2J, and occurs sporadically in Subunits 2I, 2H, 2E, 2D, 2C, and 2B.

Cyclammina rotundata Chapman and Crespin
(Pl. 3, Figs. 6–7)

Cyclammina rotundata Chapman and Crespin, 1930, p. 96, pl. 5, figs. 1–2. Crespin, 1950, p. 72, pl. 10, fig. 5.
Haplophragmoides rotundata (Chapman and Crespin). Taylor, 1965, p. 153, fig. 4.
Cyclammina rotundata Chapman and Crespin. Ludbrook, 1977, p. 193, pl. 1, figs. 9–12, 14–17; pl. 3, fig. 36.

Discussion. This species is smaller in size and broader in cross section than *Cyclammina incisa* (Stache). *C. rotundata* is also differentiated by possessing fewer chambers, straight sutures, and a shallow umbilicus. Ludbrook (1977) reports an association with *C. incisa* in Australia and New Zealand from the late Paleocene to the Oligocene and possibly in lower Miocene sediments. Occurs sporadically in Subunit 2J.

Haplophragmoides sp.
(Pl. 3, Fig. 8–13)

Description. Test planispirally coiled, wall coarsely agglutinated, 5-6 chambers in final whorl, subcircular in outline but compressed in axial view.

Discussion. A persistent member of Subunit 2J assemblages (middle and upper part) and common in assemblages of Subunits 2B and 2C.

Textularia cf. *T. plummerae* Lalicker

Textularia cf. *plummerae* (Lalicker). Webb, 1975, p. 835, pl. 3, fig. 4.

Discussion. Numerous specimens occur in the intervals 270-42-4, 13–23 cm (Subunit 2J), and 270-36-6, 115–123 cm (Subunit 2H).

Arenodosaria antipoda (Stache)
(Pl. 2, Fig. 2)

Clavulina antipodum Stache, 1864, p. 167, pl. 21, figs. 3–8.
Clavulina robusta Stache, 1864, p. 169, pl. 21, figs. 9–10.
Arenodosaria antipodum (Stache). Hornibrook, 1961, p. 29, pl. 3, fig. 36.
Arenodosaria robusta (Stache). Hornibrook, 1961, p. 29, pl. 3, fig. 37.
Arenodosaria antipoda (Stache). Hornibrook, 1971, p. 32, pl. 5, figs. 7–8. text-fig. 8, p. 33.

Discussion. Hornibrook (1971) reports a stratigraphic range for *A. antipoda* in New Zealand of middle Eocene to middle Miocene (Bortonian to Waiauan stages) and states that this was a rare form above the lower Miocene (lower Southland Series) (Hornibrook, 1968, p. 54).

Gaudyrina reussi Stache

Gaudyrina reussi Stache, 1864, p. 171, pl. 21, fig. 11. Hornibrook, 1971, p. 32, pl. 6, figs. 83–87.

Discussion. Hornibrook (1971) notes that *G. reussi* ranges in New Zealand from late Eocene to early Miocene (Kaiatan to Otaian stages).

Karreriella obscura Srinivasan

Karreriella obscura Srinivasan, 1966, p. 233, pl. 1, figs. 1–2.

Flintina cf. *F. droogeri* Marks
(Pl. 17, Figs. 18–20)

Flintina droogeri Marks, 1951, p. 41, pl. 5, figs. 2–3.

Pyrgo cf. *P. vespertilio* (Schlumberger)
(Pl. 17, Figs. 16–17)

Biloculina vespertilio Sclumberger, 1891, p. 174, pl. 10, figs. 74–76; text-figs. 20–22.

Pyrgo vespertilio (Schlumberger). Quilty, 1974, p. 48, pl. 2, fig. 38.

Discussion. Quilty (1974) reports *P. vespertilio* from the early Miocene of Tasmania.

Quinqueloculina seminula (Linné)
(Pl. 4, Figs. 1–2; Pl. 17, Figs. 2–5)

Serpula seminulum Linnaeus, 1758, p. 786, pl. 2, fig. 1.

Quinqueloculina seminulum (Linne). Hayward and Buzas, 1979, p. 36, pl. 3, fig. 34.

Discussion. Reported by Hayward and Buzas (1979) from the early Miocene of New Zealand and by Quilty (1974) from the early Miocene of Tasmania.

Quinqueloculina triangularis d'Orbigny
(Pl. 4, Fig. 3; Pl. 17, Figs. 6–10)

Quinqueloculina triangularis d'Orbigny, 1846, p. 288, pl. 18, figs. 7–9. Vella, 1957, p. 23, pl. 6, figs. 100, 101, 108.

Triloculina rotunda d'Orbigny
(Pl. 17, Figs. 11–13)

Triloculina rotunda d'Orbigny, 1826, p. 299. McKnight, 1962, p. 107, pl. 12, fig. 38. Quilty, 1974, p. 59, pl. 2, figs. 78–79.

Discussion. Quilty (1974) reports this species from the early Miocene of Tasmania.

Astacolus crepidulus (Fichtel and Moll)
(Pl. 19, Figs. 6–7)

Nautilus crepidula Fichtel and Moll, 1798, p. 107, pl. 19, figs. g–i.

Dentalina cf. *D. advena* (Cushman)
(Pl. 19, Figs. 13–15)

Nodosaria advena Cushman, 1923, p. 79, pl. 14, fig. 12.

Marginulina cf. *M. cocoaensis* Cushman
(Pl. 19, Fig. 10)

Marginulina cocoaensis Cushman, 1925, p. 67, pl. 10, figs. 9–10.

Marginulina tumida Reuss
(Pl. 19, Figs. 8–9)

Marginulina tumida Reuss, 1851, p. 64, pl. 3, fig. 14.

Marginulinopsis cf. *M. pedum* (d'Orbigny)
(Pl. 20, Figs. 3–4)

Marginulina pedum d'Orbigny, 1846, p. 68, pl. 3, figs. 13–14.

Lagena elongata (Ehrenberg)

Miliola elongata Ehrenberg, 1844, p. 274.

Lagena elongata (Ehrenberg). Anderson, 1975, pl. 5, fig. 5. Hayward and Buzas, 1979, p. 61, pl. 19, fig. 239.

Lagena gracilis Williamson

Lagena gracilis Williamson, 1848, p. 13, pl. 1, figs. 3–4. Pflum, 1966, p. 180, pl. 16, fig. 27. Hayward and Buzas, 1979, p. 61, pl. 19, fig. 237.

Lagena cf. *L. laevigata* (d'Orbigny)
(Pl. 19, Fig. 3)

Oolina laevigata d'Orbigny, 1839, p. 19, pl. 5, fig. 3.

Lagena laevigata (d'Orbigny). Heron-Allen and Earland, 1932, p. 361, pl. 10, fig. 4.

Lagena laevis Montagu
(Pl. 4, Fig. 6)

Lagena laevis Montagu, 1803, p. 524. Quilty, 1974, p. 68, pl. 3, figs. 101–102.

Lagena nebulosa Cushman
(Pl. 19, Fig. 2)

Lagena laevis (Montagu) var. *nebulosa* Cushman, 1923, p. 29, pl. 5, figs. 4–5.

Lagena nebulosa Cushman. McKnight, 1962, p. 115, pl. 16, fig. 85.

Lagena sequenziana Fornasini
(Pl. 19, Figs. 4–5)

Lagena sequenziana Fornasini, 1886, p. 352, pl. 8, figs. 1–6.

Lagena striata (d'Orbigny)
(Pl. 4, Fig. 5)

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

Lagena striata (d'Orbigny). Quilty, 1974, p. 69, pl. 3, fig. 105.

Lagena sulcata (Walker and Jacob)
(Pl. 4, Fig. 7)

Serpula (Lagena) sulcata Walker and Jacob, 1798, p. 634, pl. 14, fig. 5.

Lagena sulcata (Walker and Jacob). Murray, 1971, p. 87, pl. 34, figs. 5–8.

Lenticulina callifera (Stache)
(Pl. 20, figs. 11–12)

Cristellaria callifera Stache, 1864, p. 236, pl. 23, fig. 15.

Robulus calliferus (Stache). Hornibrook, 1971, p. 42, pl. 9, figs. 148–149.

Lenticulina callifera (Stache). Hayward and Buzas, 1979, p. 62, pl. 19, figs. 244–246.

Discussion. Hornibrook (1971) records a New Zealand stratigraphic range of late Eocene to early Miocene (Runangan to Otaian stages).

Lenticulina lenticula (Stache)
(Pl. 20, Fig. 15)

Robulina lenticula Stache, 1864, p. 246, pl. 23, fig. 25.

Robulus lenticulus (Stache). Hornibrook, 1971, p. 43, pl. 9, figs. 158–159.

Discussion. Recorded from the Oligocene (Whaingaroan Stage) in New Zealand (Hornibrook, 1971).

Nodosaria calomorpha Reuss
(Pl. 19, Fig. 1)

Nodosaria calomorpha Reuss, 1866, p. 129, pl. 1, figs. 15–19. Hornibrook, 1961, p. 47, pl. 5, fig. 95.

Saracenaria kellumi Dorreen
(Pl. 20, Figs. 5–8)

Saracenaria kellumi Dorreen, 1948, p. 289, pl. 37, fig. 4.

Vaginulina awamoana Hornibrook
(Pl. 19, Figs. 11–12)

Vaginulina awamoana Hornibrook, 1961, p. 44, pl. 5, figs. 77, 81, 82.

Discussion. *V. awamoana* occurs in the early Miocene of New Zealand (Hutchinsonian and Awamoan stages).

Vaginulina cf. *V. rheophagica* Sidebottom

Vaginulina rheophagica Sidebottom, 1918, p. 139, pl. 5, figs. 5, 7.

Fissurina agassizi Todd and Brönnimann
(Pl. 18, Figs. 15–16)

Fissurina agassizi Todd and Brönnimann, 1957, p. 36, pl. 9, fig. 14.

Fissurina annectens (Burrows and Holland)
(Pl. 4, Fig. 15)

Lagena annectens Burrows and Holland, 1866, p. 203, pl. 7, fig. 11.

Fissurina annectens (Burrows and Holland). Quilty, 1974, p. 89, pl. 4, fig. 150.

***Fissurina bisulcata* (Heron-Allen and Earland)**
(Pl. 4, Figs. 13–14)

Lagena bisulcata Heron-Allen and Earland, 1932, p. 380, pl. 11, figs. 29–32.

***Fissurina danica* (Madsen)**
(Pl. 4, Fig. 12; Pl. 18, Figs. 5–6)

Lagena danica Madsen, 1895, p. 196, pl. O, fig. 4.

***Fissurina fimbriata* (Brady)**
(Pl. 4, Figs. 18–19)

Lagena fimbriata Brady, 1884, p. 486, pl. 60, figs. 26–28. McKnight, 1962, p. 114, pl. 16, fig. 78.

***Fissurina kerguelenensis* Parr**
(Pl. 4, Fig. 16)

Fissurina kerguelenensis Parr, 1950, p. 305, pl. 8, fig. 7. Hayward and Buzas, 1979, p. 57, pl. 16, fig. 206.

***Fissurina laevigata* Reuss**
(Pl. 18, Figs. 11–12)

Fissurina laevigata Reuss, 1850, p. 366, pl. 46, fig. 1.

***Fissurina lucida* (Williamson)**
(Pl. 18, Figs. 7–8)

Entosolenia marginata (Montagu) var. *lucida* Williamson, 1848, p. 17, pl. 2, fig. 7.

***Fissurina marginata* (Montagu)**
(Pl. 18, Figs. 9–10)

Vermiculum marginatum Montagu, 1803, p. 524.
Fissurina marginata (Montagu). Quilty, 1974, p. 90, pl. 4, fig. 153. Hayward and Buzas, 1979, p. 57, pl. 16, fig. 207.

***Oolina apiculata* Reuss**
(Pl. 4, Fig. 11)

Oolina apiculata Reuss, 1851, p. 22, pl. 2, fig. 1.
Lagena apiculata (Reuss). McKnight, 1962, p. 113, pl. 15, fig. 71.
Oolina apiculata Reuss. Quilty, 1974, p. 92, pl. 4, fig. 157.

***Oolina apiopleura* (Loeblich and Tappan)**
(Pl. 4, Figs. 8–9)

Lagena apiopleura Loeblich and Tappan, 1953, p. 59, pl. 10, figs. 14–15.

***Oolina globosa* (Montagu)**
(Pl. 4, Fig. 10; Pl. 18, Fig. 17)

Vermiculum globosa Montagu, 1803, p. 523.
Oolina globosa (Montagu). Quilty, 1974, p. 92, pl. 4, fig. 158. Hayward and Buzas, 1979, p. 68, pl. 23, figs. 284–285.

***Parafissurina curta* Parr**
(Pl. 18, Figs. 24–25)

Parafissurina curta Parr, 1950, p. 318, pl. 10, figs. 6–7.

***Parafissurina groenlandica* (Stschedrina)**

Entosolenia groenlandica Stschedrina, 1946, p. 144, 147, pl. 4, fig. 19.

***Parafissurina lateralis* (Cushman)**
(Pl. 18, Figs. 22–23)

Lagena lateralis Cushman, 1913, pl. 1, fig. 1.
Entosolenia lateralis (Cushman). McKnight, 1962, p. 121, pl. 19, fig. 117.
Parafissurina lateralis (Cushman). Hayward and Buzas, 1979, p. 69, pl. 23, fig. 294.

***Parafissurina subcarinata* Parr**
(Pl. 18, Figs. 20–21)

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

***Parafissurina* cf. *P. tasmanica* Parr**
(Pl. 18, Figs. 18–19)

Parafissurina tasmanica Parr, 1950, p. 319, pl. 10, fig. 15.

***Sphaeroidina bulloides* d'Orbigny**
(Pl. 5, Figs. 1–4)

Sphaeroidina bulloides d'Orbigny, 1826, p. 267, modèles no. 65. Boltovskoy, 1978, p. 169, pl. 7, fig. 11. Hayward and Buzas, 1979, p. 74, pl. 27, fig. 335.

***Cassidulinoides bradyi* (Norman)**
(Pl. 5, Figs. 9–10)

Cassidulina bradyi Norman *in* Brady, 1881, p. 59. Brady, 1884, pl. 54, figs. 6–10.
Evolvocassidulina bradyi (Norman). Hayward and Buzas, 1979, p. 55, pl. 14, fig. 179.

Discussion. A common taxon in Subunits 2J, 2I, 2H, 2G, 2F, 2E, and rare in 2A. The main difference between *C. bradyi* and *C. parkerianus* appears to be inflation of chambers; *C. parkerianus* being the more inflated form.

***Cassidulinoides braziliensis* (Cushman)**
(Pl. 5, Figs. 13–14)

Cassidulina braziliensis Cushman, 1922, p. 130, pl. 25, figs. 4–5. Uchio, 1960, pl. 9, figs. 13–14.

Discussion. This species does not have wide distribution in the literature, probably because it is morphologically similar to other species of *Cassidulinoides.* Hayward and Buzas (1979, p. 56, pl. 14, fig. 181) figure a specimen of *Evolvocassidulina orientalis* (Cushman) which looks similar to *C. braziliensis* of this study. Further investigation reveals that *C. orientalis* is a "more compressed, broader form" (Cushman, 1922, p. 129). Figures by Barker (1960, pl. 54, fig. 10) and Hornibrook (1961, pl. 10, fig. 201) indicate that the aperture is elongate in the direction of test compression, normal to what is found in specimens of *C. braziliensis.* These specimens also resemble the smaller, less inflated tests of *C. porrectus* (Heron-Allen and Earland) from antarctic Recent sediments. Recent *C. porrectus* is a larger form, with its longest dimension generally ranging between 0.7 and 0.9 mm, as compared with *C. braziliensis*, which is less than 0.5 mm long. A common taxon in Subunits 2J, 2I, 2H, 2G, 2F, and 2E.

***Cassidulinoides* cf. *C. chapmani* Parr**
(Pl. 5, Fig. 12)

Cassidulinoides chapmani Parr, 1931, p. 100, figs. a–c.
Evolvocassidulina cf. *chapmani* (Parr). Hayward and Buzas, 1979, p. 55, pl. 15, fig. 180.

***Cassidulinoides* cf. *C. parkerianus* (Brady)**
(Pl. 5, Fig. 11)

Cassidulina parkeriana Brady, 1884, p. 432, pl. 54, figs. 11–16.
Cassidulinoides parkerianus (Brady). McKnight, 1962, p. 127, pl. 22, fig. 141.

Discussion. Specimens referred here to *C. parkerianus* are distinguished from *C. bradyi* (Norman) by possessing slightly more inflated chambers.

***Islandiella norcrossi* (Cushman)**
(Pl. 5, Figs. 7–8)

Cassidulina norcrossi Cushman, 1933, p. 7, pl. 2, fig. 7.

***Islandiella teretis* (Tappan)**
(Pl. 5, Fig. 5–6)

Cassidulina teretis Tappan, 1951, pl. 1, fig. 30.

***Globobulimina* sp.**
(Pl. 5, Figs. 15–16)

Globobulimina sp. Malumian, 1982, p. 58, pl. 4, figs. 15–16.

Discussion. This taxon closely resembles *Globobulimina* sp. from lower Miocene strata of Tierra del Fuego Island (local Gaviotian Stage; Malumian, 1982). At Site 270, *Globobulimina* sp. is closely associated with the characteristically agglutinated faunas.

Trifarina earlandi (Parr)

(Pl. 6, Figs. 15–16)

Uvigerina angulosa Heron-Allen and Earland (non Williamson), 1932, p. 397, pl. 12, figs. 32–39.

Angulogerina earlandi Parr. McKnight, 1962, p. 123, pl. 20, fig. 125. Echols, 1971, pl. 12, fig. 8. *Trifarina earlandi* (Parr). Anderson, 1975, p. 92, pl. 8, fig. 6.

Trifarina aff. *T. fueguina* Malumian

(Pl. 6, Figs. 10–12)

Trifarina angulosa fueguina Malumian, 1982, pp. 63–64, pl. 6, figs. 4–6.

Discussion. Specimens of Site 270 closely resemble *T. fueguina* from the lower and middle Miocene of Tierra del Fuego Island (local Gaviotian Stage) but they differ in possessing weaker ribs than the type material. Also, there appears to be some significant variability in the type material as exemplified by figs. 4, 5, and 6. Our specimens closely resemble fig. 4, one of the paratypes. *T.* aff. *fueguina* also resembles *T. fluens* (Todd) but is less angular and lacks the well-defined apertural lip of *T. fluens*. *T.* aff. *fueguina* is common at Site 270.

Trifarina pauperata (Heron-Allen and Earland)

(Pl. 6, Figs. 13–14)

Uvigerina angulosa Williamson, var. *pauperata* Heron-Allen and Earland, 1932, p. 398, pl. 12, figs. 40–43.

Angulogerina pauperta (Heron-Allen and Earland). Fillon, 1974, pl. 4, fig. 8.

Uvigerina cf. *U. miozea* Finlay

Uvigerina miozea Finlay, 1939, p. 102, pl. 12, figs. 12–14.

Hofkeruva (Trigonouva) miozea (Finlay). Vella, 1961, p. 477, pl. 1, figs. 5, 8, 9; pl. 2, fig. 6.

Uvigerina miozea Finlay. Hornibrook, 1961, p. 65, pl. 8, fig. 144.

Trigonouva miozea (Finlay). Vella, 1966, p. 97, pl. 27, fig. 23.

Euuvigerina miozea (Finlay). Hayward and Buzas, 1979, p. 55, pl. 14, fig. 178.

Discussion. The *Uvigerina miozea* species group first appears in the Waitakian Stage of New Zealand (early Miocene) or possibly in the Duntroonian Stage (late Oligocene) (Hornibrook, 1961; Hoskins, 1982). Although the name *U. miozea* has been applied to forms ranging as young as Pleistocene, Vella (1961, 1966) emphasizes that *U. miozea* s.s. ranges no younger than the Clifdenian Stage (early middle Miocene).

Buccella sp.

(Pl. 8, Fig. 13)

Description. Six-chambered, planoconvex form with subacute periphery. Umbilical region partially obscured by prominent pustules. Aperture interiomarginal, halfway between umbilicus and periphery. Supplementary sutural apertures clearly visible beyond umbilical region. Surficial resemblance to *Trochoelphidiella*. *Bucella* sp. has also been recorded in Oligocene–lower Miocene strata at the MSSTS drill site (Webb et al., in press).

Cancris laevinflatus Hornibrook

(Pl. 6, Figs. 8–9)

Cancris laevinflatus Hornibrook, 1961, p. 120, pl. 15, figs. 328, 331, 332.

Discussion. Hornibrook (1961) notes a stratigraphic range of late Oligocene to middle Miocene (Whaingaroan to Waiauan stages) for this taxon in New Zealand.

Epistominella vitrea Parker

(Pl. 6, Figs. 1–5)

Epistominella vitrea Parker, 1953, *in* Parker et al., 1953, p. 9, pl. 4, figs. 34–36, 40, 41. Murray, 1971, p. 130, pl. 54, figs. 1–6.

Discussion. This tiny species is a dominant taxon through most of the succession at Site 270; absent in Unit 4 and Subunit 2C, present and common in Subunits 2J, 2I, 2H, 2G, 2F, 2E, 2D, 2B, 2A, and Unit 1.

Rosalina globularis d'Orbigny

(Pl. 6, Figs. 6–7)

Rosalina globularis d'Orbigny, 1826, p. 271, pl. 13, figs. 1–2.

Discorbis globularis (d'Orbigny). McKnight, 1962, p. 125, pl. 20, fig. 133.

Rosalina globularis d'Orbigny. Fillon, 1974, pl. 4, figs. 11–12.

Discussion. Absent in Unit 4, present in only two intervals from Subunit 2J, but a persistent member of assemblages from Subunits 2I through 2A.

Elphidium magellanicum s.l. Heron-Allen and Earland

(Pl. 7, Figs. 1–9)

Elphidium (Polystomella) magellanicum Heron-Allen and Earland, 1932, p. 440, pl. 16, figs. 26–28. Murray, 1971, p. 163, pl. 68, figs. 1–7.

Description. Test planispiral, involute. Periphery rounded, slightly lobate in outline. Chambers inflated, 5 to 8½ in final whorl; 5½ to 6½ most common. Sutures depressed, slightly curved. Dense pustulation fills umbilical areas and sutures, obscuring sutural foramina and apertural face (Pl. 7, Figs. 8–9). Aperture a series of interiomarginal foramina, usually three (Pl. 7, Fig. 6).

Discussion. A variable species group with 5 to 8½ chambers in the final whorl. *E. magellanicum* previously described as having 5–7 (Hansen and Lykke-Andersen, 1976). Specimens from Site 270 with 7 to 8½ chambers in the final whorl are somewhat similar to *Protelphidium obiculare* (Brady) or *Elphidium barletti* Cushman (Pl. 7, Figs. 5, 7). *P. obiculare* characteristically has 7–10 chambers in the final whorl and is a much broader form than *E. magellanicum*. *E. barletti* has more numerous chambers, 10–12 in the final whorl, and better defined sutural foramina. This is a dominant taxon throughout most of the succession of Site 270, first appearing in Subunit 2I and ranging through Subunit 2A.

Elphidium cf. *E. nitidum* Dorreen

(Pl. 7, Fig. 11)

Elphidium nitidum Dorreen, 1948, p. 290, pl. 37, fig. 11.

Elphidium sp.

(Pl. 7, Fig. 10)

Description. Seven inflated chambers, periphery broadly rounded. Tests of several specimens are longer than broad. Appears to have 5–7 poorly preserved retral processes per lumen. Aperture not discernible. All specimens poorly preserved.

Discussion. Differs from *E. magellanicum* in possessing recognizable retral processes. In gross morphology it resembles *E. poeyanum* (d'Orbigny). Rare specimens occur in Unit 4 and the lower part of Subunit 2J.

Trochoelphidiella pustulosa n. sp.

(Pl. 8, Figs. 1–12, 14–15; Pl. 21, Figs. 14–19)

Holotype. Pl. 21, Figs. 14–16, Sample 270-32,CC (Subunit 2G), length 0.26 mm, width 0.21 mm, breadth 0.15 mm (megalospheric).

Paratypes. Pl. 8, Figs. 1,2, 15, Sample 270-31-3, 59–67 cm (Subunit 2G), length 0.30 mm, width 0.25 mm, breadth 0.15 mm (megalospheric); Pl. 8, Figs. 9–11, Sample 270-29-6, 8–18 cm (Subunit 2G), length 0.25 mm, width 0.20 mm, breadth 0.14 mm (megalospheric); Pl. 21, Figs. 17–18, Sample 270-31-3, 59–67 cm (Subunit 2G), length 0.33 mm, width 0.25 mm, breadth 0.18 mm (microspheric); Pl. 8, Fig. 3, Sample 270-29-6, 8–18 cm, length 0.26 mm, width 0.20 mm, breadth 0.15 mm (megalospheric); Pl. 8, Figs. 4, 12, Sample 270-32-3, 114–123 cm (Subunit 2G), length 0.24 mm, width, 0.20 mm, breadth 0.13 mm (megalospheric); Pl. 8, Figs. 5–6 and Pl. 21, Fig. 19, Sample 270-29-6, 8–18 cm (Subunit 2G), length 0.38 mm, width 0.30 mm (megalospheric); Pl. 8, Figs. 7, 8, 14, Sample 270-33-3, 102–110 cm (Subunit 2G), length 0.20 mm, width 0.17 mm, breadth 0.13 mm (megalospheric).

Description. Test calcareous, trochospirally coiled, never planispiral. Spiral side nearly flat, umbilical side slightly convex with depressed umbilicus. Periphery rounded. Dimorphic; the megalospheric form is the most common, possessing a total of about 13 chambers arranged in 2 whorls. the microspheric generation commonly has about 22 chambers in 3 whorls. Chambers increase rapidly in size as added, inflated on umbilical side, especially so in the last-formed chambers. The final chamber is rarely found intact. Sutures moderately curved on the spiral side, nearly radial on the umbilical side. The aperture consists of one to three small foramina at the base of the final chamber and extending from the periphery to the umbilicus (Pl. 8, Figs. 12, 14, 15). Apertures usually obscured by pustulation where complete final chambers are preserved; readily observable at the base of the penultimate chamber where pustulation is poorly developed. The umbilicus is depressed and contains dense pustulation. The umbilical extensions of each chamber cover a primitive canal system. Coarse pustules emerge through the chambers in the umbilical area from the underlying canals. In some specimens, primitive sutural canals are apparent as fissures between the umbilical extensions of the chambers. These extensions fuse together toward the periphery (Pl. 8, Figs. 1, 4, 11). No septal foramina or retral processes are apparent. However, an irregular pattern of foramina is developed in the umbilical area. The spiral side is generally smooth and devoid of pustulation. The simple sutural canal system may extend around the periphery to the spiral side, there expressed externally as small foramina at the base of the spiral chambers. The surface texture of the test is smooth to finely granular. Finely perforate. The microspheric and megalospheric forms are similar in size. Both range in diameter from 0.24 to 0.38 mm, width from 0.19 to 0.30 mm, and breadth from 0.10 to 0.15 mm. The proloculus of the microspheric generation is about 0.008 mm compared with 0.040 to 0.050 mm in the dominant megalospheric generation.

Discussion. *Trochoelphidiella pustulosa* n. sp. shares several characteristics with the Pliocene genotype, *T. onyxi* (Webb, 1974). The attitude of the septal walls, both dorsally and ventrally, is similar in both species. The presence of a canal system, though crudely developed in *T. pustulosa*, establishes an affinity with *T. onyxi*. Both possess interiomarginal multiple apertures and exhibit a prominent pustulation on the umbilical side. Dimorphism, with a dominance of the megalospheric generation, is another shared feature. *Trochoelphidiella pustulosa* differs from Pliocene *T. onyxi* in several respects. The chambers of *T. onyxi* increase gradually as added, producing a test that is circular in outline in contrast to the more oblong shape of *T. pustulosa*, which is produced by chambers that increase rapidly in size. *T. pustulosa* lacks the distinctive, paired, septal canal foramina of *T. onyxi*. The canal system of *T. pustulosa* is rather simple and is developed primarily in the umbilical area. The pustulation of *T. pustulosa* is coarser than that of the Pliocene *T. onyxi*. The spiral side of *T. onyxi* is convex, and low to highly elevated, whereas the spiral side of *T. pustulosa* is nearly flat. The apertures of *T. pustulosa* also differ somewhat from *T. onyxi* in that they are confined to a single row of small foramina at the base of the final chamber and extend only from the periphery to the umbilicus. Those of *T. onyxi* consist to one to two rows of small foramina that may extend across the entire base of the apertural lumen (interiomarginal). A further distinction between the two species is in the size of their two generations; the megalospheric and microspheric forms of *T. pustulosa* are similar in size, whereas the two generations of *T. onyxi* demonstrate a marked difference in size, the microspheric form being the larger. *Trochoelphidella pustulosa* is biostratigraphically significant at Site 270. It first appears in 270-38-3, 87–96 cm (Subunit 2I) and ranges up through Subunits 2H, 2G, 2F, with a single occurrence in Subunit 2B. It is probably ancestral to *T. uniforamina* D'Agostino (early to middle and ?late Miocene) and *T. onyxi* Webb (Pliocene). Type specimens to be placed in the U.S. National Museum, Washington, D.C.

Trochoelphidiella uniforamina D'Agostino
(Pl. 9, Figs. 1–12; Pl. 10, Figs. 11–13; Pl. 21, Figs. 8–13)

Trochoelphidiella uniforamina D'Agostino, 1980, p. 76, pl. 5, figs. 1–12.

Hypotypes. Pl. 9, Figs. 1–3, 9–12, and Pl. 21, Figs. 11–13, Sample 270-5-2, 122–132 cm (Subunit 2A), length 0.56 mm, width 0.46 mm, breadth 0.30 mm (microspheric); Pl. 9, Fig. 4, Section 270-28-6, bottom (Subunit 2F), length 0.25 mm, width 0.23 mm, breadth 0.13 mm (megalospheric); Pl. 9, Figs. 5–6 and Pl. 21, Figs. 8–10, Sample 270-15,CC (Subunit 2B), length 0.18 mm, width 0.15 mm, breadth 0.07 mm (megalospheric); Pl. 9, Figs. 7–8, Section 270-28-6, bottom (Subunit 2F), length 0.23 mm, width 0.20 mm, breadth 0.13 mm (megalospheric).

Description. Test calcareous, trochospirally coiled, never planispiral. Circular in outline, biconvex in edge view. Dimorphism pronounced, with the megalospheric form the most common. Chambers increase gradually in size as added, slightly inflated on the spiral side, more so on the umbilical side. Sutures moderately curved on the spiral side, nearly radial on the umbilical side. Aperture consists of one to three small interiomarginal foramina. Apertures usually obscured by pustulation (Pl. 9, Fig. 9). The umbilicus is slightly depressed and covered by pustulose ornament, which also covers sutures on the umbilical side. A sutural canal system is developed by septal doubling and chamber overlap. The canal system does not appear to extend to the spiral side. Communication with the exterior is via a series of single, elongate sutural foramina (Pl. 9, Figs. 9–12). The spiral side is generally smooth and devoid of pustulation. The surface texture of the test is finely granular.

Discussion. *Trochoelphidiella uniforamina* D'Agostino is morphologically similar to the Pliocene genotype *T. onyxi* (Webb, 1974). There are several significant differences. *T. uniforamina* lacks an umbilical lumen, a feature present in *T. onyxi*. The series of sutural canal foramina of *T. uniforamina* occur in a single row and are elongate parallel to the septa. This differs from the characteristic paired septal canal foramina of *T. onyxi* which are elongate normal to the septa. This canal system extends around the periphery to the spiral side in *T. onyxi* whereas in *T. uniforamina* it is restricted to the umbilical side. A further difference is in the multiple apertures, which in *T. onyxi* may be in one or two rows, compared with a single row in *T. uniforamina*.

Although *Trochoelphidiella uniforamina* is closely related to *T. onyxi*, it also shares similarities with *T. pustulosa* n. sp. The nature of the multiple apertures, lack of an umbilical lumen, and presence of a canal system restricted to the umbilical side are all characteristics common to both *T. uniforamina* and *T. pustulosa*. In all other respects, *T. pustulosa* differs from *T. uniforamina* as it does from *T. onyxi*.

Trochoelphidiella uniforamina appears to be intermediate between *T. pustulosa* and *T. onyxi*. Its first appearance in the early Miocene (270-35-3, 112–121 cm, Subunit 2H) is preceded stratigraphically by *T. pustulosa* (270-38-3, 87–96 cm, Subunit 2I) with several transitional specimens (270-35,CC) which do not exhibit the true characteristics of *T. uniforamina* (Pl. 10, Figs. 11–13). *T. uniforamina* is most prolific by the middle Miocene, as documented by D'Agostino (1980). It is not known at present whether a late Miocene precursor to Pliocene *T. onyxi* exists (Webb, 1974). *T. uniforamina* occurs sporadically through Subunits 2H, 2G, 2F, 2E, 2B, and 2A.

Trochoelphidiella sp.
(Pl. 10, Figs. 1–10; Pl. 21 Figs. 1–7)

Hypotypes. Pl. 10, Figs. 1–2, and Pl. 21, Figs. 1–2, Sample 270-37-4, 133–142 cm (Subunit 2I), length 0.62 mm, width 0.55 mm, breadth, 0.25 mm; Pl. 10, Figs. 3–4 and Pl. 21, Figs. 3–4, Sample 270-29-6, 8–18 cm (Subunit 2G), length 0.27 mm, width 0.22 mm, breadth 0.11 mm; Pl. 10, Figs. 5–7, 10, Sample 270-8-3, 113–128 cm, breadth 0.15 mm; Pl. 10, Figs. 8–9, Sample 270-6-1, 113–123 cm (Subunit 2A), width 0.23 mm, breadth 0.14 mm; Pl. 21, Figs. 5–7, Sample 270-32-3, 114–123 cm (Subunit 2G), length 0.34 mm, width 0.30 mm, breadth 0.16 mm.

Description. Test calcareous, low trochospiral coil. Periphery rounded to subangular (Pl. 10, Figs. 6, 9; Pl. 21, Figs. 1, 3, 6). Circular to oblong in outline, biconvex in side view with tendency to be flat on the umbilical side. Dimorphism not observed. Chambers increasing gradually as added, slightly inflated on the umbilical side. Aperture consists of one or two small interiomarginal foramina. Umbilicus slightly depressed, pustulose to coarsely granular as are the umbilical sutures. A septal canal system is present but it is uncertain if the sutural foramina are paired or singular. The canal system is best developed on the umbilical side and may or may not extend to the spiral side. About 8 chambers in the final whorl. Surface texture of the test is finely to coarsely granular.

Discussion. These rare specimens of *Trochoelphidiella* possess morphologic characteristics different from *T. pustulosa* n.sp., *T. uniforamina* D'Agostino, or *T. onyxi* Webb. The low trochospiral coil and tendency for the umbilical side to be flat distinguish this group. They may represent a new species. All tests appear megalospheric. *Trochoelphidiella* sp. is rare in Subunits 2G and 2A.

***Eponides bradyi* Earland**
(Pl. 23, Figs. 11-13)

Truncatulina pygmaea Hantken. Brady, 1884, pl. 95, figs. 9-10.
Eponides bradyi Earland, 1934, p. 187, pl. 8, figs. 36-38. Boltovskoy, 1978, p. 15, pl. 4, figs. 1-3.

***Eponides tumidulus* (Brady)**
(Pl. 12, Fig. 2)

Truncatulina tumidulus Brady, 1884, pl. 95, fig. 8.

***Eponides* cf. *E. weddellensis* Earland**
(Pl. 12, Fig. 1)

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

***Cibicides lobatulus* (Walker and Jacob)**
(Pl. 11, Figs. 10-12)

Nautilus lobatus Walker and Jacob, 1798, p. 642, pl. 14, fig. 36.
Cibicides lobatulus (Walker and Jacob). Murray, 1971, p. 175, pl. 73, figs. 1-7.

***Cibicides* cf. *C. mediocris* Finlay**
(Pl. 22, Figs. 13-16)

Cibicides mediocris Finlay, 1940, p. 464, pl. 67, figs. 198, 199. Hornibrook, 1961, p. 160, pl. 25, figs. 499, 500, 502. Hayward and Buzas, 1979, p. 48, pl. 10, figs. 127-129.

Discussion. Hornibrook (1961) gives the range of this species in New Zealand as early Oligocene to late Miocene (Duntroonian to Tongaporutuan).

***Cibicides pseudoungerianus* (Cushman)**
(Pl. 22, Figs. 4-6)

Truncatulina pseudoungeriana Cushman, 1922, p. 97, pl. 20, fig. 9
Cibicides pseudoungerianus (Cushman). Murray, 1971, p. 176, pl. 74, figs. 1-6.

***Cibicides refulgens* Montfort**
(Pl. 11, Figs. 13-15)

Cibicides refulgens Montfort, 1808-1810, p. 122. McKnight, 1962, p. 129, pl. 23, fig. 150. Anderson, 1975, p. 84, pl. 10, fig. 3.

***Cibicides temperata* s.l. Vella**
(Pl. 11, Figs. 1-9; Pl. 22, Figs. 1-3)

Cibicides temperata Vella, 1957, p. 40, pl. 9, figs. 201-203. Hornibrook, 1961, p. 162, pl. 24, figs. 476, 477, 482.
Cibicidoides temperatus (Vella). Hayward and Buzas, 1979, p. 49, pl. 11, figs. 135-137.

Discussion. *Cibicides temperata* displays considerable morphologic variation. The height of the ventral surfaces is illustrated in Pl. 11, Figs. 2, 6. The height of the dorsal surface also varies, from nearly flat (Pl. 11, Fig. 4) to biconvex (Pl. 11, Fig. 2). The attitude of the sutures on the umbilical side ranges from slightly curved to nearly radial. The characteristics that distinguish this species group are the 6-8 chambers in the final whorl (6½ to 7 most common) and the low but wide aperture. *C. temperata* is common and persistent throughout Unit 2 (late Oligocene-early Miocene) at Site 270. Hornibrook (1961) gives the range of this species in New Zealand as late Eocene (Runangan Stage) to Recent.

***Cibicides* cf. *C. thiara* (Stache)**
(Pl. 22, Figs. 7-9)

Rosalina thiara Stache, 1864, p. 279, pl. 24, figs. 29-30.
Cibicides thiara (Stache). Hornibrook, 1961, p. 159, pl. 25, figs. 495, 497. Hornibrook, 1971, p. 52, pl. 11, figs. 188-190.

Discussion. Hornibrook (1961) records the range of this species in New Zealand as late Eocene to late Oligocene (upper Arnold Series to Waitakian Stage).

***Cibicides vortex* Dorreen**
(Pl. 22, Figs. 10-12)

Cibicides vortex Dorreen, 1948, p. 299, pl. 41, fig. 5. Hornibrook, 1961, p. 160, pl. 24, figs. 490-492. Hayward and Buzas, 1979, p. 49, pl. 11, figs. 138-139.

Discussion. In New Zealand this species ranges from middle Eocene to middle Miocene (Bortonian to Lillburnian stages; Hornibrook, 1961).

***Fursenkoina schreibersiana* (Czjzek)**
(Pl. 12, Fig. 3)

Virgulina schreibersiana Czjzek, 1848, p. 11, pl. 13, figs. 18-21. Hornibrook, 1961 p. 64, pl. 8, fig. 138.

***Ehrenbergina glabra* Heron-Allen and Earland**
(Pl. 12, Figs. 11-12)

Ehrenbergina hystrix Brady var. *glabra* Heron-Allen and Earland, 1922 p. 140, pl. 5, figs. 1-6.
Ehrenbergina glabra Heron-Allen and Earland. McKnight, 1962, p. 127, pl. 22, fig. 142. Fillon, 1974, pl. 5, figs. 9-10.

***Globocassidulina biora* (Crespin)**
(Pl. 12, Fig. 10)

Cassidulina biora Crespin, 1960, p. 28, pl. 3, figs. 1-10.
Globocassidulina biora (Crespin). Fillon, 1974, p. 133, pl. 1, figs. 8-15.

***Globocassidulina crassa* (d'Orbigny)**
(Pl. 12, Figs. 7-9)

Cassidulina crassa d'Orbigny, 1839, p. 56, pl. 7, figs. 18-20.
Globocassidulina crassa (d'Orbigny) var. *rossensis* Kennett, 1967, p. 134, pl. 11, figs. 4-6.
Globocassidulina crassa rossensis Kennett. Fillon, 1974, p. 132, pl. 1, figs. 1-7.

***Globocassidulina subglobosa* (Brady)**
(Pl. 12, Figs. 4-6)

Cassidulina subglobosa Brady, 1884, p. 60, pl. 54, fig. 17.
Cassidulina subglobosa subglobosa Brady. Boltovskoy, 1978, p. 155, pl. 2, fig. 34.
Globocassidulina subglobosa (Brady). Hayward and Buzas, 1979, p. 59, pl. 17, figs. 219-220.

***Astrononion echolsi* Kennett**
(Pl. 13, Figs. 1-2)

Astrononion echolsi Kennett, 1967, p. 134, pl. 11, figs. 7-8. Fillon, 1974, p. 139, pl. 6, figs. 1-3.

***Nonionella bradii* (Chapman)**
(Pl. 13, Fig. 6; Pl. 23, Figs. 1-2)

Nonionina scapha (Fichtel and Moll) var. *bradii* Chapman, 1916, p. 71, pl. 5, fig. 42.
Nonionella bradii (Chapman). McKnight, 1962, p. 118, pl. 17, fig. 99. Fillon, 1974, pl. 5, figs. 12-13. Anderson, 1975, p. 90, pl. 11, fig. 6.

***Nonionella iridea* Heron-Allen and Earland**
(Pl. 13, Figs. 3-4; Pl. 23, Figs. 5-7)

Nonionella iridea Heron-Allen and Earland, 1932, p. 438, pl. 16, figs. 14-16. Fillon, 1974, p. 140, pl. 5, figs. 11, 14.

***Nonionella magnalingua* Finlay**
(Pl. 13, Fig. 5; Pl. 23, Figs. 3-4)

Nonionella magnalingua Finlay, 1940, p. 456, pl. 65, figs. 144, 146. Hornibrook, 1961, p. 94, pl. 12, figs. 226, 232, 233.

***Pullenia bulloides* (d'Orbigny)**
(Pl. 13, Fig. 10)

Nonionina bulloides d'Orbigny, 1846, p. 107, pl. 5, figs. 9-10.
Pullenia bulloides (d'Orbigny). Hornibrook, 1961, p. 90, pl. 11, figs. 205-206.

Pullenia subcarinata (d'Orbigny)
(Pl. 13, Figs. 7–9)

Nonionina subcarinata d'Orbigny, 1839, p. 28, pl. 5, figs. 23–24.
Pullenia subcarinata (d'Orbigny). McKnight, 1962, p. 128, pl. 22, fig. 44.

Gyroidina cf. *G. obicularis* d'Orbigny
(Pl. 13, Figs. 15–16)

Gyroidina obicularis d'Orbigny, 1826, p. 278, no. 1, modèles no. 13. Boltovskoy, 1978, p. 160, pl. 4, figs. 16–17.
Gyroidinoides obicularis (d'Orbigny). Corliss, 1979, p. 9, pl. 5, figs. 1–3.

Gyroidina parva Cushman and Renz
(Pl. 13, Figs. 11–12)

Gyroidina parva Cushman and Renz, 1941, p. 23, pl. 4, fig. 2.
Gyroidina parva Cushman and Renz. Becker and Dusenbury, 1958, p. 39, pl. 7, fig. 8.

Gyroidina zelandica Finlay
(Pl. 13, Figs. 13–14; Pl. 23, Figs. 8–10)

Gyroidina zelandica Finlay, 1939, p. 323, pl. 28, figs. 138–140.
Gyroidinoides zelandica (Finlay). Hornibrook, 1961, p. 113, pl. 16, figs. 339, 334.
Gyroidina zelandica Finlay. Douglas, 1973, pl. 12, figs. 4–9; pl. 24, figs. 5–6. Hayward and Buzas, 1979, p. 60, pl. 18, figs. 221–223.

Oridorsalis tenera (Brady)
(Pl. 13, fig. 17)

Truncatulina tenera Brady, 1884, pl. 95, fig. 11.
Eponides tenera (Brady). McKnight, 1962, p. 126, pl. 21, fig. 136.
Oridorsalis tenera (Brady). Fillon, 1974, pl. 6, figs. 10–11.

Anomalinoides globulosa (Chapman and Parr)
(Pl. 14, Figs. 13–16)

Anomalina grosserugosa (Guembel). Brady, 1884, pl. 94, figs. 4–5.
Anomalina globulosa Chapman and Parr, 1937, p. 117, pl. 9, fig. 27. Boltovskoy, 1978, p. 152, pl. 1, figs. 5, 8.
Anomalinoides globulosa (Chapman and Parr). Hayward and Buzas, 1979, p. 39, pl. 4, figs. 50–51.

Discussion. Reported from the Oligocene of Ninetyeast Ridge (Indian Ocean) by Boltovskoy (1978) and from the early Miocene of New Zealand by Hayward and Buzas (1979).

Anomalinoides cf. *A. macraglabra* (Finlay)
(Pl. 14, Figs. 8–9)

Anomalina macraglabra Finlay, 1940, p. 460, pl. 65, figs. 141–143.
Anomalinoides macraglabra (Finlay). Hornibrook, 1961, p. 155, pl. 24, figs. 473–475. Hayward and Buzas, 1979, p. 40, pl. 5, figs. 52–53.

Discussion. In New Zealand, *A. macraglabra* ranges from the late Eocene to middle Miocene (Runangan to Waiauan stages) (Hornibrook, 1961).

Anomalinoides pinguiglabra (Finlay)
(Pl. 14, Figs. 10–12)

Anomalina pinguiglabra Finlay, 1940, p. 460, pl. 66, figs. 160–165.
Anomalina pinguiglabra (Finlay). Hornibrook, 1961, p. 156, pl. 23, figs. 464–466.

Discussion. *A. pinguiglabra* ranges from the early Oligocene to middle Miocene in New Zealand (Whaingaroan Stage to upper Southland Series) (Hornibrook, 1961).

Melonis affinis (Reuss)
(Pl. 14, Figs. 5–7)

Nonionina affinis Reuss, 1851, p. 72, pl. 5, fig. 32.
Nonion affine (Reuss). Boltovskoy, 1978, p. 162, pl. 5, figs. 1–2.
Melonis affinis (Reuss). Hayward and Buzas, 1979, p. 65, pl. 20, fig. 256.

Melonis barleeanus (Williamson)
(Pl. 14, Figs. 1–4)

Nonionina barleeana Williamson, 1858, p. 32, pl. 3, figs. 68–69.
Melonis barleeanum (Williamson). Corliss, 1979, p. 10, pl. 5, figs. 7–8.

Robertina tasmanica Parr
(Pl. 23, Figs. 14–15)

Robertina tasmanica Parr, 1950, p. 369, pl. 15, figs. 10–11.

Chiloguembelina cubensis (Palmer)
(Pl. 15, Fig. 11)

Guembelina cubensis Palmer, 1934, p. 74, text-figs. 1–6.
Chiloguembelina spp. ex group *cubensis* (Palmer). Blow, 1969, p. 222, 378, pl. 54, figs. 4–6.
Chiloguembelina cubensis (Palmer). Jenkins, 1971, p. 66, pl. 1, figs. 3–5.

Globigerinelloides cf. *G. volutus* (White)
(Pl. 16, Fig. 16)

Globigerina volutus White, 1928, p. 197, pl. 28, fig. 5.
Globigerinelloides volutus (White). Webb, 1973, p. 552, pl. 2, figs. 5–7.

Discussion. Recycled from Cretaceous sediments.

Globorotalia sp.
(Pl. 16, Figs. 10–15)

Discussion. The very small size, umbilical-extraumbilical arched aperture, five inflated chambers in the final whorl, and chambers that rapidly increase in size as added are characteristic features of this species and not known in named antarctic Quaternary taxa. The specimens have a weakly to moderately pustulose surface. An extensive literature search failed to find an adequate reference to this species. Engelhardt (1980) notes a similar form from the late Miocene of the southeast Indian Ocean.

Globorotalia cf. *G. gemma* Jenkins
(Pl. 15, Figs. 12–13)

Globorotalia (Turborotalia) postcretacea (Myatliuk). Blow and Banner, 1962, p. 120, pl. 12, figs. g–j.
Globorolatia gemma Jenkins, 1966, p. 1115, fig. 11, no. 97–103.
Turborotalia gemma (Jenkins). Srinivasan, 1968, p. 146, pl. 14, figs. 3–4.
Globorotalia gemma Jenkins. Blow, 1969, p. 348, pl. 34, fig. 9.
Globorotalia (Turborotalia) gemma Jenkins. Jenkins, 1971, p. 115, pl. 10, figs. 263–269.

Globorotalia cf. *G. siakensis* LeRoy
(Pl. 15, Figs. 14–16)

Globorotalia siakensis Leroy, 1939, pl. 3, figs. 30–31.
Globorotalia (Turborotalia) siakensis Leroy. Blow, 1969, p. 356, pl. 10, figs. 7–9; pl. 34, figs. 4–5.
Globorotalia (Jenkinsella) siakensis Leroy. Kennett and Srinivasan, 1983, p. 172, pl. 42, figs. 1, 6–8.

Globigerina cf. *G. angiporoides* Hornibrook
(Pl. 15, Figs. 5–7)

Globigerina angipora Stache. Hornibrook, 1961, p. 145, text-figs. 3a–d.
Globigerina (Subbotina) angiporoides angiporoides Hornibrook. Jenkins, 1971, p. 160, Pl. 20, figs. 588–594.

Globigerina megastoma Earland
(Pl. 16, Figs. 6–8)

Globigerina megastoma Earland, 1934, p. 177, pl. 8, figs. 9–12. Banner and Blow, 1960, p. 14, pl. 1, fig. 3. Kennett, 1968, p. 42.

Discussion. This species closely resembles *Globorotalia anfracta* Parker. The nature of the aperture appears to be the only criterion to distinguish the two species. The aperture of *Globorotalia anfracta* is extraumbilical-umbilical, whereas that of *Globigerina megastoma* is umbilical, with a strong tendency toward an extraumbilical position. Is is this extraumbilical tendency that makes some specimens of *G.*

megastoma look more like *Globorotalia*. In Earland's (1934, p. 177) original description of *G. megastoma,* he states that the test is large; "maximum breadth of the final convolution about 0.60 mm." Banner and Blow (1960, p. 15) examined Heron-Allen and Earland's collections in the British Museum and noted that there were "very many small specimens of this species". Antarctic collections of *Globigerina megastoma* discussed by Ward (1979) and D'Agostino (1980) have been examined by the authors and found to contain specimens ranging in maximum diameter from 0.11 to 0.35 mm. These populations also demonstrate the full range of aperture position from extraumbilical-umbilical to umbilical.

Globigerina cf. *G. ouachitaensis* Howe and Wallace
(Pl. 15, Figs. 8-10)

Globigerina ouachitaensis Howe and Wallace, 1932, p. 74, pl. 10, figs. 7a, b. Jenkins, 1971, p. 153, pl. 16, figs. 489-490.

Globorotaloides cf. *G. suteri* Bolli
(Pl. 15, Figs. 3-4)

Globorotaloides suteri Bolli, 1957, p. 117, pl. 27, figs. 9-13. Jenkins, 1971, p. 189, pl. 22, figs. 646-648. Kennett and Srinivasan, 1983, p. 214, pl. 53, figs. 1, 3-5.

Globigerinita cf. *G. glutinata* (Egger)
(Pl. 16, Figs. 3-5)

Globigerina glutinata Egger, 1893, p. 371, pl. 13, figs. 19-21.

Globigerinita glutinata (Egger). Kennett and Srinivasan, 1983, p. 224, pl. 56, figs. 1, 3-5.

Globigerinoides trilobus (Reuss)
(Pl. 15, Figs. 1-2)

Globigerina triloba Reuss, 1850, p. 374, pl. 47, fig. 11.

Globigerinoides quadrilobatus trilobus (Reuss). Blow, 1969, p. 326.

Globigerinoides trilobus trilobus (Reuss). Jenkins, 1971, p. 180, pl. 19, figs. 571-581.

Globigerinoides triloba (Reuss). Kennett and Srinivasan, 1983, p. 62, pl. 13, figs. 1-3.

Neogloboquadrina pachyderma (Ehrenberg)
(Pl. 16, Figs. 1-2)

Aristerospira pachyderma Ehrenberg, 1861, p. 303.

Neogloboquadrina pachyderma (Ehrenberg), Kennett and Srinivasan, 1983, p. 192, pl. 47, figs. 3-5.

Candeina antarctica Leckie and Webb

Candeina antarctica Leckie and Webb, 1985, pl. 1, figs. 1-15; pl. 2, figs. 1-9; pl. 3, figs. 3, 6, 8.

Discussion. *Candeina antarctica* was the dominant, virtually monospecific planktonic foraminiferal species throughout the Ross Sector of Antarctica during the latest Oligocene to middle Miocene (Leckie and Webb, 1985).

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REFERENCES

References not cited here can be found in the foraminifer treatise by Loeblich and Tappan (1964).

Allis, R. G., Barrett, P. J., and Christoffel, D. A., 1975. A paleomagnetic stratigraphy for Oligocene and early Miocene marine glacial sediments at Site 270, Ross Sea, Antarctica. *In* Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 879-884.

Anderson, J. B., 1975. Ecology and distribution of foraminifera in the Weddell Sea of Antarctica. *Micropaleontology*, 21:69-96.

Asano, K., 1950. Some Lituolidae from the Tertiary of Japan. *Contr. Cushman Found. Foram. Res.*, 1:75-79.

Banner, F. T., and Blow, W. H., 1960. Some primary types of species belonging to the superfamily Globigerinaceae. *Contr. Cushman Found. Foram. Res.*, 11:1-41.

Barker, R. W., 1960. *Taxonomic Notes on the Species Figured by H. B. Brady in His Report on the Foraminifera dredged by H.M.S.* Challenger *during the Years 1873-1876.* Soc. Econ. Paleont. Mineral. Spec. Publ. 9.

Barrett, P. J., 1975. Textural characteristics of Cenozoic preglacial and glacial sediments at Site 270, Ross Sea, Antarctica. *In* Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 757-767.

Becker, L. E., and Dusenbury, A. N., Jr., 1958. *Mio-Oligocene (Aquitanian) Foraminifera from the Goajira Peninsula, Colombia.* Cushman Found. Foram. Res., Spec. Publ., 4.

Berggren, W. A., Kent, D. V., Flynn, J. J., and Van Couvering, J. A., in press. Cenozoic geochronology. *In* Snelling, N. J. (Ed.), *Geochronology and the Geologic Time Scale.* Geol. Soc., London, Spec. Pap.

Blow, W. H., 1969. Late Middle Eocene to Recent planktonic foraminiferal biostratigraphy. *In* Brönnimann, P., and Renz, H. H. (Eds.), *Proc. 1st Int. Conf. Planktonic Microfossils, Geneva, 1967*: Leiden (E. J. Brill), 199-421.

Blow, W. H., and Banner, F. T., 1962. The Mid-Tertiary (Upper Eocene to Aquitanian) Globigerinaceae. *In* Eames, F. E., Banner, F. T., Blow, W. H., and Clarke, W. J. (Eds.), *Fundamentals of Mid-Tertiary Stratigraphical Correlation*: Cambridge (Cambridge Univ. Press), pp. 61-152.

Boltovskoy, E., 1978. Late Cenozoic benthonic foraminifera of the Ninetyeast Ridge (Indian Ocean). *Mar. Geol.*, 26:139-175.

Bukry, D., 1981. Cenozoic coccoliths from the Deep Sea Drilling Project. *In* Warme, J. E., Douglas, R. G., and Winterer, E. L. (Eds.), *The Deep Sea Drilling Project: A Decade of Progress*, Soc. Econ. Paleontol. Mineral., Spec. Publ., 32:335-353.

Burns, D. A., 1975. Nannofossil biostratigraphy for Antarctic sediments, Leg 28, DSDP. *In* Hayes, D. E., Frakes, L. A. et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 589-598.

Chapman, F., 1904. On some Cainozoic foraminifera from Brown's Creek, Otway Coast. *Rec. Geol. Surv. Vict.*, 1:227-230.

Chapman, F., 1916. Report on the Foraminifera and Ostracoda out of marine muds from soundings in the Ross Sea. *British Antarct. Exped. 1907-1909, Repts. Sci. Investig., Geol.*, 2(3):53-80.

Chapman, F., and Parr, W. J., 1937. *Foraminifera, Australian Antarctic Expedition, 1911-1914: Scientific Reports, Series C—Zoology and Botany*, 1(pt. 2):1-190.

Chen, P.-H., 1975. Antarctic radiolaria. *In* Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 437-513.

Ciesielski, P. F., 1975. Biostratigraphy and paleoecology of Neogene and Oligocene silicoflagellates from cores recovered during Antarctic Leg 28, Deep Sea Drilling Project. *In* Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 625-691.

Codignotto, J. O., and Malumian, N., 1981. Geología de la region al norte del paralelo 54°S de la Isla Grande de la Tierra del Fuego. *Rev. Assoc. Geol. Argentina*, 36:44-88.

Cook, H. E., Zemmels, I., and Matti, J. C., 1975. X-ray mineralogy data, Austral-Antarctic region, Deep Sea Drilling Project Leg 28.

In Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 981–998.

Corliss, B. H., 1979. Taxonomy of Recent deep-sea benthonic foraminifera from the southeast Indian Ocean. *Micropaleontology*, 25: 1–19.

Crespin, I., 1950. Some Tertiary Foraminifera from Victoria, Australia. *Contr. Cushman Found. Foram. Res.*, 1:70–74.

________, 1960. Some Recent foraminifera from Vestfold Hills, Antarctica. *Sci. Rep. Tohoku Univ.* Ser. 2 (Geol.), Spec. Vol. 4:19–31.

Cushman, J. A., 1925. New foraminifera from the upper Eocene of Mexico. *Contr. Cushman Lab. Foram. Res.*, 1(1):4–8.

________, 1933. New Arctic foraminifera collected by Capt. R. A. Bartlett from Fox Basin and off the northeast coast of Greenland. *Smithsonian Misc. Coll.*, 89(9):1–8.

________, 1951. *Paleocene Foraminifera of the Gulf Coast Region of the United States and Adjacent Areas.* U.S. Geol. Surv. Prof. Paper, 232.

Cushman, J. A., and Jarvis, P. W., 1928. Cretaceous foraminifera from Trinidad. *Contr. Cushman Lab. Foram. Res.*, 4:85–103.

D'Agostino, A. E., 1980. Foraminiferal biostratigraphy, paleoecology, and systematics of DSDP Site 273, Ross Sea, Antarctica [M.S. thesis]. Northern Illinois University, DeKalb.

Dorreen, J. M., 1948. A foraminiferal fauna from the Kaiatan Stage (Upper Eocene) of New Zealand. *J. Paleontol.*, 22:281–300.

Douglas, R. G., 1973. Benthonic foraminiferal biostratigraphy in the central North Pacific, Leg 17, Deep Sea Drilling Project. *In* Winterer, E. L.,Ewing, J. I. et al., *Init. Repts. DSDP*, 17: Washington (U.S. Govt. Printing Office), 607–671.

Earland, A., 1934. Foraminifera, part III. The Falklands sector of the Antarctic (excluding South Georgia). *Discovery Repts*, 10:1–208.

________, 1936. Foraminifera, Part IV. Additional records from the Weddell Sea Sector from material obtained by S. Y. *Scotia*. *Discovery Repts.*, 13:1–76.

Echols, R. J., 1971. Distribution of foraminifera in sediments of the Scotia Sea area, Antarctic waters. *In* Reid, J. L. (Ed.), *Antarctic Oceanology 1.* Antarct. Res. Ser., 15:93–168.

Engelhardt, N. L., 1980. Paleoecologic and biostratigraphic interpretations of late Miocene foraminifera at DSDP Site 265 (Leg 28), southeast Indian Ocean [M.S. thesis]. Northern Illinois University, DeKalb.

Fillon, R. H., 1974. Late Cenozoic foraminiferal paleoecology of the Ross Sea, Antarctica. *Micropaleontology*, 20:129–151.

Ford, A. B., and Barrett, P. J., 1975. Basement rocks of the south-central Ross Sea, Site 270, DSDP Leg 28. *In* Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 861–868.

Hansen, H. J., and Lykke-Anderson, A-L., 1976. Wall structure and classification of fossil and recent elphidiid and nonionid foraminifera. *Fossils and Strata*, 10:1–37.

Hayes, D. E., Frakes, L. A., et al., 1975. *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office).

Hayward, B. W., and Buzas, M. A., 1979. *Taxonomy and Paleoecology of Early Miocene Benthic Foraminifera of Northern New Zealand and the North Tasman Sea.* Smithsonian Contr. Paleobiol., 36.

Heirtzler, J. R., Dickinson, G. O., Herron, E. M., Pitman, W. C. III, and Le Pichon, X., 1968. Marine magnetic anomalies, geomagnetic field reversals and motions of the ocean floor and continents. *J. Geophys. Res.*, 73:2119–2136.

Heron-Allen, E., and Earland, A., 1922. Protozoa, Part II. Foraminifera. *British Antarct. Exped. 1910, Zool.*, 6(2):25–268.

Hornibrook, N. de B., 1961. *Tertiary Foraminifera from Oamaru District (N.Z.) Part I—Systematics and Distribution.* N. Z. Geol. Surv. Paleontol. Bull., 34(1).

________, 1968. *A Handbook of New Zealand Microfossils (Foraminifera and Ostracoda).* N. Z. Geol. Surv., Info. Ser. 62.

________, 1971. *A Revision of the Oligocene and Miocene Foraminifera from New Zealand Described by Karrer and Stache in the Reports of the "Novara" Expedition (1864).* N. Z. Geol. Surv. Paleontol. Bull., 43.

Hoskins, R. H., 1982. *Stages of the New Zealand Marine Cenozoic: A Synopsis.* N. Z. Geol. Surv. Rept., 107.

Jenkins, D. G., 1966. Planktonic foraminiferal zones and new taxa from the Danian to Lower Miocene of New Zealand. *N. Z. J. Geol. Geophys.*, 8:1088–1126.

________, 1971. *New Zealand Cenozoic Planktonic Foraminifera.* N. Z. Geol. Surv. Paleontol. Bull., 42.

Kaneps, A., 1975. Cenozoic planktonic foraminifera from Antarctic deep-sea sediments, Leg 28, DSDP. *In* Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 573–583.

Kemp, E. M., 1975. Palynology of Leg 28 drillsites, Deep Sea Drilling Project. *In* Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 599–608.

Kemp, E. M., and Barrett, P. J., 1975. Antarctic glaciation and early Tertiary vegetation. *Nature*, 258(5535):507–508.

Kennett, J. P., 1967. New foraminifera from the Ross Sea, Antarctica. *Contr. Cushman Found. Foram. Res.*, 18:133–135.

________, 1968. The fauna of the Ross Sea: Part 6, Ecology and distribution of foraminifera. *N. Z. Dept. Sci. Industr. Res. Mem.*, 46: 1–48.

Kennett, J. P., and Srinivasan, M. S., 1983. *Neogene Planktonic Foraminifera, A Phylogenetic Atlas*: Stroudsburg, PA (Hutchinson Ross).

LaBrecque, J. L., Kent, D. V., and Cande, S. C., 1977. Revised magnetic polarity time scale for Late Cretaceous and Cenozoic time. *Geology*, 5:330–335.

Leckie, R. M., and Webb, P. N., 1980. A provisional late Oligocene-early Miocene foraminiferal zonation, Ross Sea Continental Shelf, Antarctica. *Geol. Soc. Am. Abstr. Progr.*, 12:469.

________, 1983. Late Oligocene–early Miocene glacial record of the Ross Sea, Antarctica: Evidence from DSDP Site 270. *Geology*, 11: 578–582.

________, 1985. *Candeina antarctica* n.sp. and the phylogenetic history and distribution of *Candeina* spp. in the Paleogene–early Neogene of the Southern Ocean. *J. Foram. Res.*, 15(2):65–78.

LeRoy, D. O., 1939. Some small foraminifera, ostracods and otoliths from the Neogene ("Miocene") of the Rokan-Tapanoeli area, central Sumatra. *Natuurk. Tijdschr. Nederl.-Indie*, 99(6):215–296.

Loeblich, A. R., Jr., and Tappan, H., 1964. Sarcodina, chiefly "Thecamoebians" and Foraminiferida. *In* Moore, R. C. (Ed.), *Treatise in Invertebrate Paleontology*, Protista 2, Pt. C: Lawrence (Univ. Kansas Press.).

Loutit, T. S., and Kennett, J. P., 1981. New Zealand and Australian Cenozoic sedimentary cycles and global sea-level changes. *Am. Assoc. Pet. Geol. Bull.*, 65:1586–1601.

Ludbrook, N. H., 1977. Early Tertiary *Cyclammina* and *Haplophragmoides* (Foraminifera: Lituolidae) in southern Australia. *Trans. R. Soc. S. Aust.*, 101(7):165–198.

McCollum, D. W., 1975. Diatom stratigraphy of the Southern Ocean. *In* Hayes, D. E., Frakes, L. A., et al., *Init. Repts. DSDP*, 28: Washington (U.S. Govt. Printing Office), 515–571.

McDougall, I., 1977. Potassium-argon dating of glauconite from a greensand drilled at Site 270 in the Ross Sea, DSDP Leg 28. *In* Barker, P. F., Dalziel, I. W. D., et al., *Init. Repts. DSDP*, 36: Washington (U.S. Govt. Printing Office), 1071–1072.

McKnight, W. M., Jr., 1962. The distribution of foraminifera off parts of the Antarctic coast. *Bull. Am. Paleontol.*, 44(201):61–158.

Malumian, N., 1982. Foraminiferos benthicos de la Formacíon Carmen Silva, Mioceno, Isla Grande de la Tierra del Fuego. *Rev. Assoc. Paleont. Argentina*, 19:37–66.

Marks, P., Jr., 1951. A revision of the smaller foraminifera from the Miocene of the Vienna Basin. *Contr. Cushman Found. Foram. Res.*, 2:33–73.

Murray, J. W., 1971. *An Atlas of British Recent Foraminiferids*: New York (Elsevier Publ. Co.).

Osterman, L. E., and Kellogg, T. B., 1979. Recent benthic foraminifera distributions from the Ross Sea, Antarctica: relation to ecologic and oceanographic conditions. *J. Foram. Res.*, 9:250–269.

Palmer, D. K., 1934. The foraminiferal genus *Guembelina* in the Tertiary of Cuba. *Mem. Soc. Cubana Hist. Nat.*, 8:73–76.

Parker, F. L., Phleger, F. B., and Peirson, J. F., 1953. *Ecology of Foraminifera from San Antonio Bay and Environs, Southwest Texas.* Cushman Found. Foram. Res., Spec. Publ. 2.

Parr, W. J., 1931. A new species of the foraminifera: *Cassidulinoides chapmani. Victorian Naturalist*, 48:99-100.

________, 1950. Foraminifera: *Repts. B.A.N.Z. Antarct. Res. Exped., 1929-1931, Ser. B*, 5:235-392.

Pflum, C. E., 1966. The distribution of Foraminifera in the eastern Ross Sea, Amundsen Sea and Bellingshausen Sea, Antarctica. *Bull. Am. Paleontol.*, 50(226):151-209.

Quilty, P. G., 1974. Tasmanian Tertiary Foraminifera. Part 1. Textulariina, Miliolina, Nodosariacea. *R. Soc. Tasmania, Pap. Proc.*, 108:31-106.

Savage, M. L., and Ciesielski, P. F., 1983. A revised history of glacial sedimentation in the Ross Sea region. *In* Oliver, R. L., James, P. R., and Jago, J. B. (Eds.), *Proc. Int. Symp. Antarct. Earth Sci., 4th, Adelaide, Australia, 1982*: (Australian National Academy of Sciences), pp. 555-559.

Srinivasan, M. S., 1966. Descriptions of new species and notes on taxonomy of foraminifera from the Upper Eocene and Lower Oligocene of New Zealand. *Trans. R. Soc. N. Z., Geol.*, 3:231-256.

________, 1968. Late Eocene and early Oligocene planktonic foraminifera from Port Elizabeth and Cape Foulwind, New Zealand. *Contr. Cushman Found. Foram. Res.*, 19:142-159.

Stainforth, R. M., Lamb, J. L., Luterbacher, H., Beard, J. H., and Jeffords, R. M., 1975. *Cenozoic Planktonic Foraminiferal Zonation and Characteristics of Index Forms.* Univ. Kansas Paleontol. Contrib., Art. 62.

Stschedrina, Z. G., 1946. *New Species of Foraminifera from the Arctic Ocean.* Trans. Arctic Sci. Res. Inst. Northern Sea Route Board Drifting Expedition on the Icebreaker *G. Sedov* in 1937-1940, Moscow-Leningrad (Vol. 3, Biology).

Tappan, H., 1951. Northern Alaska index foraminifera. *Contr. Cushman Found. Foram. Res.*, 2:1-8.

Taylor, D. J., 1965. Preservation, composition, and significance of Victorian Lower Tertiary *Cyclammina* faunas. *R. Soc. Victoria*, 78:143-160.

Vella, P., 1957. *Studies in New Zealand Foraminifera.* N. Z. Geol. Surv. Paleontol. Bull., 28.

________, 1961. Upper Oligocene and Miocene uvigerinid foraminifera from Raukumara Peninsula, New Zealand. *Micropaleontology*, 7:467-483.

________, 1966. Some foraminiferal lineages in New Zealand. *In* Drooger, C. W., Reiss, Z., Rutsch, R. F., and Marks, P. (Eds.), *Proc. 3rd Session in Berne, Int. Union Geol. Sci. Medit. Neogene Strat., 1964*: Leiden (E. J. Brill), 87-102.

Ward, B. L., 1979. Late Quaternary foraminifera from elevated deposits of the Cape Royds-Barne areas, Ross Island, Antarctica [M.S. Thesis]. Northern Illinois University, DeKalb.

Weaver, F. M., and Gombos, A. M., Jr., 1981. Southern high-latitude diatom biostratigraphy. *In* Warme, J. E., Douglas, R. G., and Winterer, E. L. (Eds.), *The Deep Sea Drilling Project: A Decade of Progress.* Soc. Econ. Paleontol. Mineral., Spec. Publ., 32:445-470.

Webb, P. N., 1972. Wright Fjord, Pliocene marine transgression of an Antarctic dry valley. *Antarct. J. U. S.*, 7:225-232.

________, 1973. Upper Cretaceous-Paleocene Foraminifera from Site 208 (Lord Howe Rise, Tasman Sea), DSDP Leg 21. *In* Burns, R. E., Andrews, J. E., et al., *Init. Repts. DSDP*, 21: Washington (U.S. Govt. Printing Office), 541-573.

________, 1974. Micropaleontology, paleoecology and correlation of the Pecten Gravels, Wright Valley, Antarctica, and description of *Trochoelphidiella onyxi* n. gen. n. sp. *J. Foram. Res.*, 4:184-199.

________, 1975. Paleocene Foraminifera from DSDP Site 283, south Tasman Basin. *In* Kennett, J. P., Houtz, R. E., et al., *Init. Repts. DSDP*, 29: Washington (U.S. Govt. Printing Office), 833-843.

________, 1982a. Climatic, paleoceanographic and tectonic interpretation of Paleogene-Neogene biostratigraphy from MSSTS-1 drillhole, McMurdo Sound, Antarctica (abstract). *In* Oliver, R. L., James, P. R., Jago, J. B. (Eds.), *Proc. Int. Symp. Antarct. Earth Sci., 4th, Adelaide, Australia, 1982*: (Australian National Academy of Sciences), p. 175.

________, 1982b. Review of Late Cretaceous-Cenozoic stratigraphy, tectonics, paleontology and climate in the Ross Sector (abstract). *In* Oliver, R. L., James, P. R., Jago, J. B. (Eds.), *Proc. Int. Symp. Antarct. Earth Sci., 4th, Adelaide, Australia, 1982*: (Australian National Academy of Sciences), p. 174.

Webb, P. N., Harwood, D. M., McKelvey, B. C., Mercer, J. H., and Stott, L. D., 1984. Cenozoic marine sedimentation and ice-volume variation on the east Antarctic craton. *Geology*, 12:287-291.

Webb, P. N., Leckie, R. M., and Ward, B. L., 1982. Cenozoic foraminiferal biostratigraphy of MSSTS-1 drillhole, McMurdo Sound, Antarctica. *Geol. Soc. Am. Abstr. Progr.*, 14:643.

________, in press. Late Oligocene foraminifera from MSSTS-1 drillhole, McMurdo Sound, Antarctica. *Bull. N.Z. Dept. Indust. Sci. Res., Misc. Ser.*

Webb, P. N., and Wrenn, J. H., 1982. Late Cenozoic micropaleontology and biostratigraphy of eastern Taylor Valley, Antarctica. *In* Craddock, C., (Ed.), *SCAR Symposium on Geology and Solid-Earth Geophysics, 1977*: Madison (University of Wisconsin Press), pp. 1117-1122.

White, M. P., 1928. Some index Foraminifera of the Tempico Embayment area of Mexico. *J. Paleontol.*, 2:197-198.

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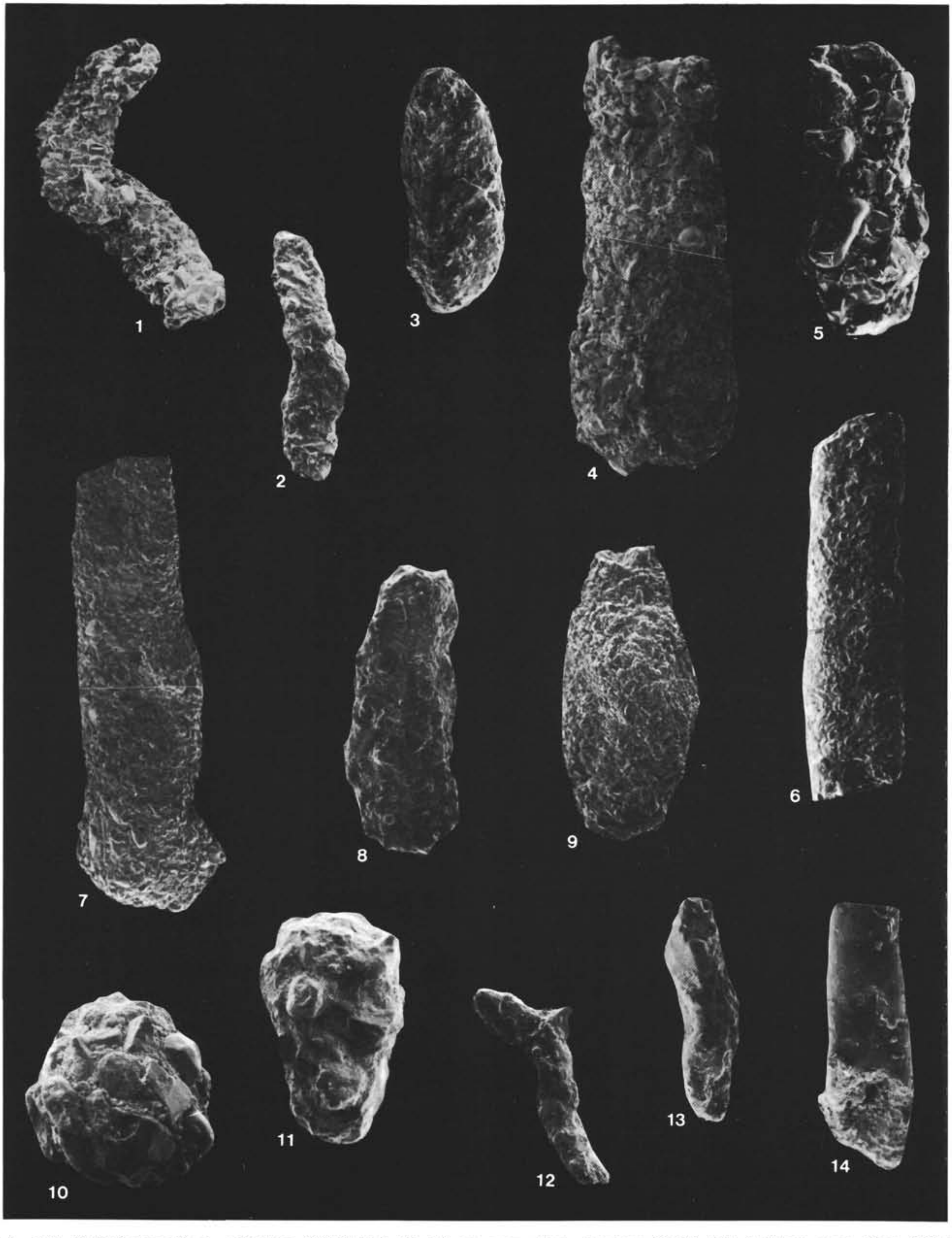

Plate 1. **1-2.** *Bathysiphon* aff. *B. cylindrica,* (1) 270-15-3, 97–110 cm, max. diam. 1.5 mm; (2) 270-41-2, 0–10 cm, max. diam. 0.92 mm. **3.** *Bathysiphon* cf. *B. alba,* 270-42-3, 19–29 cm, max. diam. 0.79 mm. **4.** *Bathysiphon discreta,* 270-42-3, 94–107 cm, max. diam. 2.9 mm. **5.** *Bathysiphon* sp. 1, 270-42-3, 94–107 cm, max. diam. 2.1 mm. **6.** *Bathysiphon* sp. 2, 270-42-2, 131–141 cm, max. diam. 2.8 mm. **7.** *Hyperammina cylindrica,* 270-15-3, 97–110 cm, max. diam. 3.2 mm. **8.** *Astrorhiza* cf. *A. granulosa,* 270-42-3, 19–29 cm, max. diam. 1.07 mm. **9.** *Rhabdammina linearis,* 270-20-6, 85–95 cm, max. diam. 1.78 mm. **10.** *Psammosphaera fusca,* 270-42-3, 94–107 cm, max. diam. 1.05 mm. **11.** *Jaculella* cf. *J. acuta,* 270-36-6, 115–123 cm, max. diam. 1.0 mm. **12.** *Rhizammina algaeformis,* 270-42-2, 131–141 cm, max. diam. 1.22 mm. **13.** *Marsipella* sp., 270-36-6, 115–123 cm, max. diam. 0.85 mm. **14.** *Protobotellina cylindrica,* 270-42-3, 94–107 cm, max. diam. 1.0 mm.

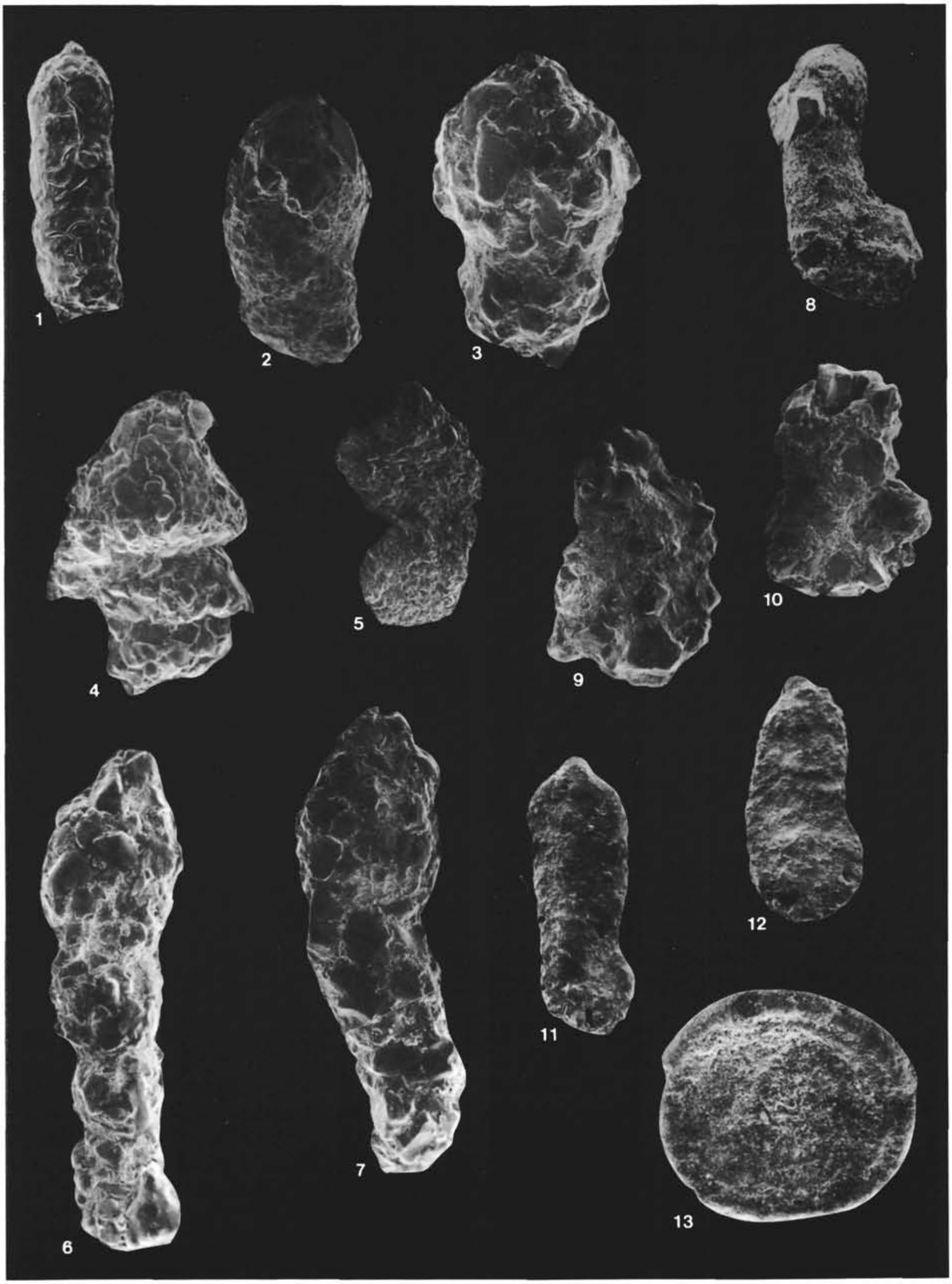

Plate 2. **1.** *Reophax* sp. 1, 270-42-2, 131–141 cm, max. diam. 1.05 mm. **2.** *Arenodosaria antipoda*, 270-20-6, 85–95 cm, max. diam. 1.36 mm. **3.** *Reophax* sp. 2, 270-15-3, 50–57 cm, max. diam. 1.0 mm. **4.** *Reophax* sp. 2, 270-15-3, 97–110 cm, max. diam. 1.9 mm. **5.** *Reophax* cf. *R. cushmani*, 270-20-6, 85–95 cm, max. diam. 1.8 mm. **6.** *Reophax* cf. *R. nodulosus*, 270-40-5, 70–79 cm, max. diam. 1.8 mm. **7.** *Reophax scorpiurus*, 270-42-3, 94–107 cm, max. diam. 1.62 mm. **8.** *Ammobaculites* cf. *A. coprolithiformis*, 270-19-5, 113–122 cm, max. diam. 2.3 mm. **9–10.** *Ammobaculites* cf. *A. expansus*, (9) 270-15-3, 50–57 cm, max. diam. 0.80 mm; (10) 270-15-3, 97–110 cm, max. diam. 0.70 mm. **11–12.** *Ammoscalaria pseudospiralis*, 270-43-6, 65–79 cm, (11) max. diam. 1.18 mm; (12) max. diam. 1.43 mm. **13.** *Ammodiscus* cf. *A. glabratus*, 270-18-5, 129–139 cm, max. diam. 0.30 mm.

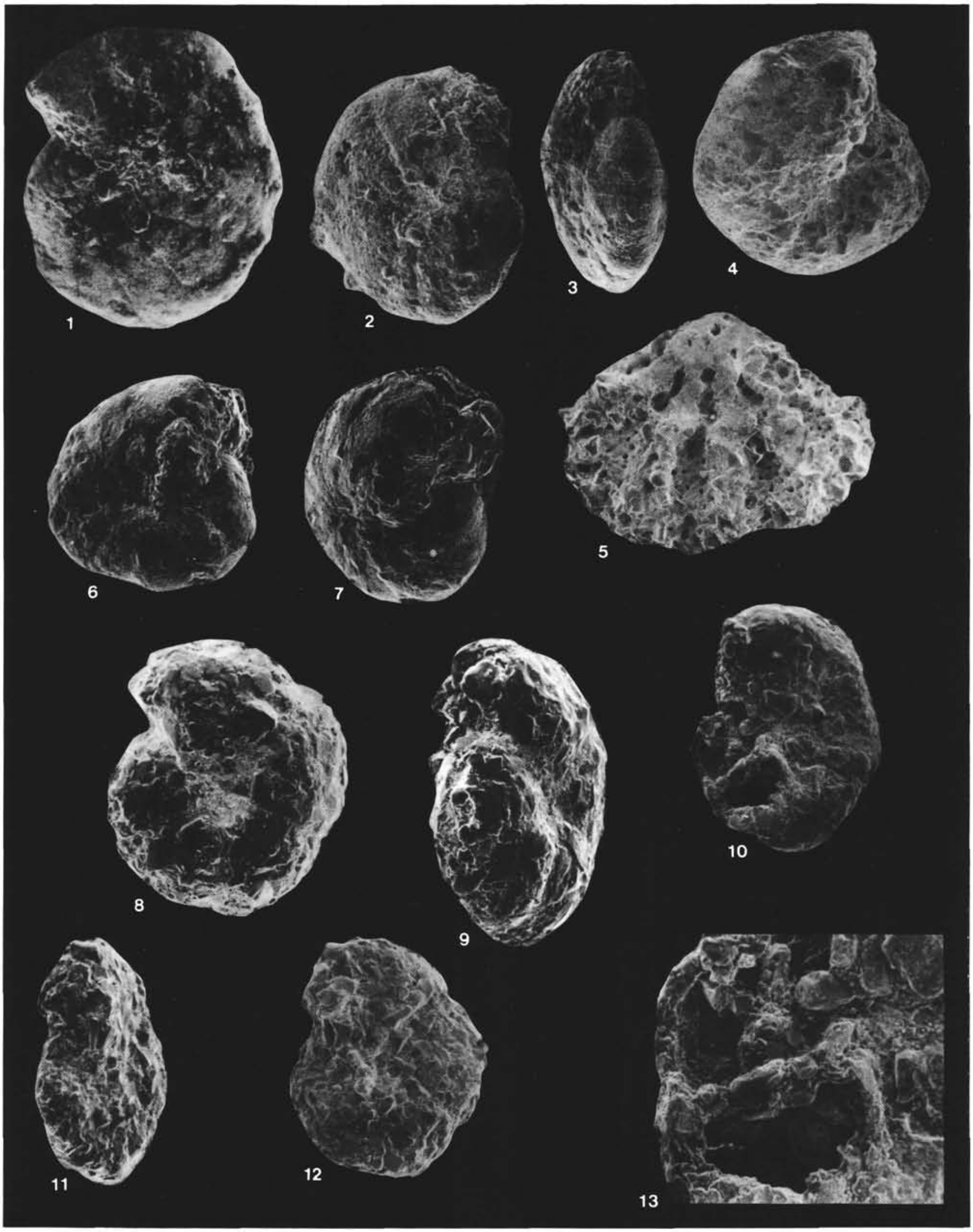

Plate 3. **1–5.** *Cyclammina incisa*, (1) microspheric form, 270-41-2, 0–10 cm, max. diam. 2.35 mm; (2) megalospheric form, 270-41-2, 0–10 cm, max. diam. 0.75 mm; (3) same specimen, oblique apertural view; (4) microspheric form, 270-15-3, 97–110 cm, max. diam. 1.60 mm; (5) internal view of broken specimen, 270-18-5, 129–139 cm. **6–7.** *Cyclammina rotundata*, (6) 270-41-3, 134–142 cm, max. diam. 1.15 mm; (7) same specimen, oblique apertural view. **8–13.** *Haplophragmoides* sp., (8) 270-15-3, 50–57 cm, max. diam. 1.0 mm; (9) same specimen, oblique apertural view; (10) 270-17-5, 130–140 cm, max. diam. 0.80 mm; (11) oblique apertural view, 270-17-5, 130–140 cm, max. diam. 0.60 mm; (12) same specimen, side view; (13) closeup of broken chambers.

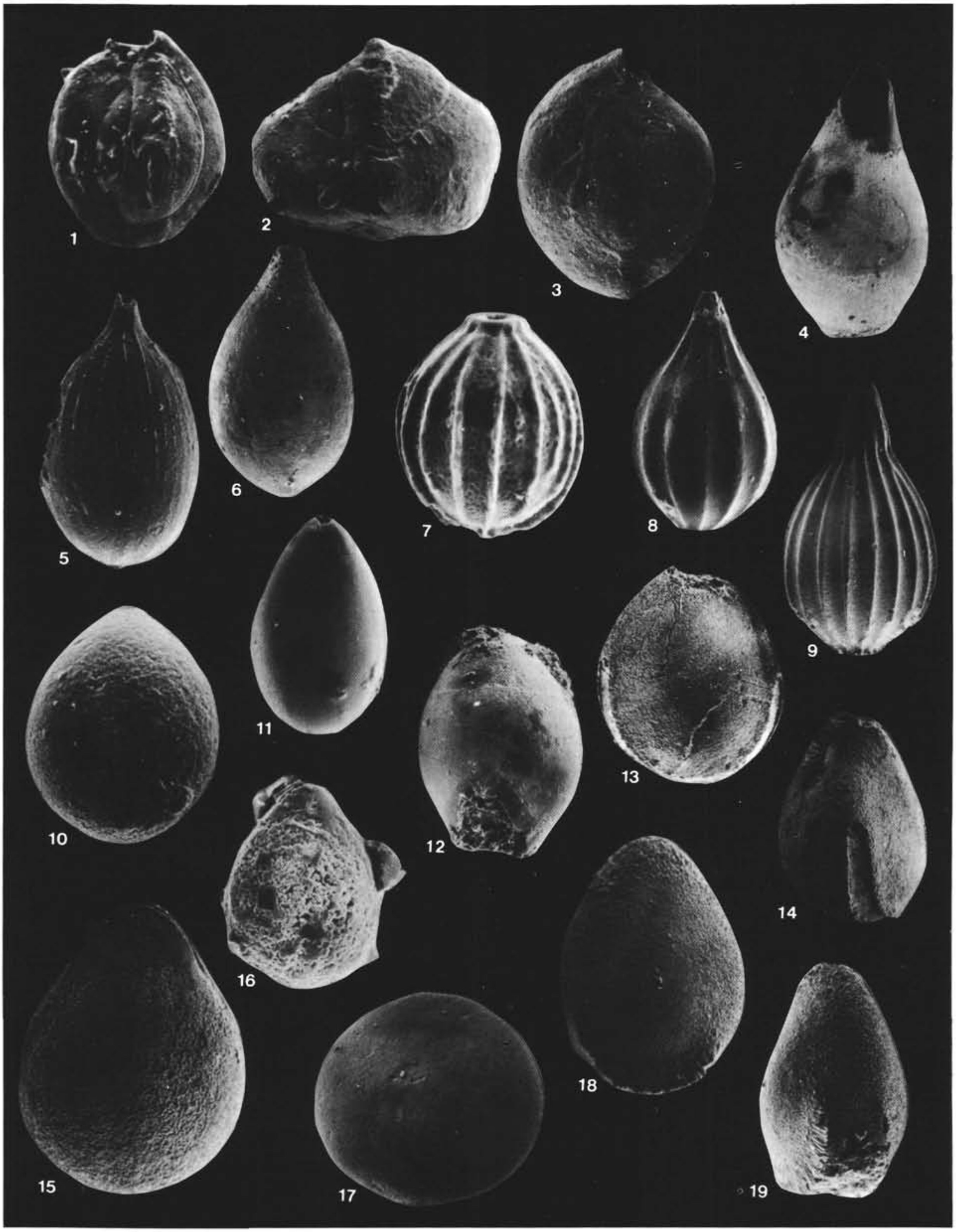

Plate 4. **1–2.** *Quinqueloculina seminula*, (1) 270-22-6, 135–145 cm, max. diam. 0.23 mm; (2) same specimen, apertural view. **3.** *Quinqueloculina trianqularis*, 270-23-4, 72–82 cm, max. diam. 0.40 mm. **4.** *Nodosaria* sp. 1, 270-19-5, 113–122 cm, max. diam. 0.83 mm. **5.** *Lagena striata*, 270-22-6, 135–145 cm, max. diam. 0.32 mm. **6.** *Lagena laevis*, 270-17,CC, max. diam. 0.50 mm. **7.** *Lagena sulcata*, 270-3,CC, max, diam. 0.11 mm. **8–9.** *Oolina apiopleura*, (8) 270-22-6, 135–145 cm, max. diam. 0.24 mm; (9) 270-19-5, 113–122 cm, max. diam. 0.38 mm. **10.** *Oolina globosa*, 270-13,CC, max. diam. 0.15 mm. **11.** *Oolina apiculata*, 270-22-6, 135–145 cm, max. diam. 0.24 mm. **12.** *Fissurina danica*, edge view, 270-19-5, 113–122 cm, max. diam. 0.32 mm. **13–14.** *Fissurina bisulcata*, (13) 270-37-4, 133–142 cm, max. diam. 0.35 mm; (14) edge view, same specimen. **15.** *Fissurina annectens*, 270-32-3, 114–123 cm, max. diam. 0.30 mm. **16.** *Fissurina kerguelenensis*, 270-3,CC, max. diam. 0.12 mm. **17.** *Fissurina* sp. 1, 270-29-6, 8–18 cm, max. diam. 0.23 mm. **18–19.** *Fissurina fimbriata*, (18) 270-13-3, 114–125 cm, max. diam. 0.23 mm; (19) edge view, same specimen.

Plate 5. **1–4.** *Sphaeroidina bulloides*, (1) 270-19-5, 113–122 cm, max. diam. 0.41 mm; (2) 270-35-3, 112–121 cm, max. diam. 0.13 mm; (3) 270-21-5, 102–112 cm, max. diam. 0.18 mm; (4) 270-21-5, 102-112 cm, max. diam. 0.11 mm. **5–6.** *Islandiella teretis*, (5) edge view, 270-3,CC, max. diam. 0.30 mm; (6) same specimen. **7–8.** *Islandiella norcrossi*, (7) oblique apertural view, 270-3,CC, max. diam. 0.20 mm; (8) same specimen. **9–10.** *Cassidulinoides bradyi*, (9) 270-31-3, 59–67 cm, max. diam. 0.50 mm; (10) 270-23-4, 72–82 cm, max. diam. 0.49 mm. **11.** *Cassidulinoides* cf. *C. parkerianus*, 270-23-4, 72–82 cm, max. diam. 0.70 mm. **12.** *Cassidulinoides* cf. *C. chapmanni*, 270-33-3, 102–112 cm, max. diam. 0.57 mm. **13–14.** *Cassidulinoides braziliensis*, (13) 270-34-3, 28–38 cm, max. diam. 0.37 mm; (14) 270-32,CC, max. diam. 0.52 mm. **15–16.** *Globobulimina* sp., (15) 270-19-5, 113–122 cm, max. diam. 1.05 mm; (16) 270-19-6, 113–122 cm, max. diam. 0.92 mm.

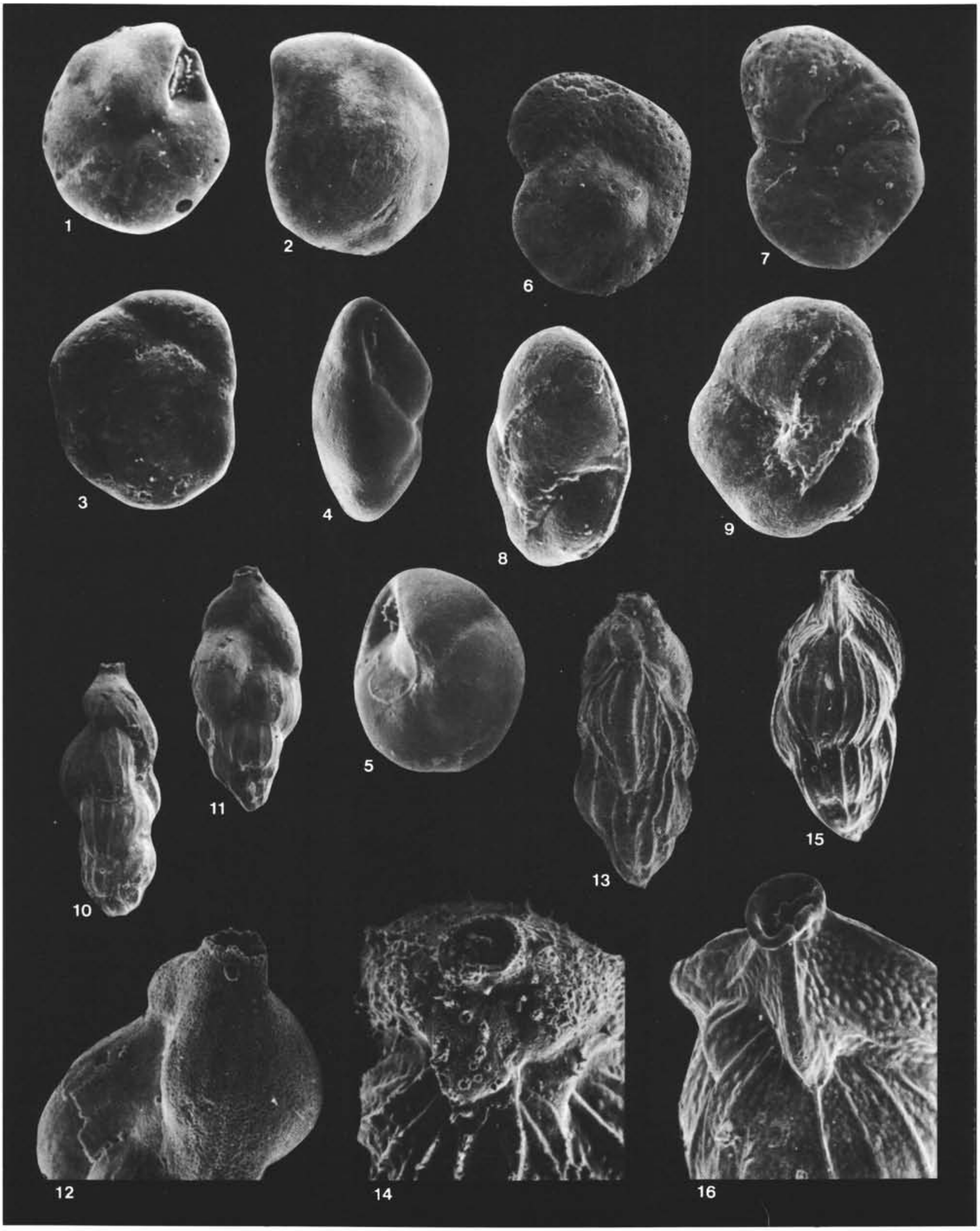

Plate 6. **1–5.** *Epistominella vitrea*, (1) umbilical side, 270-3,CC, max. diam. 0.13 mm; (2) spiral side, 270-3,CC, max. diam. 0.13 mm; (3) spiral side, 270-12-3, (top of section), max. diam. 0.16 mm; (4) apertural view, same specimen; (5) umbilical side, 270-12-1 (top of section), max. diam. 0.15 mm. **6–7.** *Rosalina globularis*, (6) spiral side, 270-34-3, 28–38 cm, max. diam. 0.37 mm; (7) umbilical side, 270-34,CC, max. diam. 0.31 mm. **8–9.** *Cancris laevinflatus*, (8) oblique apertural view, 270-21-5, 102–112 cm, max. diam. 0.18 mm; (9) umbilical side, same specimen. **10–12.** *Trifarina* aff. *T. fueguina*, (10) 270-15-3, 97–110 cm, max. diam. 0.42 mm; (11) 270-15-3, 97–110 cm, max. diam. 0.41 mm; (12) aperture, same specimen. **13–14.** *Trifarina pauperata*, (13) 270-1-2, 52–54 cm, max. diam. 0.54 mm; (14) aperture, same specimen. **15–16.** *Trifarina earlandi*, (15) 270-3,CC, max. diam. 0.58 mm; (16) aperture, same specimen.

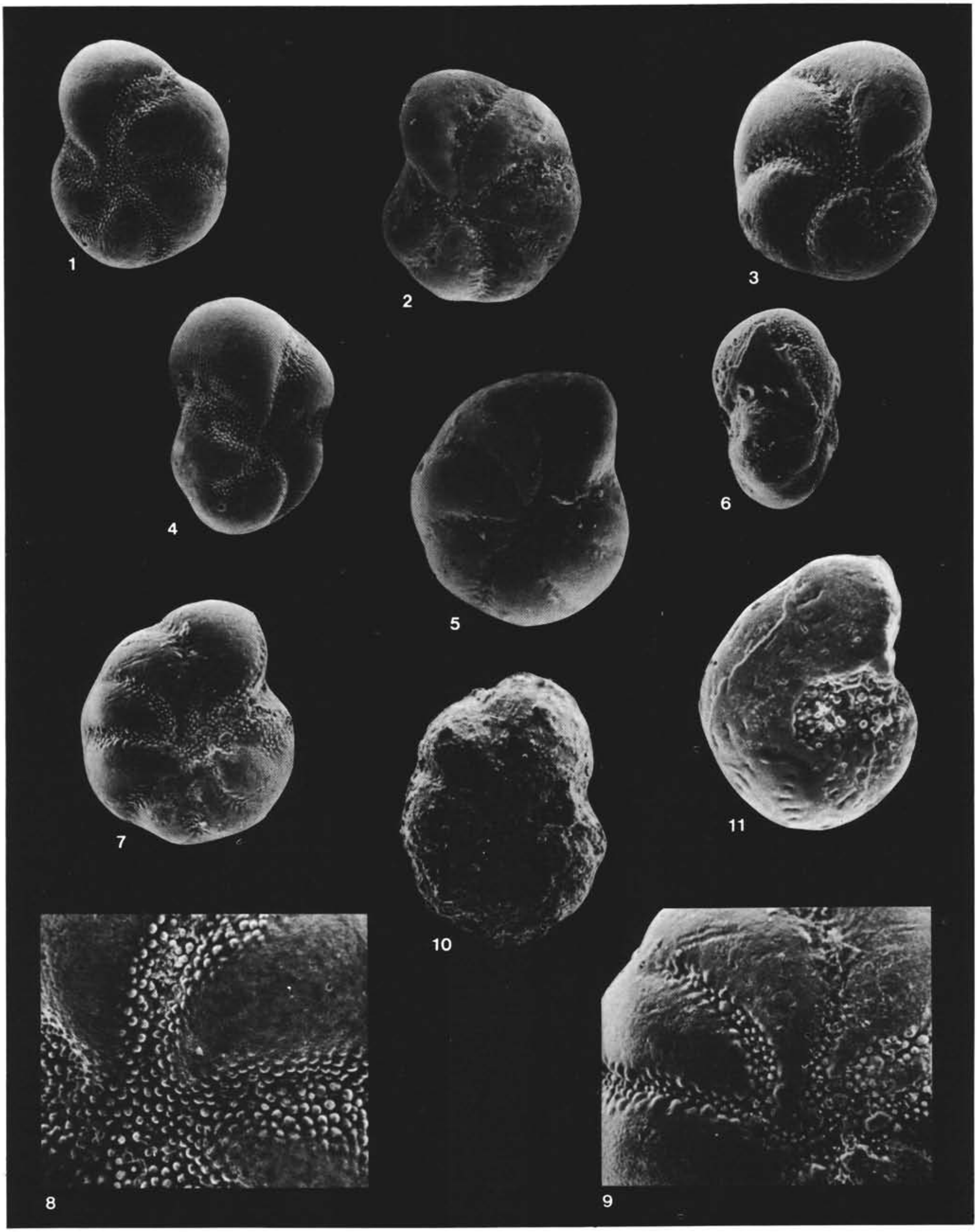

Plate 7. **1–4, 6, 8.** *Elphidium magellanicum*, (1) 270-15-3, 50–57 cm, max. diam. 0.33 mm; (4, 8) same specimen; (2) 270-8-3, 113–128 cm, max. diam. 0.42 mm; (3) 270-8-3, 113–128 cm, max. diam. 0.25 mm; (6) edge view, 270-12-1 (top of section), max. diam. 0.30 mm. **5, 7, 9.** *Elphidium* cf. *E. magellanicum*, (5) 270-33-3, 102–110 cm, max. diam. 0.41 mm; (7) 270-8-3, 113–128 cm, max. diam. 0.37 mm; (9) same specimen. **10.** *Elphidium* sp., 270-43-6, 65–79 cm, max. diam. 0.40 mm. **11.** *Elphidium* cf. *E. nitidum*, 270-43-5, 18–31 cm, max. diam. 0.20 mm.

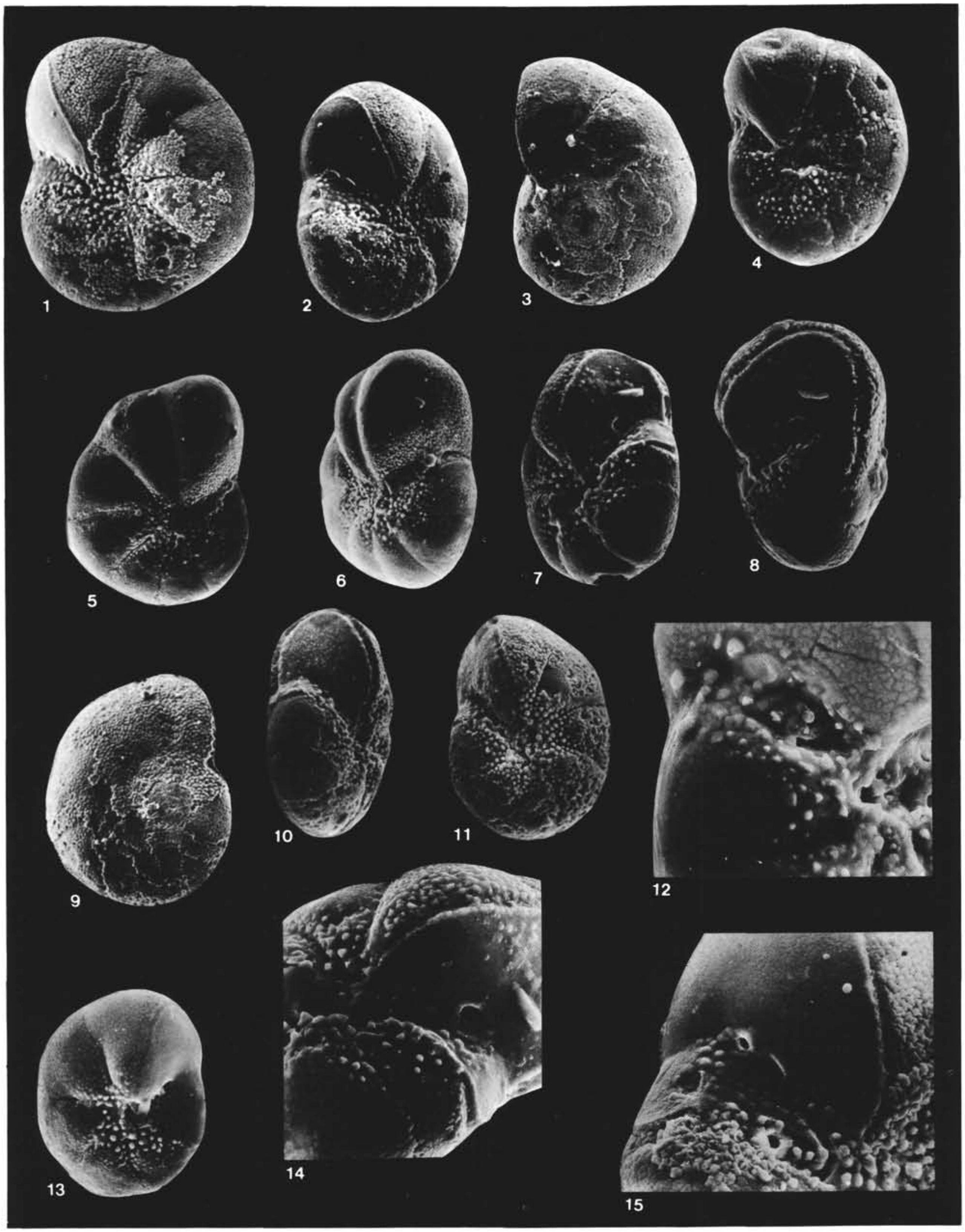

Plate 8. **1–12, 14, 15.** *Trochoelphidiella pustulosa* n. sp., all megalospheric forms, (1) umbilical view, 270-31-3, 59–67 cm, max. diam. 0.30 mm; (2) same specimen; (15) aperture, same specimen; (3) spiral view, 270-29-6, 8–18 cm, max. diam. 0.26 mm; (4) umbilical view, 270-32-3, 114–123 cm, max. diam. 0.24 mm; (12) aperture, same specimen; (5) umbilical view, 270-29-6, 8–18 cm, max. diam. 0.38 mm; (6) oblique apertural view, same specimen; (7) oblique edge view, 270-33-3, 102–110 cm, max. diam. 0.20 mm; (8) edge view, same specimen; (14) aperture, same specimen; (9) spiral view, 270-29-6, 8–18 cm, max. diam. 0.25 mm; (10) edge view, same specimen; (11) umbilical view, same specimen. **13.** *Buccella* sp., umbilical view, 270-29-6, 8–18 cm, max. diam. 0.18 mm.

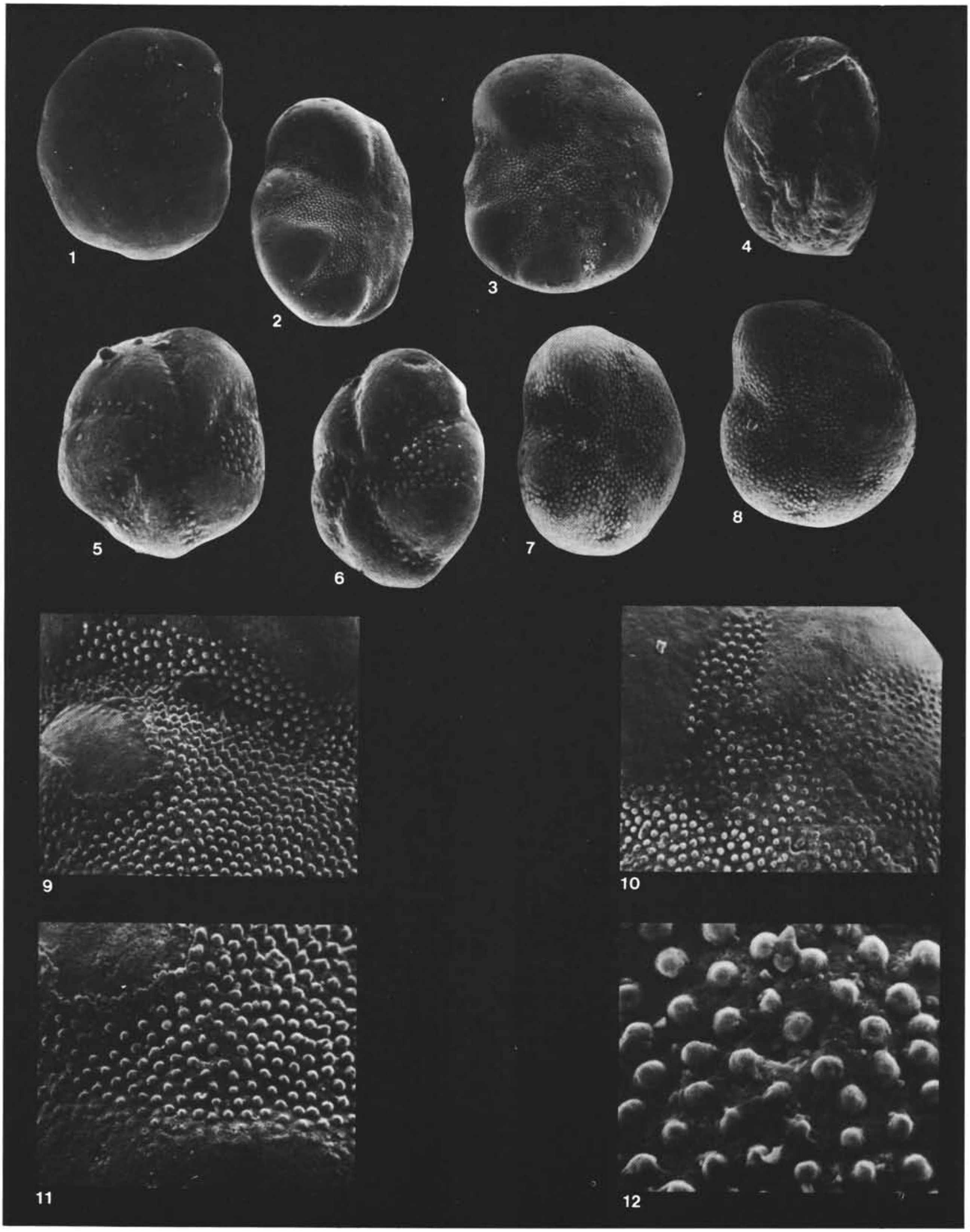

Plate 9. **1–12.** *Trochoelphidiella uniforamina*, (1) microspheric form, spiral view, 270-5-2, 122–132 cm, max. diam. 0.56 mm; (2) oblique apertural view, same specimen; (3) umbilical view, same specimen; (9) aperture, same specimen; (10) sutural foramina, same specimen; (11) sutural foramina, same specimen; (12) sutural foramina, same specimen; (4) oblique edge view, 270-28-6 (bottom of section), max. diam. 0.25 mm; (5) megalospheric form, umbilical view, 270-15,CC, max. diam. 0.18 mm; (6) oblique apertural view, same specimen; (7) megalospheric form, oblique apertural view, 270-28-6 (bottom of section), max. diam. 0.23 mm; (8) umbilical view, same specimen.

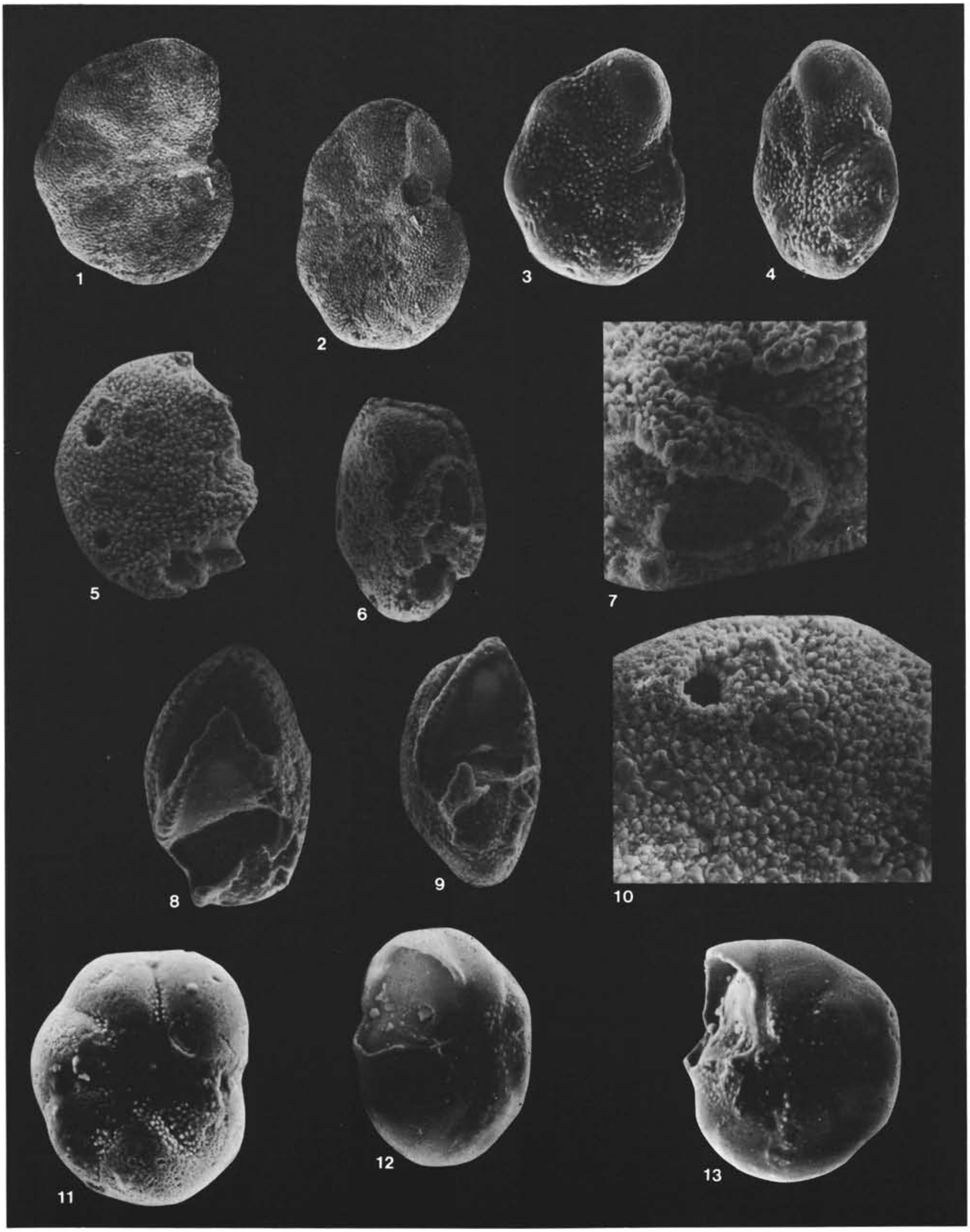

Plate 10. **1–10.** *Trochoelphidiella* sp., (1) umbilical view, 270-37-4, 133–142 cm, max. diam. 0.62 mm; (2) oblique edge view, same specimen; (3) umbilical view 270-29-6, 8–18 cm, max. diam. 0.27 mm; (4) oblique apertural view, same specimen; (5) umbilical view, 270-8-3, 113–128 cm, max. diam. 0.15 mm; (6) edge view, same specimen; (7) remnant apertures, same specimen; (10) same specimen; (8) edge view, 270-6-1, 113–123 cm, width 0.14 mm; (9) edge view, same specimen. **11–13.** *Trochoelphidiella* aff. *T. uniforamina*, (11) umbilical view, 270-35,CC, max. diam. 0.22 mm; (12) oblique apertural view, 270-35-3, 112–121 cm, max. diam. 0.21 mm; (13) umbilical view, same specimen.

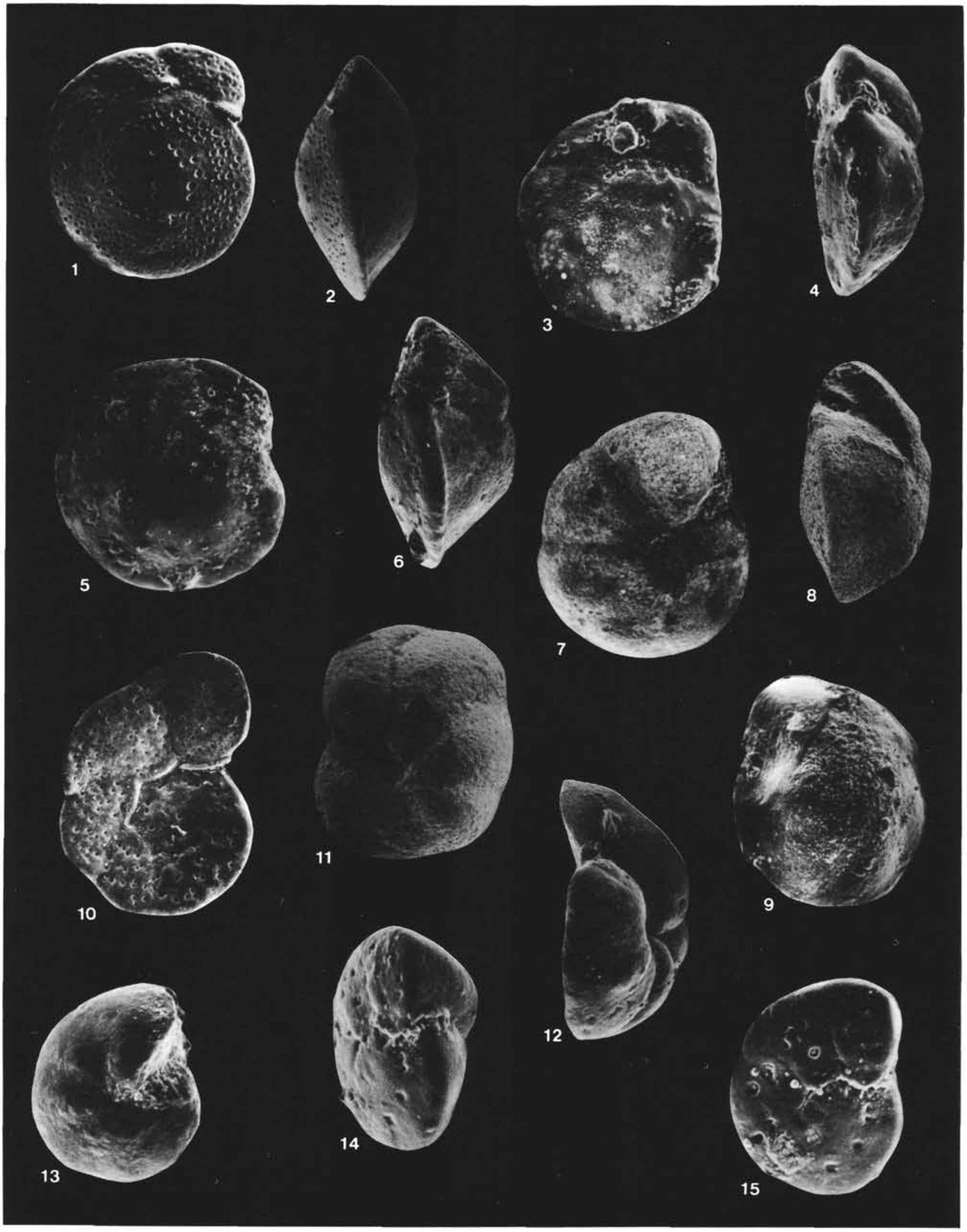

Plate 11. **1–9.** *Cibicides temperata*, (1) spiral side, 270-25-2, 50–60 cm, max. diam. 0.51 mm; (2) edge view, same specimen; (3) spiral side, 270-19-5, 113–122 cm, max. diam. 0.56 mm; (4) edge view, same specimen; (5) spiral side, 270-19-5, 113–122 cm, max. diam. 0.46 mm; (6) edge view, same specimen; (7) umbilical view, 270-19-5, 113–122 cm, max. diam. 0.62 mm; (8) edge view, 270-14,CC, max. diam. 0.35 mm; (9) umbilical view, 270-19-5, 113–122 cm, max. diam. 0.40 mm. **10–12.** *Cibicides lobatulus*, (10) spiral side, 270-33-3, 102–110 cm, max. diam. 0.35 mm; (12) edge view, same specimen; (11) umbilical side, 270-13-3, 114–125 cm, max. diam. 0.38 mm. **13–15.** *Cibicides refulgens*, (13) umbilical side, 270-3,CC, max. diam. 0.15 mm; (14) oblique apertural view, 270-3,CC, max. diam. 0.14 mm; (15) spiral side, same specimen.

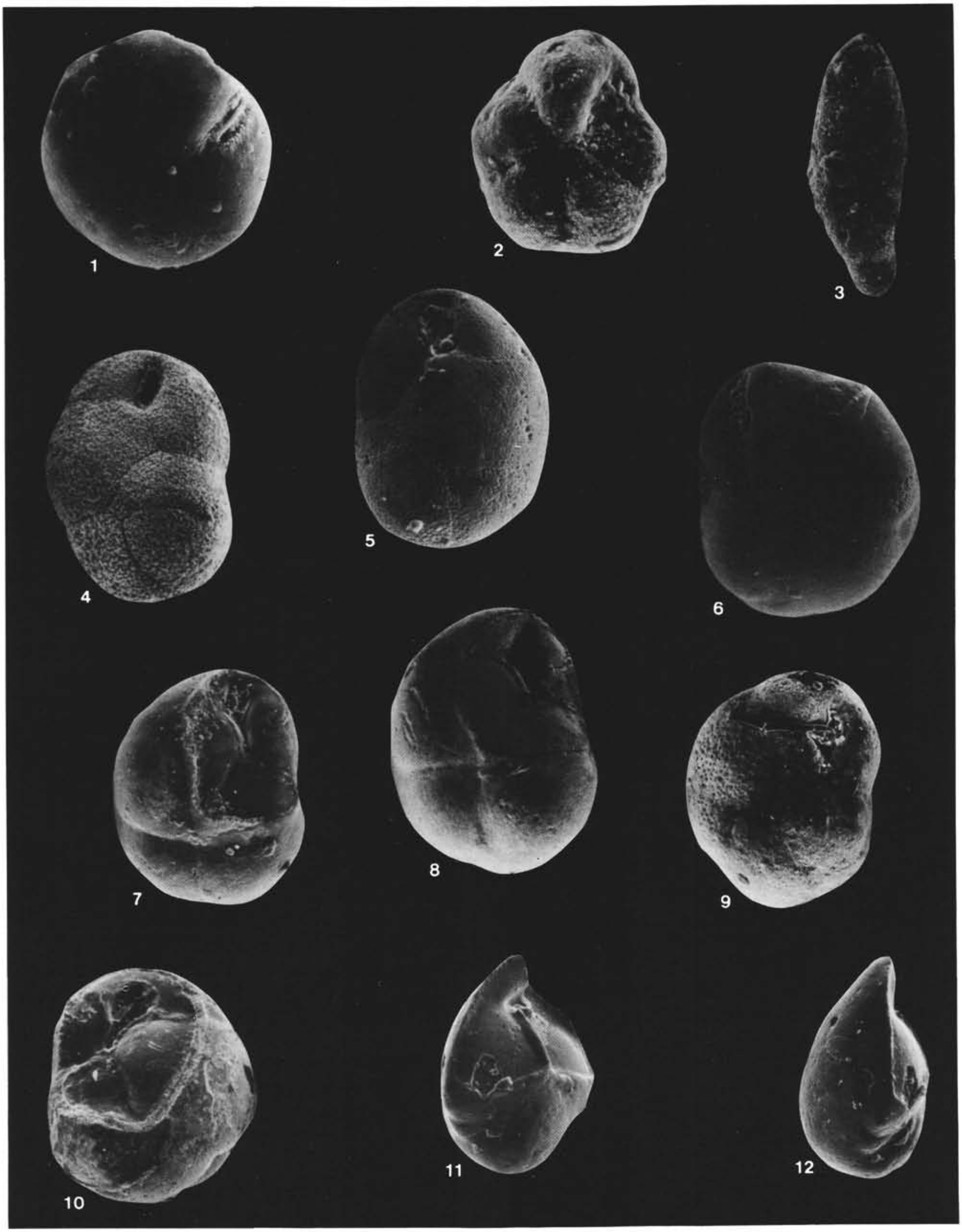

Plate 12. **1.** *Eponides* cf. *E. weddellensis*, umbilical side, 270-21-5, 102–112 cm, max. diam. 0.15 mm. **2.** *Eponides tumidulus*, umbilical side, 270-3,CC, max. diam. 0.11 mm. **3.** *Fursenkoina schreibersiana*, 270-40-5, (top of section), max. diam. 0.27 mm. **4–6.** *Globocassidulina subglobosa*, (4) 270-23-4, 72–82 cm, max. diam. 0.32 mm; (5) 270-23-4, 72–82 cm, max. diam. 0.20 mm; (6) 270-19-5, 113–122 cm, max. diam. 0.51 mm. **7–9.** *Globocassidulina crassa*, (7) 270-1-2, 52–54 cm, max. diam. 0.37 mm; (8) 270-28-6 (bottom of section), max. diam. 0.27 mm; (9) 270-1-2, 52–54 cm, max. diam. 0.40 mm. **10.** *Globocassidulina biora*, 270-3,CC, max. diam. 0.58 mm. **11–12.** *Ehrenbergina glabra*, (11) 270-3,CC, max. diam. 0.27 mm; (12) edge view, same specimen.

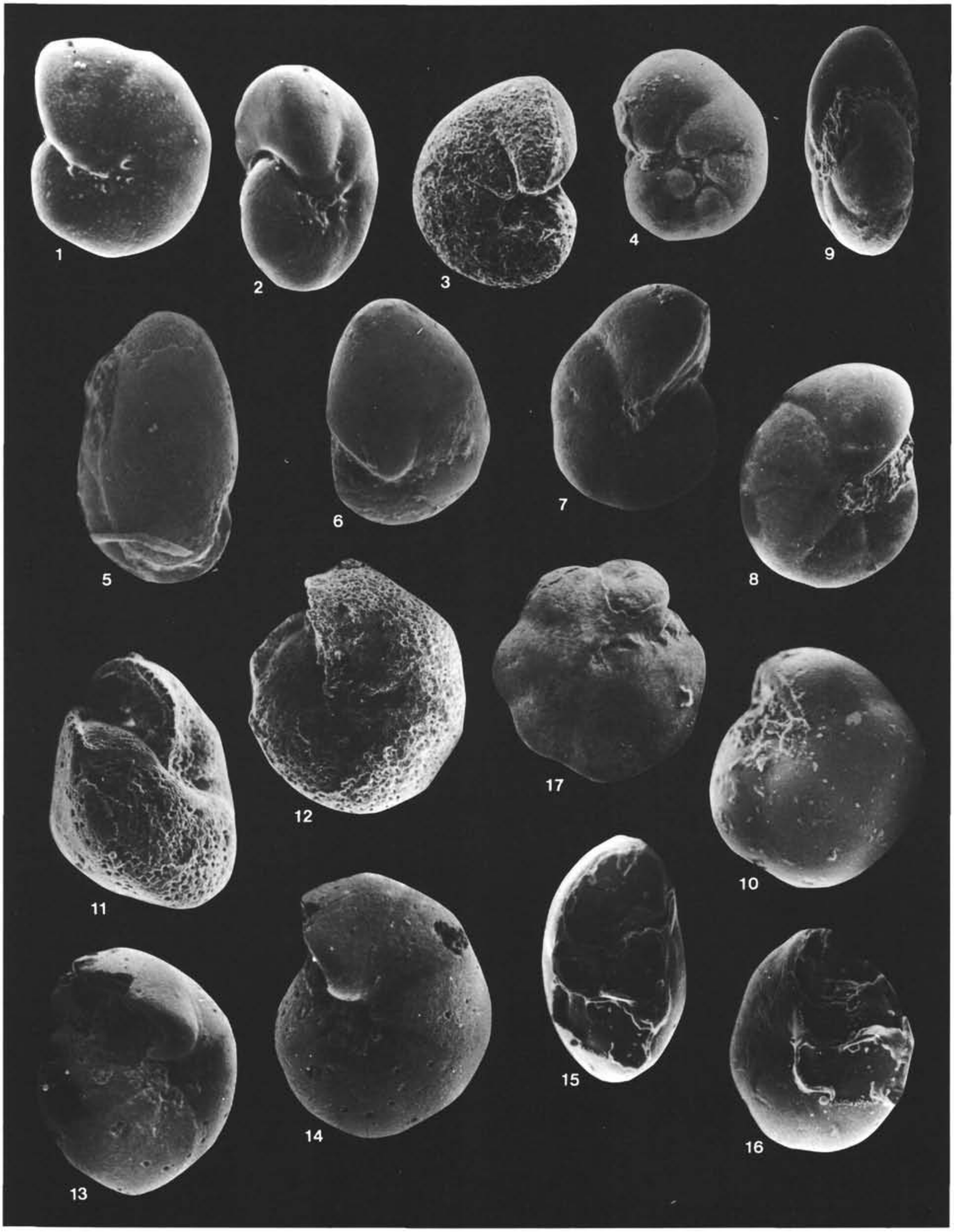

Plate 13. **1–2.** *Astrononion echolsi*, (1) side view, 270-3,CC, max. diam. 0.23 mm; (2) oblique apertural view, same specimen. **3–4.** *Nonionella iridea*, (3) umbilical view, 270-14,CC, max. diam. 0.23 mm; (4) spiral view, 270-8-3, 113–122 cm, max. diam. 0.20 mm. **5.** *Nonionella magnalingua*, umbilical view, 270-38-3, 87–96 cm, max. diam. 0.33 mm. **6.** *Nonionella bradii*, umbilical view, 270-8-3, 113–128 cm, max. diam. 0.28 mm. **7–9.** *Pullenia subcarinata*, (7) side view, 270-14-3, max. diam. 0.36 mm; (8) side view, 270-19-5, 113–122 cm, max. diam. 0.50 mm; (9) apertural view, same specimen. **10.** *Pullenia bulloides*, side view, 270-19-5, 113–122 cm, max. diam. 0.33 mm. **11–12.** *Gyroidina parva*, (11) apertural view, 270-27-4, 108–118 cm, max. diam. 0.29 mm; (12) umbilical view, same specimen. **13–14.** *Gyroidina zelandica*, (13) oblique apertural view, 270-19-5, 113–122 cm, max. diam. 0.42 mm; (14) umbilical view, same specimen. **15–16.** *Gyroidina* cf. *G. obicularis*, (15) apertural view, 270-15-3, 97–110 cm, max. diam. 0.36 mm; (16) oblique umbilical view, same specimen. **17.** *Oridorsalis tenera*, umbilical view, 270-32,CC max. diam. 0.57 mm.

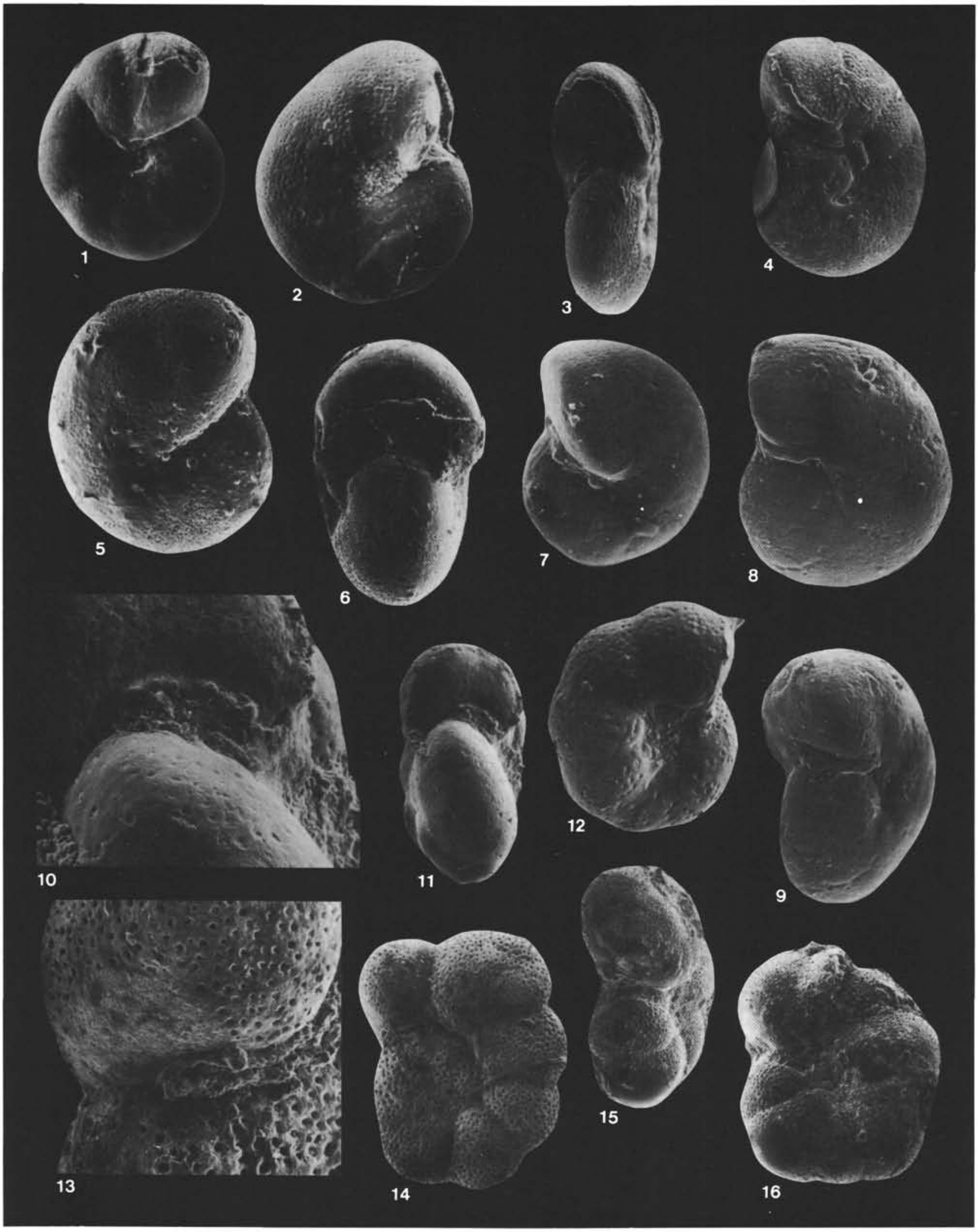

Plate 14. **1–4.** *Melonis barleeanus*, (1) 270-14-3, max. diam. 0.45 mm; (2) 270-12-1 (top of section), max. diam. 0.27 mm; (3) apertural view, 270-38,CC, max. diam. 0.48 mm; (4) same specimen. **5–7.** *Melonis affinis*, (5) side view, 270-37-4, 133–142 cm, max. diam. 0.27 mm; (6) edge view, 270-37-4, 133–142 cm, max. diam. 0.43 mm; (7) 270-38,CC, max. diam. 0.27 mm. **8–9.** *Anomalinoides* cf. *A. macraglabra*, (8) spiral view, 270-40-3, 123–131 cm, max. diam. 0.37 mm; (9) oblique edge view, same specimen. **10–12.** *Anomalinoides pinguiglabra*, (10) aperture, 270-34-3, 28–38 cm, max. diam. 0.52 mm; (11) edge view, same specimen; (12) umbilical view, 270-34-3, 28–38 cm, max. diam. 0.52 mm. **13–16.** *Anomalinoides globulosa*, (13) aperture, 270-19-5, 113–122 cm, max. diam. 1.05 mm; (14) spiral view, same specimen; (15) edge view, 270-19-5, 113–122 cm, max. diam. 1.05 mm; (16) umbilical view, same specimen.

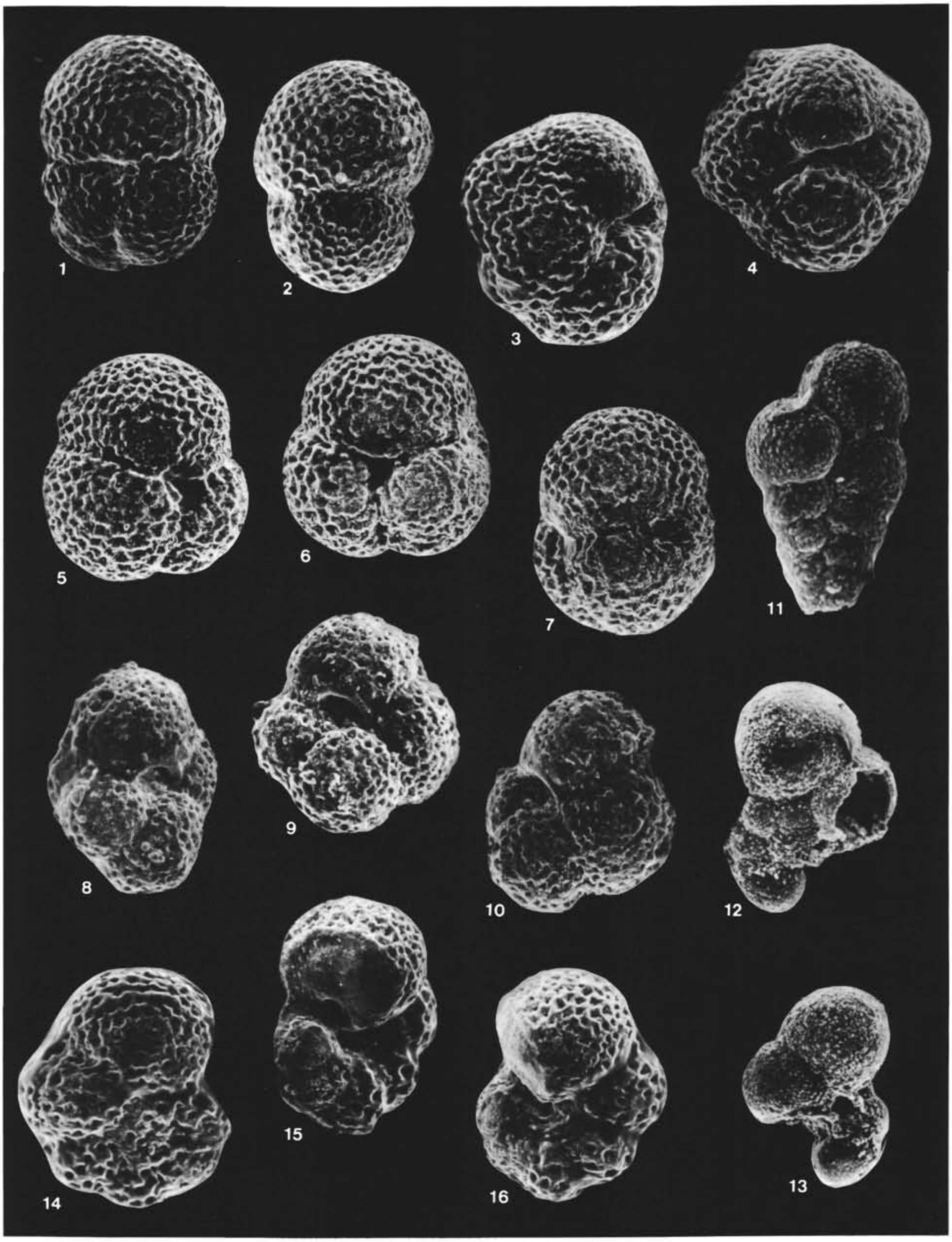

Plate 15. **1–2.** *Globigerinoides trilobus*, (1) 270-28,CC, max. diam. 0.40 mm; (2) side view, same specimen. **3–4.** *Globorotaloides* cf. *G. suteri*, (3) side view, 270-24,CC, max. diam. 0.18 mm; (4) umbilical view, same specimen. **5–7.** *Globigerina* cf. *G. angiporoides*, (5) side view, 270-15-3, 50–57 cm, max. diam. 0.23 mm; (6) umbilical view, same specimen; (7) side view, same specimen. **8–10.** *Globigerina* cf. *G. ouachitaensis*, (8) side view, 270-34-5, 59–61 cm, max. diam. 0.14 mm; (9) umbilical view, same specimen; (10) side view, same specimen. **11.** *Chiloguembelina cubensis*, 270-34,CC, max. diam. 0.15 mm. **12–13.** *Globorotalia* cf. *G. gemma*, (12) spiral view, 270-24,CC, max. diam. 0.12 mm; (13) umbilical view, same specimen. **14–16.** *Globorotalia* cf. *G. siakensis*, (14) spiral view, 270-39-6, 24–36 cm, max. diam. 0.17 mm; (15) edge view, same specimen; (16) umbilical view, same specimen.

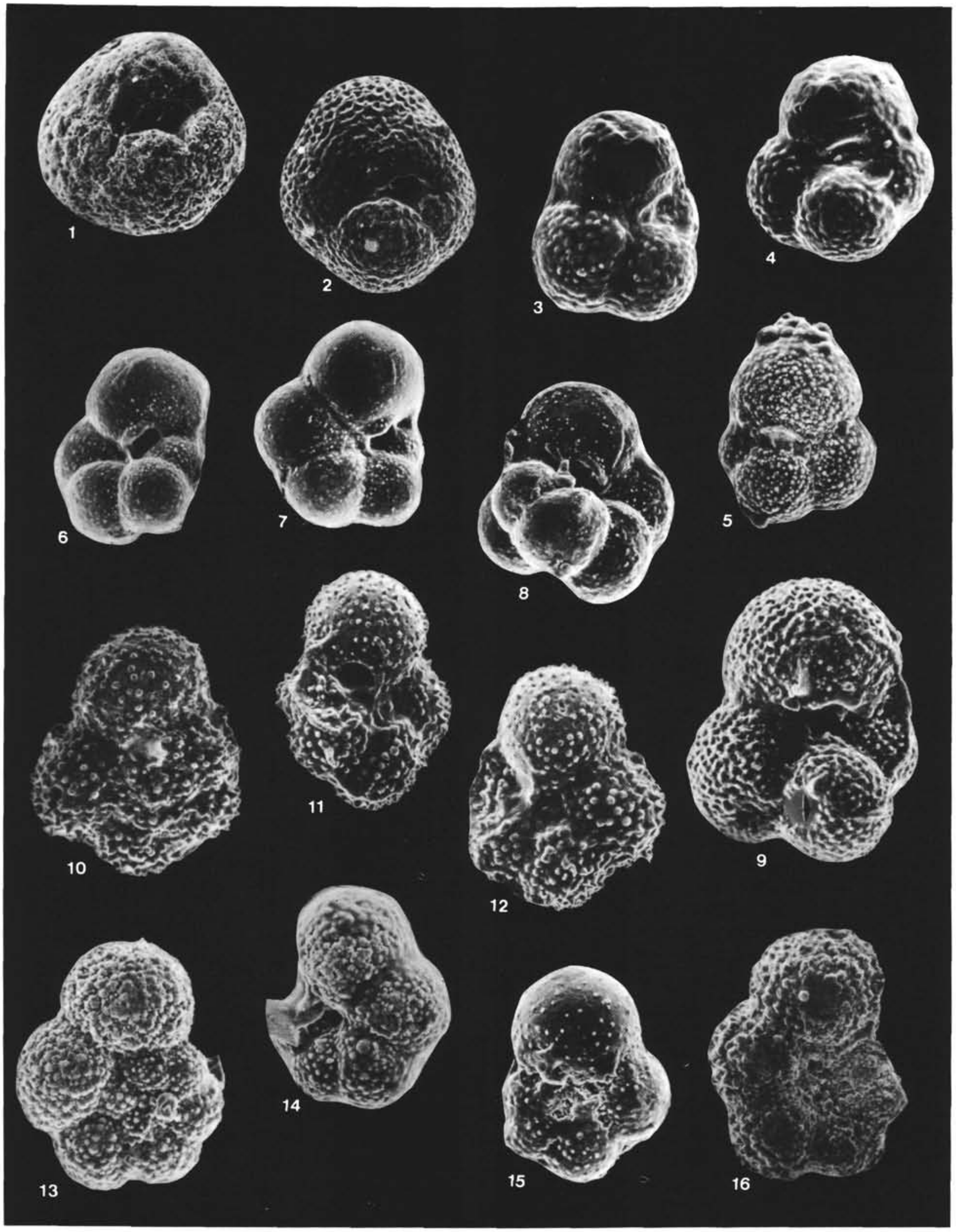

Plate 16. **1–2.** *Neogloboquadrina pachyderma*, (1) 270-1-2, 52–54 cm, max. diam. 0.20 mm; (2) 270-3,CC, max. diam. 0.31 m. **3–5.** *Globigerinita* cf. *G. glutinata*, (3) side view, 270-3,CC, max. diam. 0.13 mm; (4) umbilical view, same specimen; (5) umbilical view, 270-36-6, 115–123 cm, max. diam. 0.10 mm. **6–8.** *Globigerina megastoma*, (6) oblique apertural view, 270-3,CC, max. diam. 0.13 mm; (7) umbilical view, same specimen; (8) apertural view, 270-3,CC, max. diam. 0.13 mm. **9.** *Globigerina* sp., umbilical view, 270-3,CC, max. diam. 0.17 mm. **10–15.** *Globorotalia* sp., (10) spiral view, 270-3,CC, max. diam. 0.18 mm; (11) apertural view, same specimen; (12) umbilical view, same specimen; (13) spiral view, 270-1,CC, max. diam. 0.12 mm); (14) umbilical view, same specimen; (15) umbilical view, 270-3,CC, max. diam. 0.16 mm. **16.** *Globigerinelloides* cf. *G. volutus*, 270-19-5, 113–122 cm, max. diam. 0.15 mm.

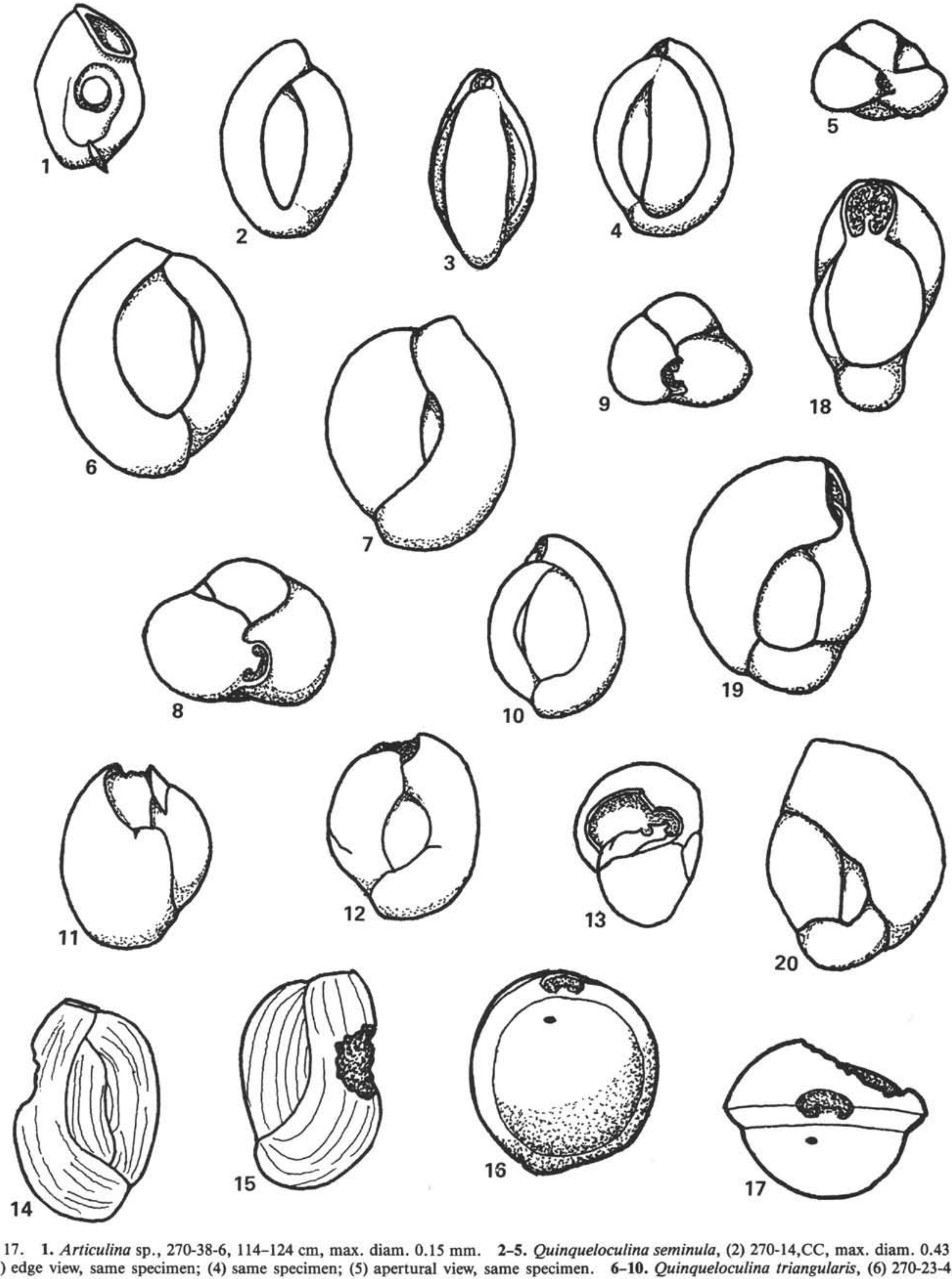

Plate 17. **1.** *Articulina* sp., 270-38-6, 114–124 cm, max. diam. 0.15 mm. **2–5.** *Quinqueloculina seminula*, (2) 270-14,CC, max. diam. 0.43 mm; (3) edge view, same specimen; (4) same specimen; (5) apertural view, same specimen. **6–10.** *Quinqueloculina triangularis*, (6) 270-23-4, 72–82 cm, max. diam. 0.54 mm; (7) same specimen; (8) apertural view, same specimen; (9) apertural view, 270-23-4, 72–82 cm, max. diam. 0.42 mm; (10) same specimen. **11–13.** *Triloculina rotundata*, (11) 270-33-3, 102–110 cm, max. diam. 0.68 mm; (12) same specimen; (13) apertural view, same specimen. **14–15.** *Triloculina* cf. *T. brongniartiana*, (14) 270-29-1, 3–5 cm, max. diam. 0.21 mm; (15) same specimen. **16–17.** *Pyrgo* cf. *P. vespertilio*, (16) 270-15-3, 97–110 cm, max. diam. 1.90 mm; (17) apertural view, same specimen. **18–20.** *Flintina* cf. *F. droogeri*, (18) 270-31-3, 59–67 cm, max. diam. 0.52 mm; (19) apertural view, same specimen; (20) same specimen.

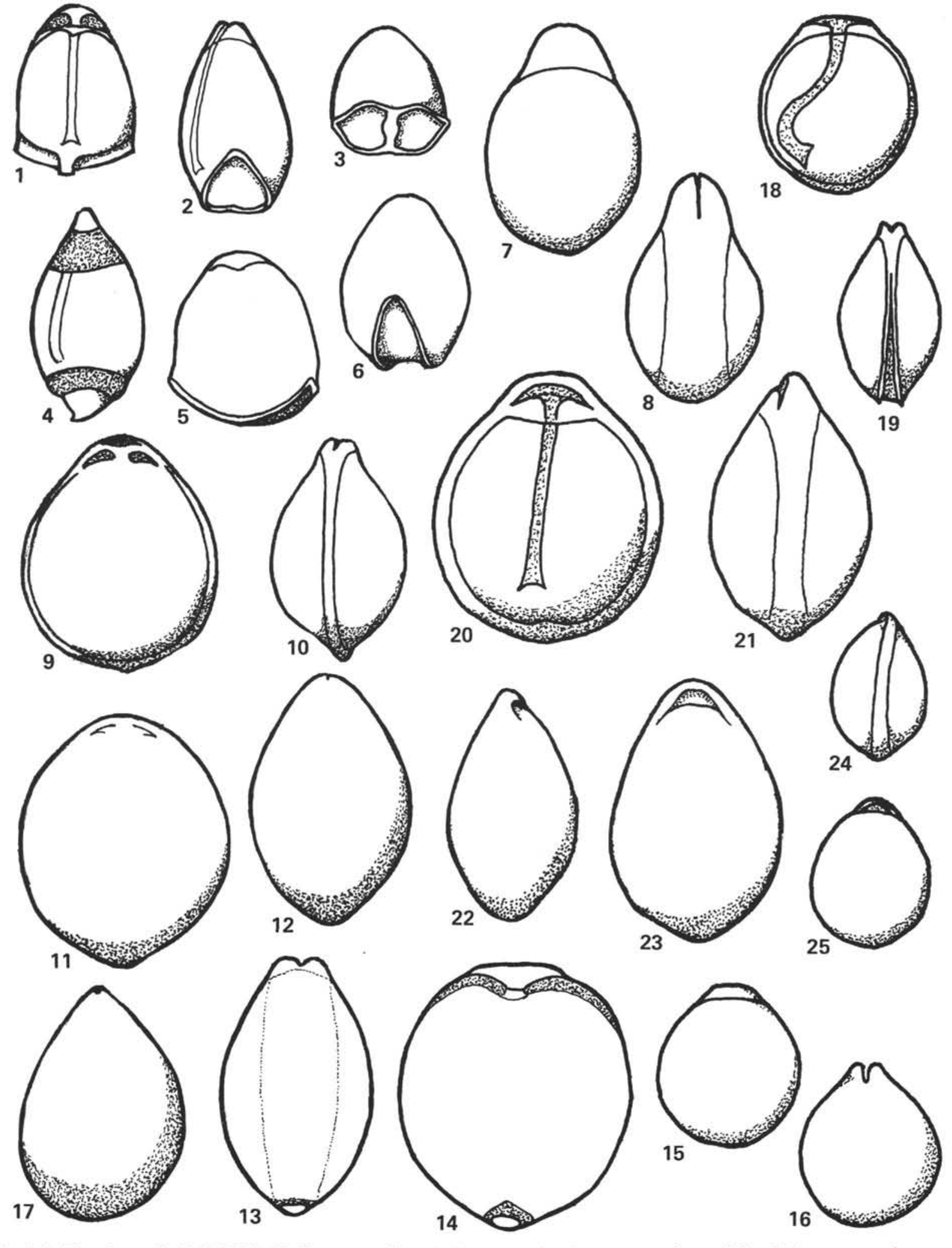

Plate 18. **1–3.** *Fissurina* sp. 3, (1) 270-25-2, 50–60 cm, max. diam. 0.19 mm; (2) edge view, same specimen; (3) basal view, same specimen. **4.** *Fissurina* sp. 4, 270-25-2, 50–60 cm, max. diam. 0.22 mm. **5–6.** *Fissurina danica*, (5) 270-15-3, 97–110 cm, max. diam. 0.17 mm; (6) edge view, same specimen. **7–8.** *Fissurina lucida*, (7) 270-40-3, 123–131 cm, max. diam. 0.21 mm; (8) edge view, same specimen. **9–10.** *Fissurina marginata*, (9) 270-19-5, 113–122 cm, max. diam. 0.25 mm; (10) edge view, same specimen. **11–12.** *Fissurina laevigata*, (11) 270-19-5, 113–122 cm, max. diam. 0.27 mm; (12) edge view, same specimen. **13–14.** *Fissurina* sp. 2, (13) edge view, 270-27-4, 108–118 cm, max. diam. 0.25 mm; (14) same specimen. **15–16.** *Fissurina agassizi*, (15) 270-38,CC, max. diam. 0.36 mm; (16) side view, same specimen. **17.** *Oolina globosa*, 270-19-5, 113–122 cm, max. diam. 0.24 mm. **18–19.** *Parafissurina* cf. *P. tasmanica*, (18) 270-8-3, 113–128 cm, max. diam. 0.16 mm; (19) edge view, same specimen. **20–21.** *Parafissurina subcarinata*, (20) 270-8-3, 113–128 cm, max. diam. 0.24 mm; (21) edge view, same specimen. **22–23.** *Parafissurina lateralis*, (22) edge view, 270-19-5, 113–122 cm, max. diam. 0.24 mm; (23) same specimen. **24–25.** *Parafissurina curta*, (24) edge view, 270-28-6 (bottom of section), max. diam. 0.34 mm; (25) same specimen.

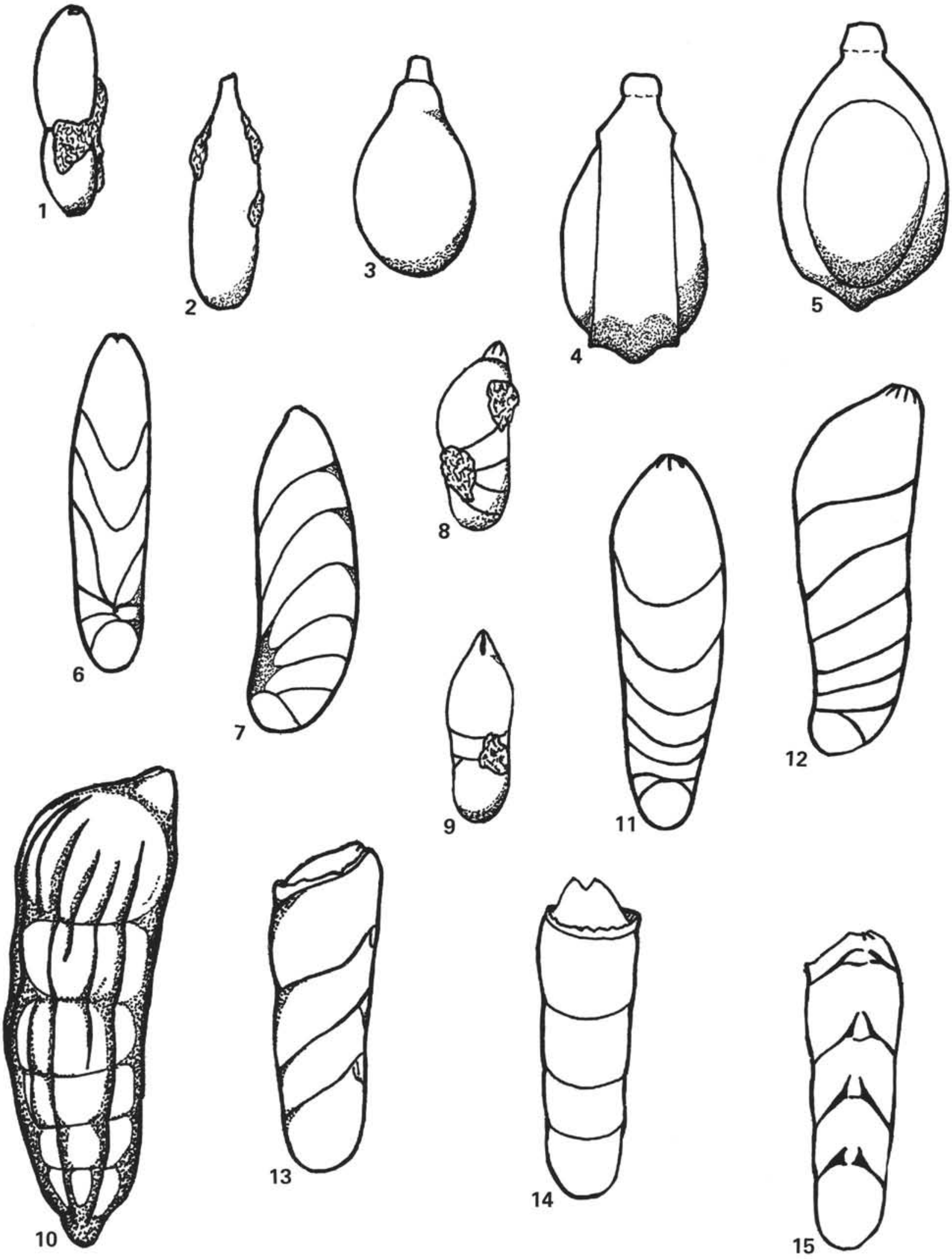

Plate 19. **1.** *Nodosaria calomorpha*, 270-34-3, 28–38 cm (max. diam. 0.45 mm). **2.** *Lagena nebulosa*, 270-9,CC, max. diam. 0.50 mm. **3.** *Lagena* cf. *L. laevigata*, 270-15-3, 97–110 cm, max. diam. 0.23 mm. **4–5.** *Lagena sequenziana*, (4) edge view, 270-19-5, 113–122 cm, max. diam. 0.32 mm; (5) same specimen. **6–7.** *Astacolus crepidulus*, (6) edge view, 270-27-4, 108–118 cm, max. diam. 0.85 mm; (7) same specimen. **8–9.** *Marginulina tumida*, (8) 270-19-5, 113–122 cm, max. diam. 0.42 mm; (9) edge view, same specimen. **10.** *Marginulina* cf. *M. cocoaensis*, 270-15-3, 97–110 cm, max. diam. 1.07 mm. **11–12.** *Vaginulina awamoana*, (11) edge view, 270-19-5, 113–122 cm, max. diam. 1.27 mm; (12) same specimen. **13–15.** *Dentalina* cf. *D. advena*, (13) 270-16-4, 123–135 cm, max. diam. 0.67 mm; (14) same specimen; (15) same specimen.

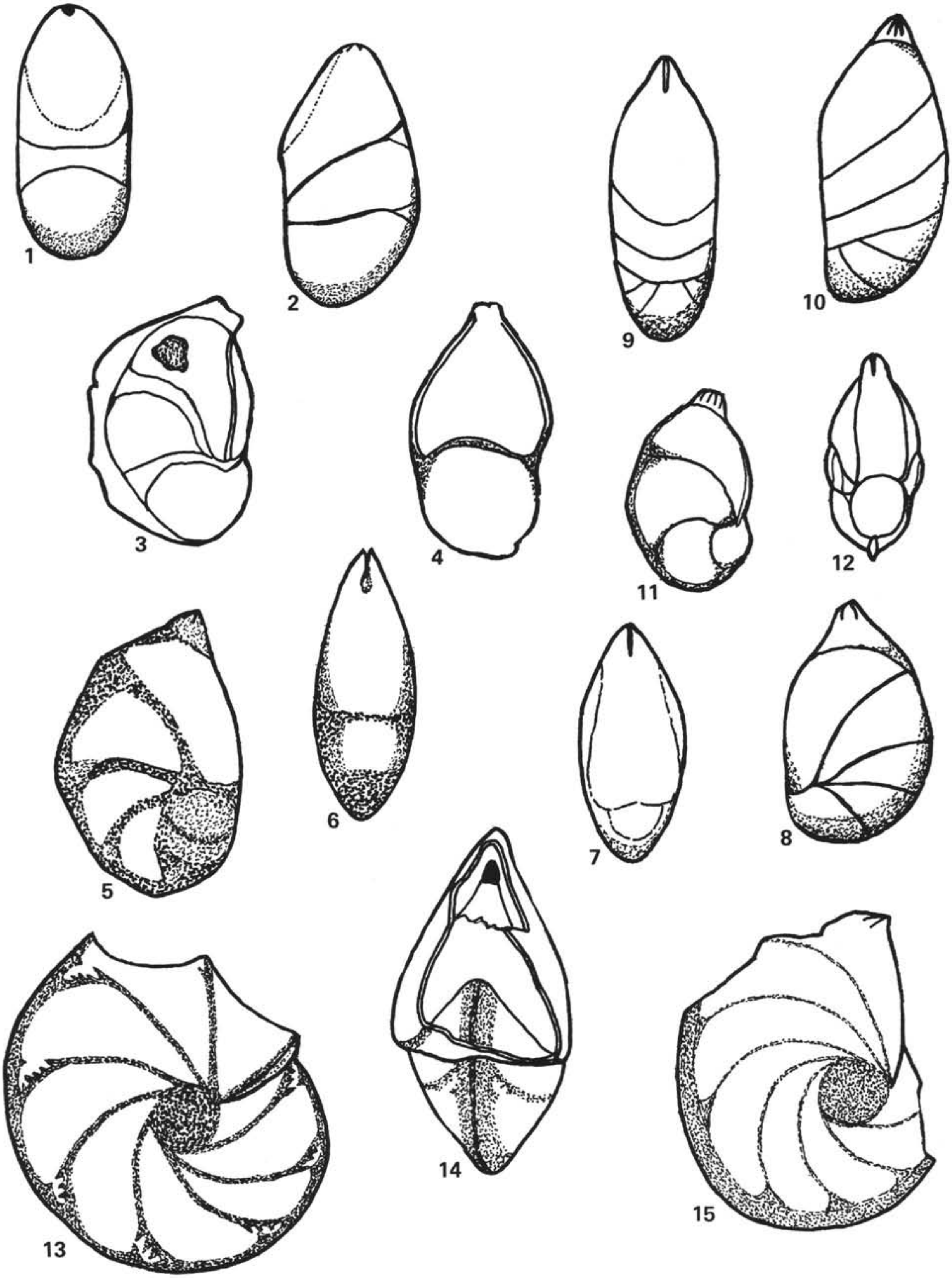

Plate 20. **1–2.** ?*Astacolus* sp., (1) edge view, 270-26-4, 100–114 cm, max. diam. 0.52 mm; (2) side view, same specimen. **3–4.** *Marginulinopsis* cf. *M. pedum*, (3) 270-3,CC, max. diam. 0.21 mm; (4) edge view, same specimen. **5–8.** *Saracenaria kellumi*, (5) 270-24-3, 110–120 cm, max. diam. 0.59 mm; (6) edge view, same specimen; (7) edge view, 270-35-3, 112–121 cm, max. diam. 0.53 mm; (8) same specimen. **9–10.** *Saracenaria* sp., (9) edge view, 270-35-3, 112–121 cm, max. diam. 0.66 mm; (10) same specimen. **11–12.** *Lenticulina callifera*, (11) 270-19-5, 113–122 cm, max. diam. 0.45 mm; (12) edge view, same specimen. **13–14.** *Lenticulina* sp., (13) 270-15-3, 97–110 cm, max. diam. 2.95 mm; (14) edge view, same specimen. **15.** *Lenticulina lenticula*, 270-37-4, 133–142 cm, max. diam. 1.15 mm.

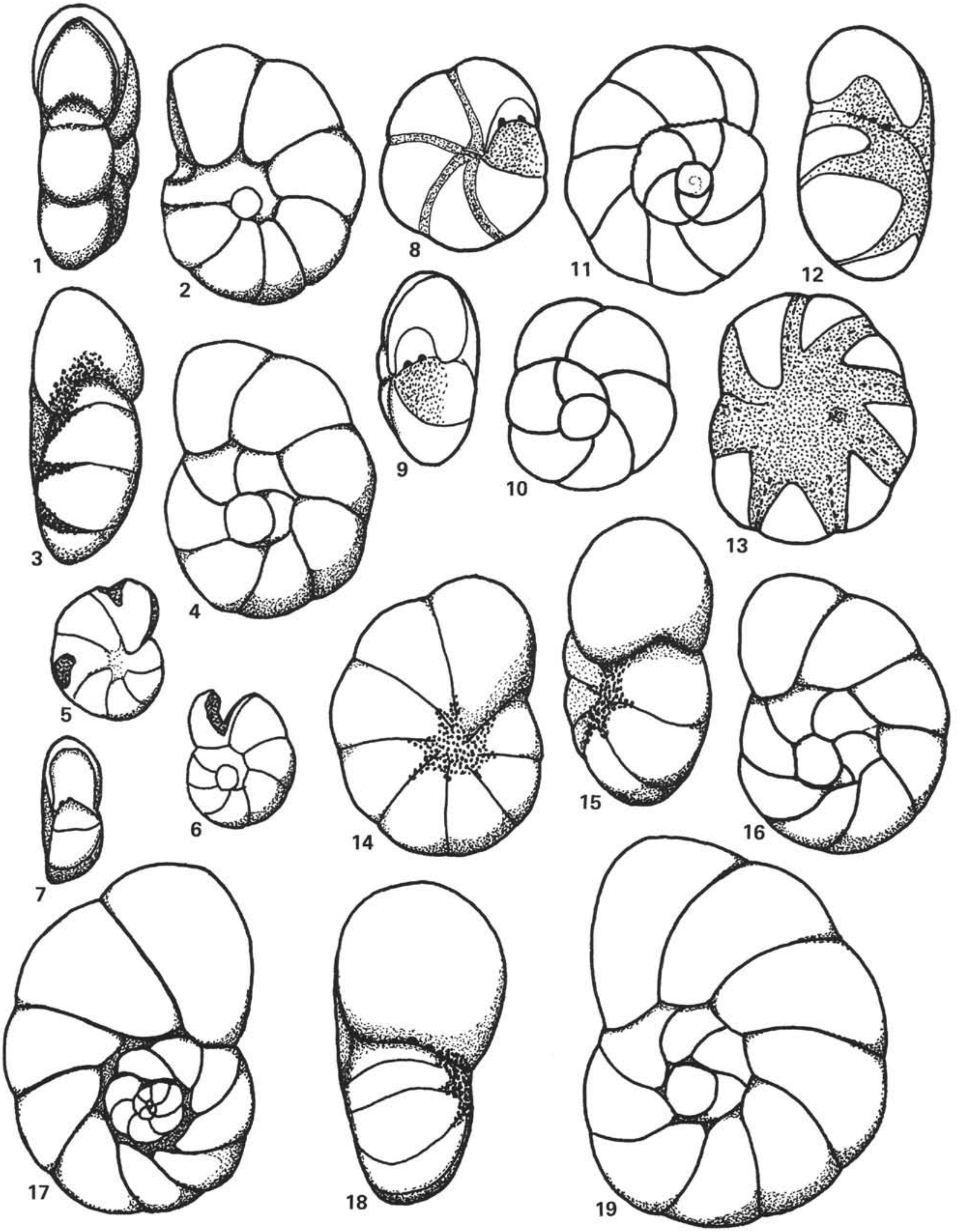

Plate 21. **1–7.** *Trochoelphidiella* sp., (1) apertural view, same specimen as Pl. 10, Figs. 1–2; (2) spiral view, same specimen; (3) apertural view, same specimen as Pl. 10, Figs. 3–4; (4) spiral view, same specimen; (5) umbilical view, 270-32-3, 114–123 cm, max. diam. 0.34 mm; (6) spiral view, same specimen; (7) apertural view, same specimen. **8–13.** *Trochoelphidiella uniforamina*, (8) megalospheric form, umbilical view, same specimen as Pl. 9, Figs. 5–6; (9) apertural view, same specimen; (10) spiral view, same specimen; (11) microspheric form, spiral view, same specimen as Pl. 9, Figs. 1–3, 9–12; (12) apertural view, same specimen; (13) umbilical view, same specimen. **14–19.** *Trochoelphidiella pustulosa* n. sp., (14) holotype, umbilical view, 270-32,CC, max. diam. 0.26 mm; (15) edge view, same specimen; (16) spiral view, same specimen; (17) microspheric form, spiral view, 270-31-3, 59–67 cm, max. diam. 0.33 mm; (18) edge view, same specimen; (19) spiral view, same specimen as Pl. 8, Figs. 5–6.

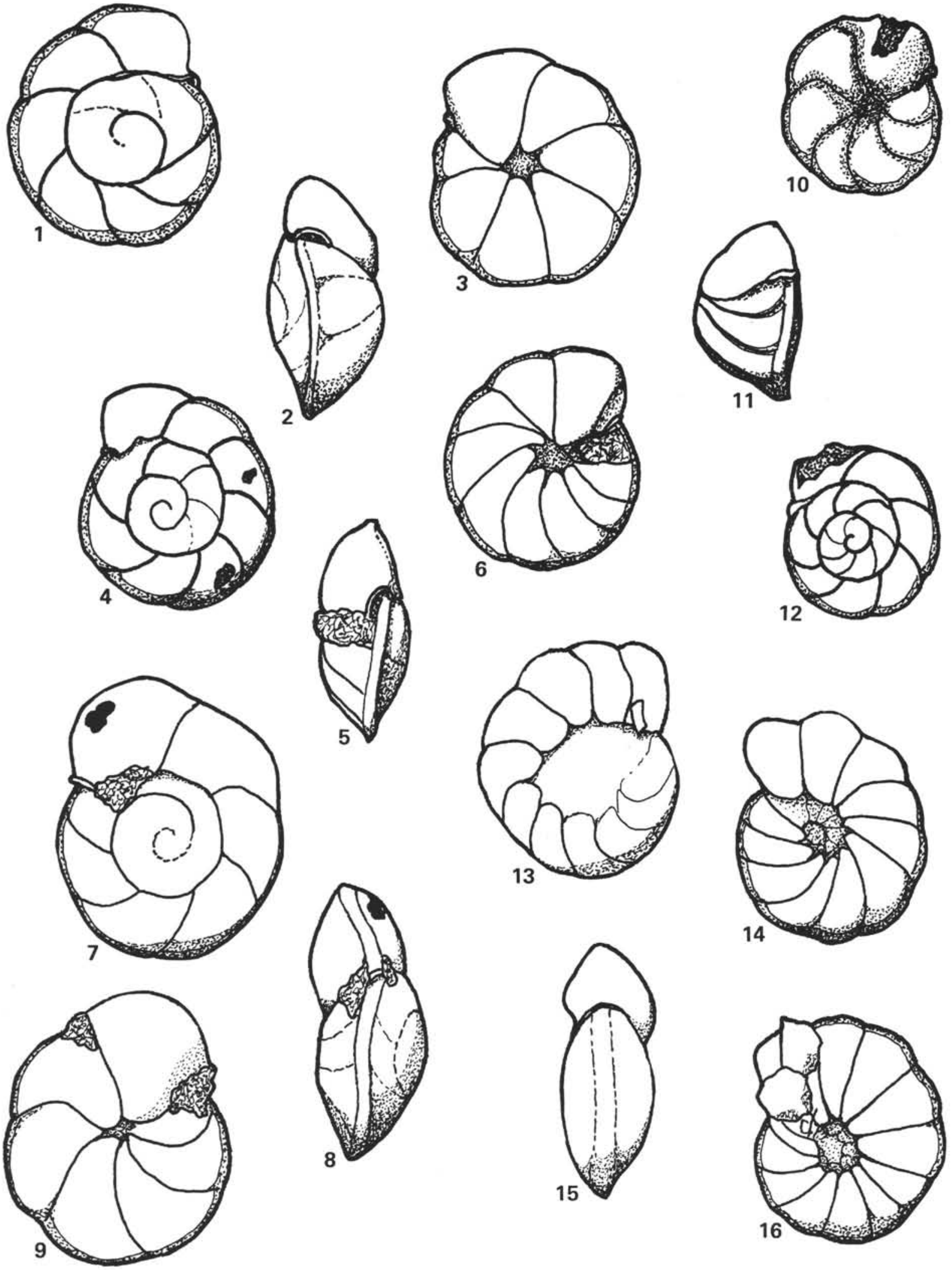

Plate 22. **1–3.** *Cibicides temperata*, (1) spiral view, 270-15-3, 97–110 cm, max. diam. 0.53 mm; (2) edge view, same specimen; (3) umbilical view, same specimen. **4–6.** *Cibicides pseudoungerianus*, (4) spiral view, 270-15-3, 97–110 cm, max. diam. 0.72 mm; (5) edge view, same specimen; (6) umbilical view, same specimen. **7–9.** *Cibicides* cf. *C. thiara*, (7) spiral side, 270-19-5, 113–122 cm, max. diam. 0.63 mm; (8) edge view, same specimen; (9) umbilical side, same specimen. **10–12.** *Cibicides vortex*, (10) umbilical view, 270-19-5, 113–122 cm, max. diam. 0.41 mm; (11) edge view, same specimen; (12) spiral view, same specimen. **13–16.** *Cibicides* cf. *C. mediocris*, (13) spiral side, 270-15-3, 97–110 cm, max. diam. 0.52 mm; (16) umbilical view, same specimen; (14) umbilical side, 270-15-3, 97–110 cm, max. diam. 0.55 mm; (15) edge view, same specimen.

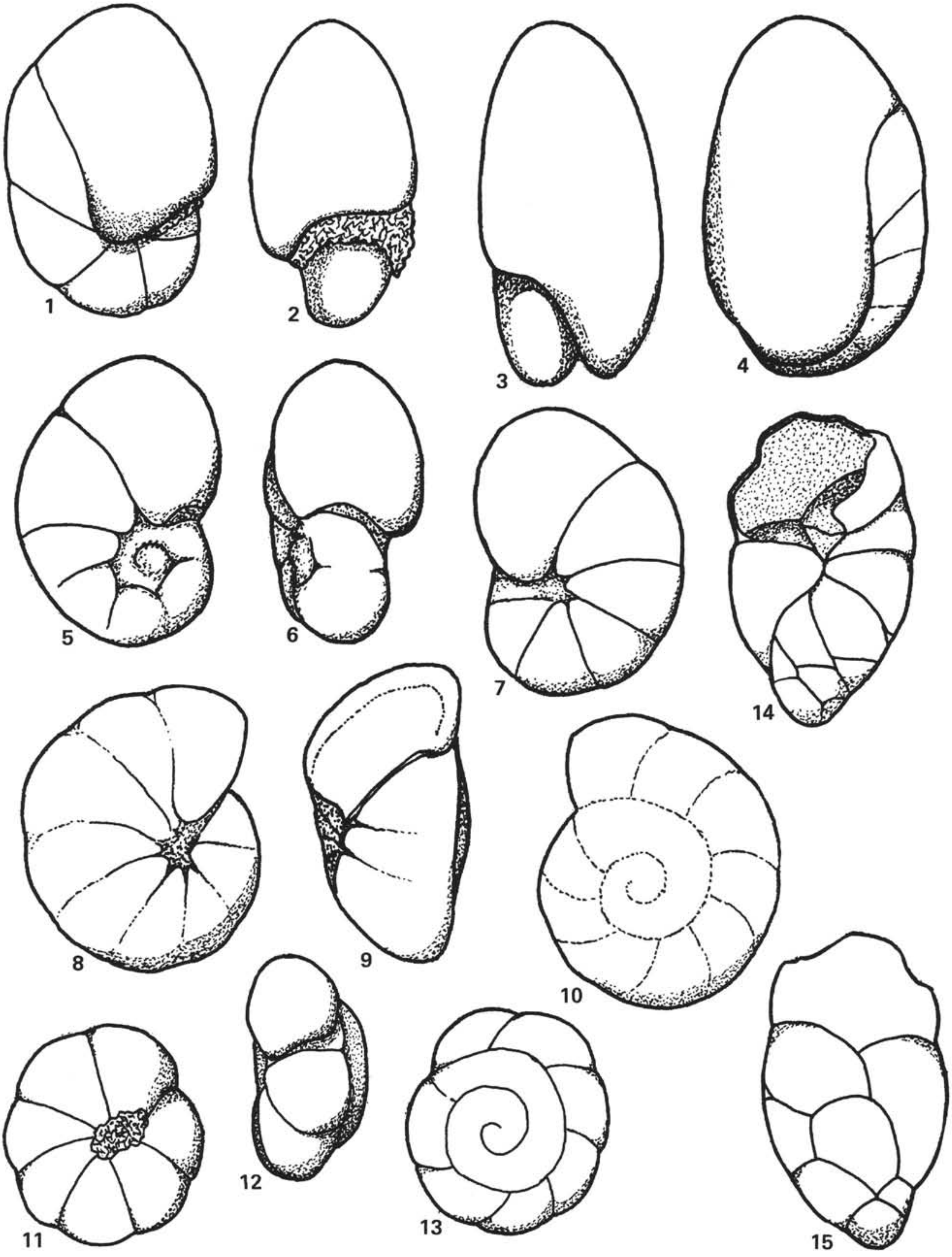

Plate 23. **1–2.** *Nonionella bradii*, (1) umbilical view, 270-19-5, 113–122 cm, max. diam. 0.26 mm; (2) apertural view, same specimen. **3–4.** *Nonionella magnalingua*, (3) apertural view, 270-38,CC, max. diam. 0.32 mm; (4) umbilical side, same specimen. **5–7.** *Nonionella iridea*, (5) spiral side, 270-38,CC, max. diam. 0.25 mm; (6) apertural view, same specimen; (7) umbilical side, same specimen. **8–10.** *Gyroidina zelandica*, (8) umbilical view, 270-19-5, 113–122 cm, max. diam. 0.42 mm; (9) apertural view, same specimen; (10) spiral view, same specimen. **11–13.** *Eponides bradyi*, (11) umbilical view, 270-19-5, 113–122 cm, max. diam. 0.21 mm; (12) edge view, same specimen; (13) spiral view, same specimen. **14–15.** *Robertina tasmanica*, (14) 270-23-4, 72–82 cm, max. diam. 0.27 mm; (15) same specimen.