

## 9. MIOCENE TO PLEISTOCENE BENTHIC FORAMINIFERS AND PALEOCEANOGRAPHY OF THE MIDDLE AMERICA SLOPE, DEEP SEA DRILLING PROJECT LEG 84<sup>1</sup>

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### ABSTRACT

Miocene through Pleistocene benthic foraminifers from Sites 566–570 on the landward slope of the Middle America Trench were examined to determine depositional history, depositional depths, water-mass changes, and downslope transport. This study indicates that these sites have undergone a gradual uplift since at least Miocene time. Deposition has occurred at middle bathyal to abyssal depths, and under the influence of early Miocene bottom water, early Miocene intermediate water, deep central Pacific bottom water, Antarctic Bottom Water, Pacific Deep Water, and Pacific Intermediate Water. Missing or dissolved intervals in the section correlate with expansions of corrosive bottom waters and widespread deep-sea hiatuses.

Lower Miocene assemblages indicate that both a deep central Pacific bottom water and an early Miocene bottom water existed on the lower slope. Pacific bottom-water assemblages indicate that a deep-water corridor connected the Pacific and Caribbean at this time. In the late early to middle Miocene, the early Miocene bottom water appears to have been restricted to even greater depths, as indicated by improved preservation of the calcium carbonate tests. The appearance of the benthic foraminifers indicative of low-oxygen conditions suggests the development of a low-oxygen intermediate water mass by late early to middle Miocene. Also, uplift in Central America appears to have affected the deep and intermediate water-mass connections between the Caribbean and Pacific, as suggested by increased transport of shallow-water assemblages, decreased water depth, and associated changes in the water masses.

Upper Miocene through Pliocene sections are incomplete, but faunal assemblages indicate the presence of the Pacific Intermediate Water and Antarctic Bottom Water. Water depths did not change during the late Miocene, and may have been slightly deeper during the Pliocene. Poor preservation of faunas, resulting from high-latitude cooling and associated expansion of the Antarctic Bottom Water, obscures trends of depositional depth. Subaerial emergence of Panama land bridge appears to have occurred at this time. Water depth generally decreased in the Pleistocene, and the water masses achieved their modern distributions.

### INTRODUCTION

On DSDP Leg 84, drilling was conducted at a series of sites on the landward slope of the Middle America Trench off Guatemala and Costa Rica. The sites were selected to test the accretionary model proposed by Seeley et al. (1974). The Guatemalan transect comprises five sites drilled at water depths ranging from 1718 m (Sites 570) to 5529 m (Site 567) (Fig. 1). The Costa Rican site (565), farther south, will not be considered in this study. Although these sites are presently located on the landward side of the trench, they may not have been in the past. One of the goals of Leg 84 was to interpret the tectonic history of this margin. Benthic foraminifers, which are particularly sensitive to physicochemical properties of seawater, provide a means of reconstructing the paleoceanography, and ultimately aid in interpreting the tectonic history.

Shelf and upper-slope benthic foraminiferal faunas have been widely studied, and are the basis for most benthic foraminiferal chronologies and paleoecologic interpretations, whereas deep-sea benthic foraminiferal faunas have only recently received attention. Ecologic and paleoecologic studies of the shelf and upper-slope faunas have suggested correlations between the distribution

of a species or a morphology and various physicochemical properties (e.g., see Ingle, 1980; Douglas, 1979, 1981). This correlation is frequently expressed as the upper depth limit of a species or as a biofacies fauna. Studies of the deep-sea faunas indicate that there is a correlation between the distributions of water masses and benthic foraminifers, and that these distributions can be traced through time (see, e.g., Woodruff and Douglas, 1981; Woodruff, in press). Techniques and conclusions from these studies can be used to reconstruct paleoceanographic conditions of a particular area.

Sites on the Middle America Trench and slope have undergone a series of depth changes because of tectonic activity. Water masses influencing the benthic foraminifers varied through time, as a result of the climatic changes and tectonics. Benthic foraminifers contained in the sediments at these sites are a mixture of the shelf, slope, and abyssal faunas, so paleoecologic interpretations can be based on a variety of techniques. The purpose of this study is to interpret the depth of deposition, water-mass character, and downslope transport as indicated by the benthic foraminifers, and from these interpretations to reconstruct the paleoceanography of the Middle America slope.

### PROCEDURE

The paleoecologic interpretations are achieved largely through analysis of the biofacies represented in each sample. A biofacies defined by water depth is recognized by a species whose upper depth limit falls within the biofacies depth range. Biofacies and associated faunas for the Middle America margin were determined from Holocene studies

<sup>1</sup> von Huene, R., Aubouin, J., et al., *Init. Repts. DSDP, 84*: Washington (U.S. Govt. Printing Office).

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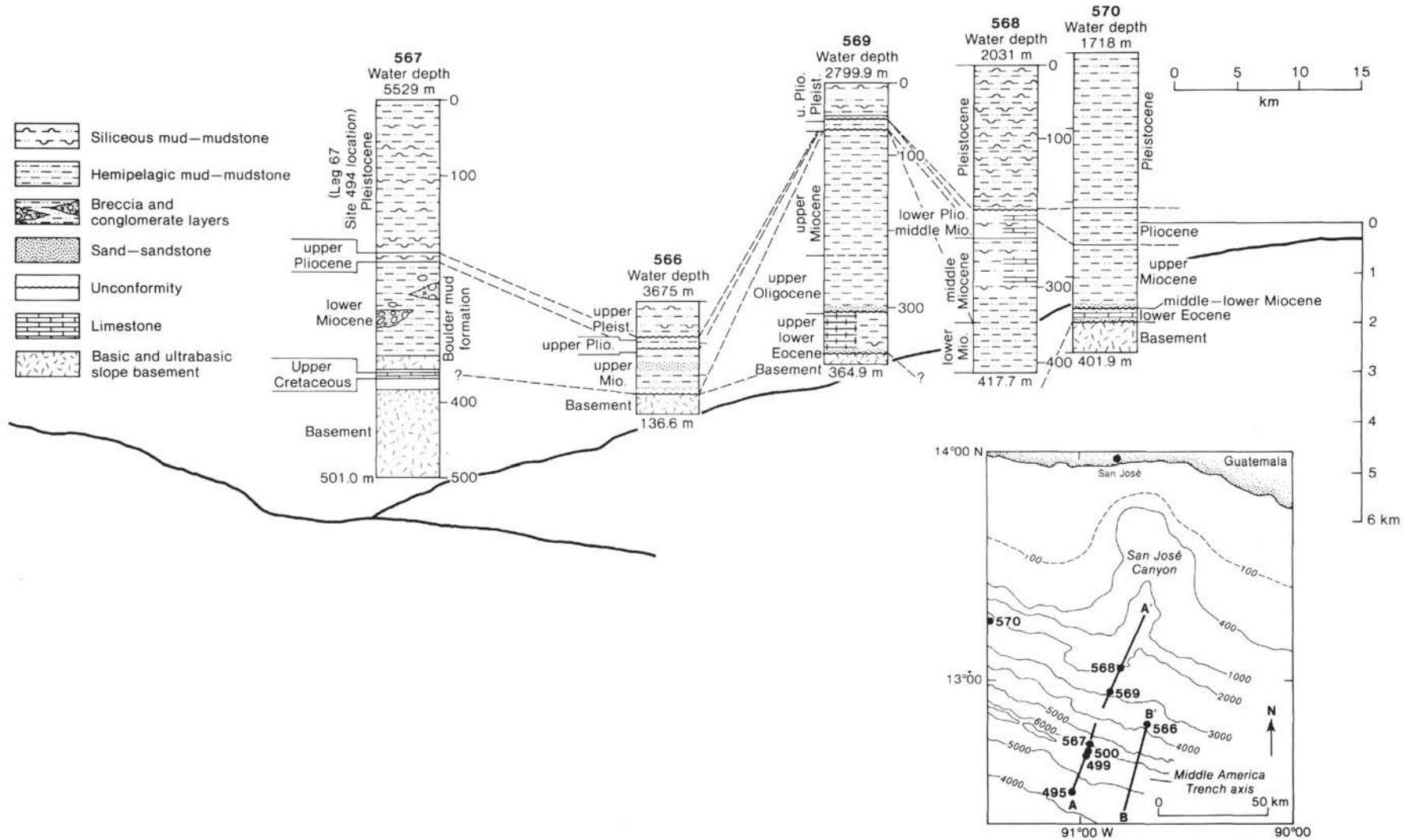


Figure 1. Locations and bathymetric distribution of the Leg 84 Guatemalan sites. Numbers at right of each column give sub-bottom depth (m). Bathymetric contours on inset in meters.

in the equatorial Pacific (Wyrтки, 1966; van Andel et al., 1975; Smith, 1964; Golik and Phleger, 1977; Bandy and Arnal, 1957; Thompson, 1982) and from more general studies along the East Pacific Margin (Uchio, 1960; Ingle, 1980; Ingle and Keller, 1980; Resig, 1981) and in the Caribbean (Phleger, 1960; Bandy, 1956; Pflum and Frerichs, 1976). Upper depth limits of benthic foraminifers used in this study are given in the Taxonomic Notes (Appendix).

The biofacies analysis examines the abundance of species indicative of the various biofacies in an assemblage; the deepest biofacies represented indicates the minimum depth of deposition. In a stratigraphic section, changes in water depth, transported or mixed faunas, and selective preservation or dissolution appear as deviations in the biofacies pattern (Douglas, 1979, 1981; Ingle, 1980; Baltuck et al., this volume). The size, shape, and condition of the foraminiferal tests and/or the presence of age-diagnostic or water-mass-specific species in the assemblage help determine the cause of the change in biofacies pattern.

The presence of key species or assemblages is used to identify specific water masses and associated physical-chemical conditions. These interpretations rely heavily on the work of Woodruff (1979 and in press). Additional information on benthic foraminifers and water-mass associations is taken from Burke (1981), Lohmann (1978), Streeter (1972, 1973), Smith (1964), and Ingle and Keller (1980). Water masses presently impinging on the Middle America margin include the Surface Water, Pacific Intermediate Water (PIW), Pacific Deep Water (PDW), and Antarctic Bottom Water (AABW) (Wyrтки, 1966; van Andel et al., 1975). Because the early Miocene ocean was warmer, less stratified, and less oxygenated than the middle to late Miocene or modern ocean, Woodruff (in press) recognizes faunal assemblages associated with early Miocene bottom water, intermediate water, and deep central Pacific bottom-water masses. Early Miocene bottom-water assemblages were found below 3.2 km water depth, and included species which became extinct 14 Ma ago, moved to shallower depths (less than 2.5 km) after 14 Ma ago, or are presently associated with the AABW. The early Miocene intermediate-water assemblages were found above 2.6 km water depth, and included species which are extinct or are now associated with the PIW and low-oxygen conditions. The deep central Pacific bottom-water assemblages were found in deep bottom-water corridors, and are believed to represent the influx of new dense bottom waters during glacial expansions. Since similar benthic foraminiferal assemblages were found on the Middle America slope, these early Miocene water masses will be included in the analysis. Water mass and other physicochemical associations or constraints of the benthic foraminiferal species used in this study are given in the Taxonomic Notes (Appendix). The locations of the DSDP sites and the distribution of water masses with respect to the benthic foraminiferal biofacies for the Middle America margin are summarized in Figure 2.

Because pre-Miocene sediments are strongly dissolved, discontinuous, or nonfossiliferous, and because the knowledge of paleoceanographic

associations of the older species is less reliable, the present study concentrates on the Miocene to Recent sediments. In the Guatemalan transect this includes the sediments in Cores 570-1 to 570-35, 568-1 to 568-44, 569-1 to 569-27, 569A-H1 to 569A-6, 567-H1 to 567-2, and 567A-H1 to 567A-13. These samples were prepared according to methods described by Stone and Keller (this volume); benthic foraminiferal faunal lists are given in Tables 1-6 (Table 2 is in back pocket); Table 7 identifies the barren samples. Since age interpretations based on benthic foraminifers are not emphasized in this chapter, ages based on planktonic foraminifers (Stone and Keller, this volume) and calcareous nannofossils (Filewicz, this volume) are used. Benthic foraminifers clarify these interpretations in intervals where they are the only preserved microfossils (Fig. 3). Also, where possible, the barren or dissolved intervals are correlated with the sequence of latest Oligocene (PH) and Miocene (NH1-NH7) deep-sea hiatuses described by Keller and Barron (1983). Biofacies and water-mass interpretations are discussed first for each site in this transect. These interpretations are then summarized, and provide the basis for reconstructing the Miocene to Pleistocene oceanography for the Middle America margin.

### SITE 570

Site 570 is 40 km landward of the trench axis on the upper part of the slope, in the area presently considered the lower middle bathyal biofacies and where the PIW impinges on the slope (Fig. 2). Sediment recovered at this site ranges from Eocene to Pleistocene. Planktonic foraminifers indicate that at a major unconformity occurs between Cores 570-35 and 570-36; cores below this unconformity are no younger than early Eocene, and cores above it range from Miocene to Pleistocene. Age interpretations based on planktonic foraminifers for the upper cores are early Miocene (570-35, CC and 570-35-4), late Miocene (570-35-1 to 570-35-28), Pliocene (570-28-3 to 570-24-1), Pliocene-Pleistocene undifferentiated (570-23 to 570-23-22), and Pleistocene (570-20 to 570-1) (Filewicz, this volume; Stone and Keller, this volume). Benthic foraminifers are generally consistent with the age interpretations based on planktonic foraminifers (Fig. 3).

Biofacies analysis of Site 570 indicates a fairly uniform pattern throughout most of the section, with deposition having occurred in the lower bathyal biofacies (Fig. 4 [back pocket]; Table 1). Water masses influencing the faunas were deep central Pacific bottom water (570-35), ABW (570-34 to 570-33, 570-28, and 570-26 to

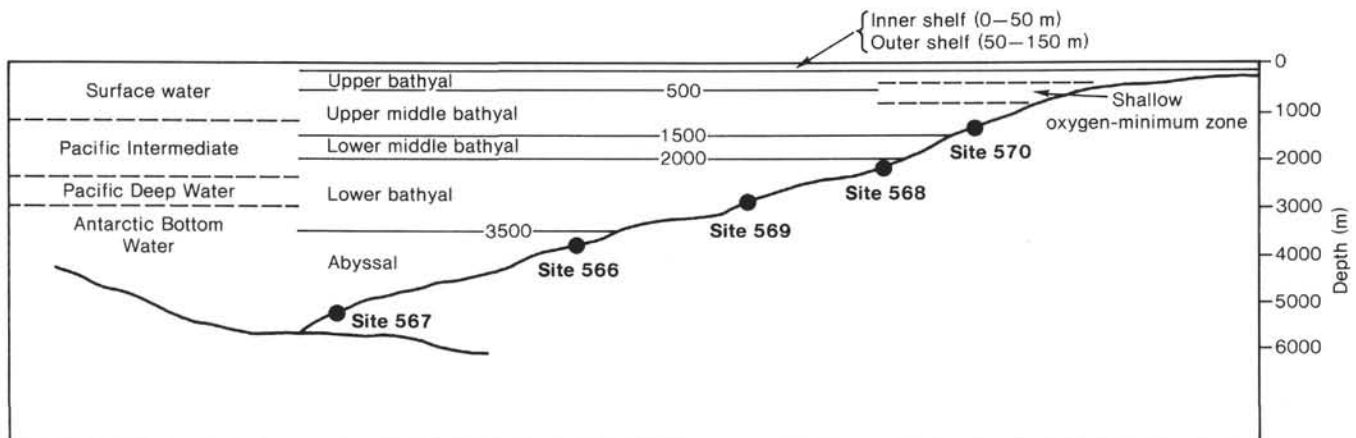


Figure 2. Distribution of water masses, benthic foraminiferal biofacies, and DSDP Leg 84 sites along the landward slope of the Middle America Trench. The water-mass distribution follows Smith (1964), Wyrтки (1966), and van Andel et al. (1975). Biofacies distribution is from Bandy and Arnal (1957), Golik and Phleger (1977), Smith (1964), Ingle (1980), Ingle and Keller (1980), and Thompson (1982).

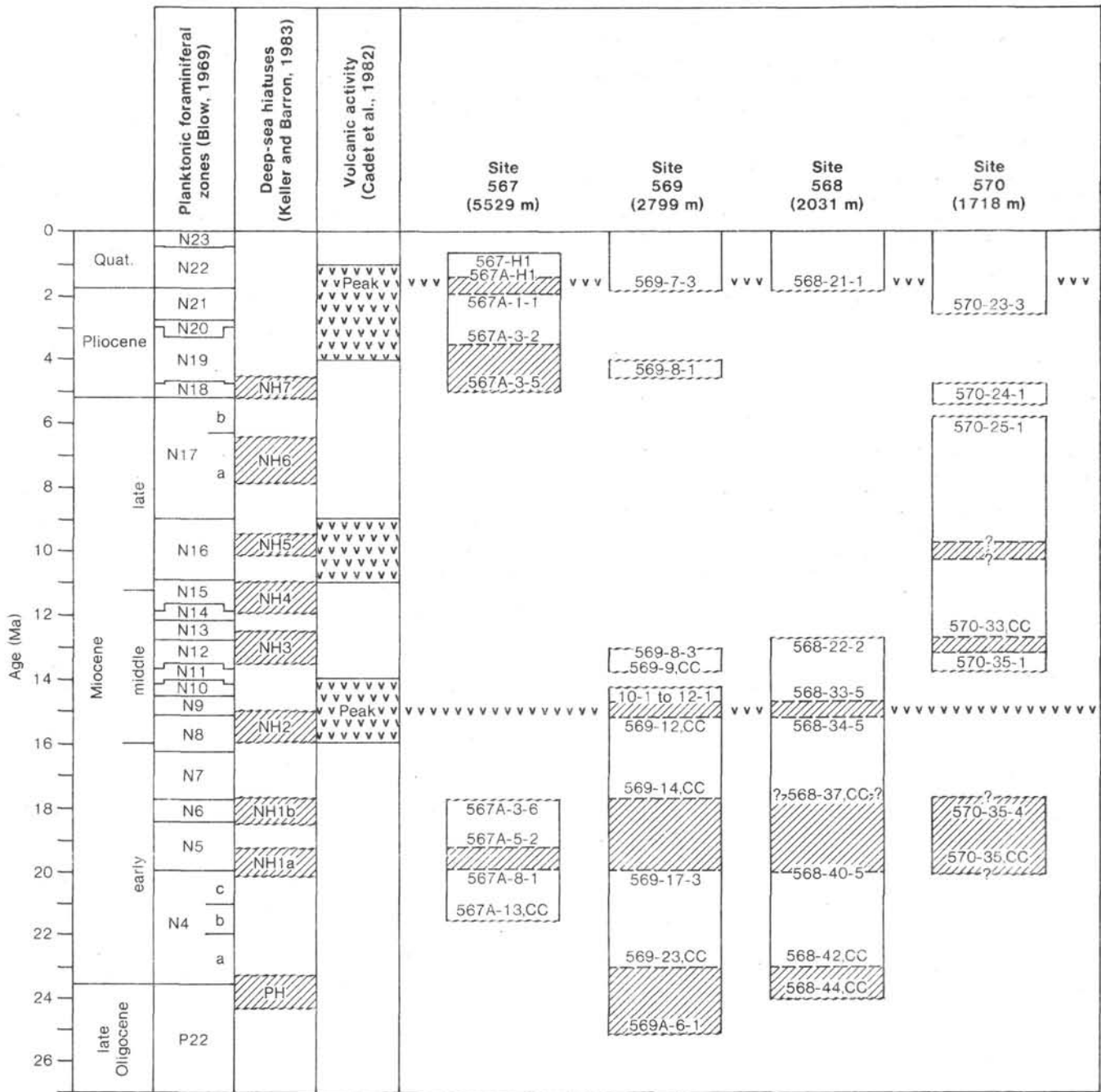


Figure 3. Age and correlation of DSDP Leg 84 sites, modified from Stone and Keller (this volume). Hachures indicate dissolved or barren intervals. Periods of peak volcanic activity are indicated by VVV.

570-24), PDW (570-23 to 570-18), and PIW (570-33 to 570-28, 570-29 to 570-23, and 570-18 to 570-1) (Fig. 4 [back pocket]). The incursions of cold corrosive bottom waters in the Miocene of Site 570 correlate with deep-sea hiatuses recognized by Keller and Barron (1983). Planktonic foraminifers, calcareous nannofossils and benthic foraminifers, lower benthic foraminiferal diversities, and the presence of species commonly associated with deep central Pacific bottom water in Core 570-34 correlate with the early Miocene deep-sea hiatus NH1. In the stratigraphically higher Cores 570-33 to 570-34 and 570-28,

the age interpretations, as well as slightly lower foraminiferal diversities and the presence of species associated with the AABW, indicate correlation with deep-sea hiatuses NH3 and NH5, respectively. Although species characteristic of the AABW continue to appear in Cores 570-26 through 570-24, the faunal turnover suggests that the dissolution in these cores and the presence of cold corrosive bottom waters are correlative with younger Miocene to Pliocene hiatuses such as NH6 or NH7. The youngest incursion of cold corrosive bottom water at Site 570 corresponds to the Pliocene to Pleistocene cold

event 2.5 to 1.2 Ma ago, evidence of which is recognized throughout the Pacific (Ingle, 1967, 1973; Kent et al., 1971; Bandy, 1972; Olsson, 1974; Shackleton and Opdyke, 1977; Keller, 1978; and Keller and Ingle, 1981) (Figs. 3 and 4 [4 in back pocket]).

Moderately well preserved early Miocene, middle bathyal species dominate the assemblages in Samples 570-35, CC and 570-35-4, 12–14 cm, but the deepest faunas represented are from the lower bathyal and abyssal biofacies. *Anomalinoidea globosus* and *Stilostomella subspinosa* are present. Woodruff (in press) associates these species with a deep central Pacific bottom-water mass that was present at depths of 2.5–3.0 km in the early Miocene (18–21 Ma ago), and which is interpreted as representing the influx of new dense cold bottom waters along deep ocean corridors. This interpretation corresponds to the lower bathyal abyssal depths, as indicated by the biofacies patterns. The abundance of uvigerinids, buliminids, stilostomellids, and siphonodosariids in these lower Miocene samples suggests the presence of lower-oxygen conditions such as might be found in the PIW. The low abundance of the deep central Pacific bottom-water species, the absence of early Miocene bottom-water or AABW species, and the abundance of lower middle bathyal and PIW species suggest that either there was considerable downslope transport during the early Miocene at Site 570, or the early Miocene ocean was not well oxygenated and the occurrence of low-oxygen species was less restricted than at present.

Biofacies analysis of Sample 570-35-1, 20–22 cm indicates that depth and water-mass associations were similar to those in the early Miocene. Lower bathyal to abyssal biofacies species represent the deepest biofacies. Species associated with the PIW mass are common, but the presence of *Epistominella umbonifera* and *Cibicides bradyi* suggest that depths increased and/or the early Miocene bottom water or AABW expanded and migrated upslope. The latter interpretation is favored because in the overlying samples, 570-34, CC and 570-34-1, 121–125 cm, foraminiferal assemblages show the effects of dissolution and a cold corrosive water mass, and the age of these assemblages corresponds to a period of climatic deterioration and cooling (Kennett et al., 1973; Shackleton and Kennett, 1975; Woodruff and Douglas, 1981; Keller and Barron, 1983; Stone and Keller, this volume). The presence of species associated with the AABW in Sample 570-35-1, 20–22 cm thus signals the coming climatic deterioration, an increase in AABW, and a corresponding rise in the calcium compensation depth (CCD), which subsequently caused the dissolution in Samples 570-34, CC and 570-34-1, 121–125 cm. It is possible for these changes to have occurred without a significant change in water depth.

Overlying the dissolution interval, benthic foraminiferal diversity and biofacies patterns are relatively uniform. Outer-shelf and upper-slope species dominate and represent the transported fauna, whereas the less abundant lower-slope and abyssal species represent the deepest biofacies fauna. Despite the apparent biofacies uniformity, the assemblages indicate subtle changes in the water mass.

In Samples 570-33, CC to 570-28-3, 48–52 cm, *Osangularia culteri* and species of *Uvigerina*, *Stilostomella*, and *Siphonodosaria* are common, and suggest the presence of the PIW. Species indicative of deeper water masses are absent, so deposition of Cores 570-33 through 570-28 probably occurred in the shallower part of the lower bathyal biofacies and under the influence of the PIW.

In Core 570-28, the diversity trend fluctuates noticeably, and although the biofacies distribution does not change, several species indicative of the AABW appear, such as *Epistominella umbonifera*, *Cibicides bradyi*, *Laticarinina pauperata*, and *Pullenia quinqueloba*. These forms continue as high in the section as Core 570-24. A faunal turnover occurs between Samples 570-28-1, 20–24 cm and 570-26-1, 14–16 cm as the modern shelf and slope species first appear. Thus, sediments in Core 570-28 through the lower part of Core 570-24 are interpreted as having been deposited in the lower middle bathyal biofacies under the influence of an expanded AABW.

Lower bathyal to abyssal faunas continue as the deepest biofacies represented in the Pleistocene faunas of Site 570. Slight variations in the diversity pattern suggest cyclic changes such as would be encountered during glacial–interglacial cycles. Lower diversities in Cores 570-23 to 570-19, 570-15 to 570-12, and 570-4 to 570-5 could correspond to cold events which occurred in the Pacific region 1.2–2.5, 0.9, and 0.7 Ma ago (Ingle, 1967, 1973; Bandy, 1972; Olsson, 1974; Keller, 1978; and Keller and Ingle, 1981). Only the lowest of these intervals, Cores 570-23 to 570-19, contains rare species which have been associated with the cold AABW. The remainder of the Pleistocene section, including the lower-diversity intervals, indicates that the site has undergone a gradual uplift and/or that water masses have migrated downslope throughout the Pleistocene. Deposition continued to be within the lower bathyal biofacies up to the highest sample, 570-1, CC. The presence of the PIW is suggested by the abundance of the buliminids and uvigerinids and by the lack of species indicative of deeper water masses.

Transported faunas are present throughout the section recovered at Site 570. In the Miocene, shelf species comprise less than 20% of the faunas, whereas in the Pliocene and Pleistocene they average 20–40%. Miocene shelf species are large, robust forms, usually with thicker tests, such as *Quinqueloculina* and *Lenticulina*. The abraded and worn condition of these tests supports the interpretation that these specimens were transported. Specimens from the Miocene upper bathyal biofacies have similar characteristics. In the Pliocene and Pleistocene, the transported shelf and upper-slope specimens are predominantly the plate-like bolivinids or the heavier conical forms such as *Uvigerina* or *Bulimina*. The change in the species transported is the result of evolution, water depth, and current patterns, as well as the proximity of the shelf and upper-slope regions. The composition and quantity of transported middle- and lower-slope species change little throughout the section. Sample spacing was too broad to identify transport mechanisms.





Table 1. (Continued).

Sample (interval in cm)	<i>Cassidulinoides bradyi</i> <i>C. waltoni</i>	<i>Ceratiobulimina alcazarus</i> <i>Chilostomella fimbriata</i> <i>C. oolina</i> <i>C. ovandea</i>	<i>Chrysalongium breviloculum</i>	<i>C. elongatum</i> <i>C. lanceolum</i> <i>Cibicides dohrni</i> <i>C. fletcheri</i> <i>C. cf. C. fletcheri</i>	<i>C. floridanus</i> <i>C. cf. C. floridanus</i> <i>C. garabatoensis</i> <i>C. cf. C. garabatoensis</i> <i>C. cf. C. to</i>	<i>C. cf. C. lobatulus</i> <i>C. mckannai</i> <i>C. sp.</i> <i>C. spp.</i> <i>C. spiralis</i>	<i>C. spiroimbatus</i> <i>C. umbonatus</i> <i>Cibicidoides bradyi</i> <i>C. coryelli</i> <i>C. kulterbergi</i>	<i>C. mundulus</i> <i>C. sinistralis</i> <i>C. spp.</i> <i>C. wuellerstorfi</i>	<i>Cyclogyra foliacea</i> <i>Dentalina baggi</i> <i>D. consobrina</i> <i>D. cooperensis</i>
1,CC									
2-3, 20-24	X	X	X			X	X		4
2-5, 20-25		X	X			2	X		10
2,CC					X	1			4
3-1, 60-64	X		X			2	X		2
3,CC						1			3
4-1, 40-44	X					X	X		
4,CC						2	X		X
5-3, 20-24				X		7	X		1
5,CC						X			X
6-3, 20-24				X		3	X		3
6,CC						9	2	X	X
7-1, 20-24			X			2	X		X
7,CC						1	X		X
8-1, 20-24	X			X		X	X		1
8,CC									
9-2, 20-24	X	2	X			1	1		X
9,CC						3			X
10-1, 41-45						1			X
10,CC						2			1
11-2, 20-24				X		3	2		
11,CC						X			X
12,CC						X			X
14-2, 138-142						3	X		X
14,CC						2	X		2
15-2, 90-94						4			X
15,CC						2			10
16-3, 104-108		X		X		5	X		2
17-3, 56-60					X	X	X		X
18-2, 20-24						4	X		1
19-1, 10-14					X	X			
20-1, 50-52									X
21-1, 70-74				X					
22-1, 22-26						6	2		
23-3, 20-24						2			
24-1, 20-24			X	X		X		X	
25-1, 20-24		X			1		X	X	X
26-1, 14-16				X	X				X
28-1, 20-24					X	X			X
28-3, 48-52					X		2		X
28-6, 48-52									
29-1, 20-24					X	2	1		X
29-3, 42-46						2	X		X
30-1, 10-14					1	X		X	2
30-3, 10-14					2	X			X
31-1, 19-23						2	X		X
32-1, 17-21						X	1		X
33,CC						3			3
34-1, 121-125						3	X		X
34,CC		2				3	3	2	2
35-1, 20-22			X	X		3	6	3	4
35-4, 12-14					5				X
35,CC						X		X	
37-1, 126-128						5			

Core 568-40 and upper part of Core 568-38, may correspond to deep-sea hiatus NH1. The *in situ* fauna throughout Cores 568-42 to 568-38 is from the lower bathyal to abyssal biofacies, and contains rare to few specimens of *Sigmoilina tenuis*, *Gyroidina soldanii*, and *G. planulata*. These species decrease in abundance upsection, and are associated with the early Miocene bottom water (Woodruff, in press). *Stilostomella*, *Chrysalongium*, and *Siphonodosaria* are common in this interval, in part because of their elongate cylindrical shape, which transports easily, and also in part because these species are associated with the early Miocene bottom water. Thus, Sections 568-42-5 to 568-38-3 are interpreted as having been deposited in the lower bathyal biofacies under the influence of the early Miocene bottom water.

Although the diversity trend in Samples 568-38-1, 80-85 cm to 568-33-5, 35-39 cm remains similar to that of the underlying samples, the biofacies pattern shifts so that the lower bathyal to abyssal species are rare and lower middle bathyal species dominate. There is also a corresponding change in water-mass-specific species. *Bulimina alcazarus* (*B. rostrata* of Woodruff, in press), *Cibicidoides bradyi*, *C. wuellerstorfi*, *Siphogenerina multicostata* (*Uvigerina multicostata* of Woodruff, in press), and *Osangularia culteri* are common, and suggest the presence of an early Miocene, low-oxygen intermediate water mass (Woodruff, in press). Species of *Stilostomella* and *Siphonodosaria* also appear because of their association with both the early Miocene intermediate bottom water masses. The benthic foraminiferal assemblage





Table 1. (Continued).

Sample (interval in cm)	<i>F. californiensis</i>	<i>F. cornuta</i>	<i>F. dibollensis</i>	<i>F. rotundata</i>	<i>F. sp.</i>	<i>Gaudryina arenaria</i>	<i>G. jacksonensis</i>	<i>Glandulina laevigata</i>	<i>Globobulimina barbata</i>	<i>G. pacifica</i>	<i>G. spinifera</i>	<i>Globocassidulina subglobosa</i>	<i>Gyrodina altiformis</i>	<i>G. altispira</i> *	<i>G. broeckhiana</i>	<i>G. multilocula</i>	<i>G. cf. G. multilocula</i>	<i>G. nitidula</i>	<i>G. perampila</i>	<i>G. planulata</i>	<i>G. cf. G. planulata</i>	<i>G. quinqueloba</i>	<i>G. soldanii</i>	<i>G. zelandica</i>	<i>Hanzawaia concentrica</i>	<i>H. illingi</i>	<i>H. cf. H. illingi</i>	<i>H. isidroensis</i>	<i>H. nitidula</i>	<i>H. sp.</i>	<i>Hoeglundina elegans</i>	<i>Karrerella chistosoma</i>	<i>Lagena castrensis</i>	<i>L. costata</i>	<i>L. elongata</i>			
1,CC				X						X																X												
2-3, 20-24				X						X		X				X										X												
2-5, 20-25										X		X				X									X		X											
2,CC										X		X				X								X		X												
3-1, 60-64										X		X				X								X		X												
3,CC				X						X		X				X										X												
4-1, 40-44		X		X						X		X				X									X		X								X	X		
4,CC										X		X				X									X		X											
5-3, 20-24			X	X						X		X				X									X		X											
5,CC		X		X						X		X				X									X		X											
6-3, 20-24		X		1						X		1				X									X		X											
6,CC		X								X		X				1								X		X												
7-1, 20-24		X								X		X				1								X		X												
7,CC										X		X				1								X		X												
8-1, 20-24		X								X		1				X								X		X												
8,CC		2		X						X		X				3									X		X											
9-2, 20-24		2		X						5		X				X									X		X											
9,CC																3									X		X											
10-1, 41-45		2		X						X		X				1										X		1										
10,CC		X														9								X		X												
11-2, 20-24						X				X		X				1										1		4										
11,CC										X						5									1		5		X									
12,CC												2				X									X		1											
14-2, 138-142		2		X						X						X									X		2											
14,CC				X						X						4									X		X											
15-2, 90-94												X				5										3												
15,CC												7													X		6											
16-3, 104-108		X								X		X				4									X		3											
17-3, 56-60		X		X						1		2				2									X		3											
18-2, 20-24										X		X				X									X		10											
19-1, 10-14												3				3										4												
20-1, 50-52												4				4									X		4											
21-1, 70-74												5				7									X		2											
22-1, 22-26											X	2				X									3		3											
23-3, 20-24										X		4				4									7		7											
24-1, 20-24										X		1		X		10									2		X											
25-1, 20-24										X		5				1								X		2		X										
26-1, 14-16										X		4		X		X									2		X											
28-1, 20-24										X		2				2									5		1											
28-3, 48-52										X		3		X		2									X		1											
28-6, 48-52										X		5				1									X		2											
29-1, 20-24										X		3		X		X									X		X											
29-3, 42-46										1		2		X		X									X		3											
30-1, 10-14										X		2				3									X		2											
30-3, 10-14						X				X		6				1									X		3											
31-1, 19-23										X		4		X											X		X											
32-1, 17-21										X		6													X		7											
33,CC												1				3									5		1											
34-1, 121-125												2																										
34,CC												7				3																						
35-1, 20-22												3													1													
35-4, 12-14												X		X											X		X											
35,CC												16																										
37-1, 126-128																																						

ing been deposited in the lower bathyal biofacies under the influence of corrosive bottom water and with considerable amounts of downslope transport.

Biofacies patterns in Cores 568-32 to 568-26 indicate that deposition occurred in the lower middle bathyal biofacies, with moderate transport from the shelf and upper slope. Species characteristic of PIW are common, and include *Bulimina alazaensis*, *Osangularia culteri*, and *Siphogenerina multicostata*. Also in this interval, there is a gradual turnover in the fauna, that is, there are numerous first and last occurrences between Cores 568-33 and 568-25.

Dissolution characterizes many of the foraminiferal faunas in Cores 568-22 to 568-25. The lower part of this interval correlates with the deep-sea hiatus NH3 of Kel-

ler and Barron (1983). The effects of NH3 extend as high as Section 568-23,CC, as indicated by the presence of middle Miocene benthic foraminifers, such as *Siphogenerina basispinata*. The stratigraphically higher dissolved or barren samples in this interval may also be part of the NH3 dissolution, but may represent a younger hiatus. All that remains of the probable *in situ* fauna is *Martinottiella pallida*, a lower-slope to abyssal arenaceous species which uses siliceous cement and is, therefore, more resistant to dissolution.

The biofacies distribution in the Pleistocene section of Site 568 is fairly uniform. The *in situ* fauna is from the lower bathyal biofacies. The only change in the biofacies pattern is the decrease in the abundance of the lower middle bathyal biofacies in Cores 568-6 to 568-1,



Table 1. (Continued).

Sample (interval in cm)	<i>Nonionella bacspinata</i>	<i>N. incisa</i>	<i>N. labradorica</i>	<i>N. pulchella</i>	<i>Nonionella</i> sp.	<i>N. stella</i>	<i>Oolina caudigera</i>	<i>O. melo</i>	<i>O. striatopunctata</i>	<i>Oridorsalis subtenera</i>	<i>O. umbonatus</i>	<i>Osangelaria culteri</i>	<i>O. mexicana</i>	<i>Parafissurina</i> cf. " <i>Lagena</i> " <i>fissulifera</i>	<i>P. fissuliformis</i>	<i>Palmerinella thalmani</i>	<i>Planularia arctibbeana</i>	<i>Planulina exorna</i>	<i>P. mexicana</i>	<i>P. cf. P. mexicana</i>	<i>P. ornata</i>	<i>P. cf. P. ornata</i>	<i>P. sp.</i>	<i>Plectofondicularia advena</i>	<i>P. californica</i>	<i>P. cf. P. kejzeri</i>	<i>P. rufivanmurrayi</i>	<i>P. vaughani</i>	<i>Pleurostomella alternans</i>	<i>P. brevis</i>	<i>P. nangjoensis</i>	<i>P. sp.</i>	<i>Præglabulimina affinis</i>	<i>P. auriculata</i>			
1,CC											X																								1		
2-3, 20-24	X						X											X				X											X	2			
2-5, 20-25																		X																X	2		
2,CC	X									X												X											X	1			
3-1, 60-64																																			X	1	
3,CC																																				1	
4-1, 40-44							X											X																	2		
4,CC							X											X																		1	
5-3, 20-24																																				10	
5,CC	X					X				X				X				X		X												X	X				
6-3, 20-24																																				2	
6,CC	X																	X	X																X		
7-1, 20-24			X							X																											
7,CC	X																																			X	
8-1, 20-24	1				X	X								X				1																	X		
8,CC																																					
9-2, 20-24					X		X	X	X									X	X																2		
9,CC																																					
10-1, 41-45						X												X	X																X	1	
10,CC																		X	X																		
11-2, 20-24										X								2			X														X		
11,CC																		X																	X		
12,CC	X																	X	X																		
14-2, 138-142	X																	X	X																	2	
14,CC																		X	X																	X	
15-2, 90-94																																					
15,CC										X																										X	
16-3, 104-108																		1																		X	
17-3, 56-60	X																	2																		X	
18-2, 20-24	X		X			X												4	X																	X	
19-1, 10-14	X																	2																		X	
20-1, 50-52																																					
21-1, 70-74																		2																		X	
22-1, 22-26																		2	X		X														X		
23-3, 20-24																		4																		X	
24-1, 20-24										X								2																			
25-1, 20-24																		X	X																		
26-1, 14-16			X															X																			
28-1, 20-24																		X	X		X															X	
28-3, 48-52																		X	X																	1	
28-6, 48-52																		X	X																		
29-1, 20-24																		X	X																		
29-3, 42-46																		X	X																		
30-1, 10-14																		X	X		X																
30-3, 10-14																		X	X		X															X	
31-1, 19-23																																					
32-1, 17-21																																					
33,CC																																					
34-1, 121-125																																					
34,CC																																					
35-1, 20-22																																					
35-4, 12-14																																					
35,CC																																					
37-1, 126-128																		X	X		X															X	

section correspond to deep-sea hiatuses NH1 (Core 569-15 to 569-17), NH2 (Core 569-12), and NH3 (Cores 569-8 and 569-9) (Fig. 3).

Biofacies analysis of Site 569 indicates that this site has fluctuated between the lower bathyal biofacies (Cores 569-14 to 569-13; 569-11 to 569-10; and 569-7 to 569-1) and abyssal biofacies (Cores 569A-6 to 569A-H1; 569-27 to 569-15; 569-12; and 569-9 to 569-8) (Fig. 6 [back pocket]; Table 3 and 4). The benthic foraminiferal assemblages also indicate that water masses influencing this area included the early Miocene bottom water, ABW, PDW, and PIW (Fig. 6 [back pocket]).

Biofacies distribution of the assemblages in Cores 569A-6 to 569A-H1 and 569-27 to 569-24 is very erratic, and primarily reflects the transported assemblages. Outer-shelf and upper-slope species are poorly preserved

forms with heavy, robust tests. Specimens from the middle to lower slope are better preserved and have more variable shapes. *Quinqueloculina venusta* represents the abyssal biofacies and the *in situ* fauna for this interval. The thick calcite test of this species is not easily dissolved. This species also indicates the early Miocene bottom waters (Woodruff, in press). Similar abyssal, early Miocene bottom-water assemblages were seen at Site 568, and are interpreted as correlating with deep-sea hiatus PH.

The *in situ* and the transported faunas in Cores 569-23 to 569-21 are similar to those in the underlying dissolution interval. The primary differences are the better preservation and an increase in the number and diversity of foraminifers. The large pulse of shelf specimens in Samples 569-21,CC, and 569-21-1, 43-47 cm contains



Table 1. (Continued).

Sample (interval in cm)	<i>S. sp.</i>	<i>S. transversa</i>	<i>Siphonia pulchra</i>	<i>Siphonodivaria gracillima</i>	<i>S. verneuillei</i>	<i>Sphaeroidina bulboides</i>	<i>Siliostomella advena</i>	<i>S. adolphina</i>	<i>S. lepidula</i>	<i>S. spp.</i>	<i>S. subspinosa</i>	<i>Suggrundia eckesi</i>	<i>Textularia leuzingeri</i>	<i>T. panamensis</i>	<i>T. sp.</i>	<i>Trifarina angulosa</i>	<i>T. bradyi</i>	<i>T. cornata</i>	<i>T. occidentalis</i>	<i>Trochammina sp.</i>	<i>Uvigerina baggi</i>	<i>U. campitana</i>	<i>U. excellens</i>	<i>U. hispida</i>	<i>U. hispidocostata</i>	<i>U. incilis</i>	<i>U. juncea</i>	<i>U. peregrina</i>	
1, CC																													
2-3, 20-24																		2						3		4		6	
2-5, 20-25																							X	X	X	X	X	9	27
2, CC																X						X	X	X	X	X	X	3	
3-1, 60-64																							1	X				5	
3, CC																													
4-1, 40-44								X				X				X							X	X		7	7		
4, CC																									1	3	9		
5-3, 20-24												X												X	6	X	11		
5, CC												X													X	X	X	33	
6-3, 20-24												X													6		17		
6, CC																									X	X	7		
7-1, 20-24																X									11	5	5		
7, CC																1		2						X	8	4	4		
8-1, 20-24														X			2						X	1	4	6	6		
8, CC																													
9-2, 20-24												X														12	7		
9, CC																									X	7	7		
10-1, 41-45																										6	16		
10, CC									X							X	X								4	4	11		
11-2, 20-24																									X	X	5	5	
11, CC																													
12, CC																													
14-2, 138-142																													
14, CC																													
15-2, 90-94																													
15, CC																													
16-3, 104-108																													
17-3, 56-60																													
18-2, 20-24									X																				
19-1, 10-14																													
20-1, 50-52						X		2																					
21-1, 70-74									1																				
22-1, 22-26																													
23-3, 20-24																													
24-1, 20-24																													
25-1, 20-24																													
26-1, 14-16																													
28-1, 20-24																													
28-3, 48-52																													
28-6, 48-52																													
29-1, 20-24																													
29-3, 42-46																													
30-1, 10-14																													
30-3, 10-14																													
31-1, 19-23																													
32-1, 17-21																													
33, CC																													
34-1, 121-125																													
34, CC																													
35-1, 20-22																													
35-4, 12-14																													
35, CC																													
37-1, 126-128																													

this dissolution interval, and become increasingly abundant upsection.

The change in diversity and biofacies patterns between Cores 569-15 and 569-14 may define a hiatus or unconformity, but more likely reflects a change in water depth or water mass. In Samples 569-14, CC to 569-12-5, 20-24 cm, foraminiferal diversity and number are high, and specimens are well preserved. Transported shelf and upper-slope species become increasingly common and diverse in this interval; lenticulinids are a major component of this group. Although the lower bathyal and abyssal biofacies occur in about the same abundance, species diagnostic of the AABW decrease in abundance, and species associated with the PIW and PDW are common. Included in this last group are the species *Osangularia culteri*, *Bulimina alazaensis*, *Cibicidoides bradyi*,

*Siphogenerina multicostata*, and *S. basispinata*. The age of the faunas corresponds to a time of eustatic rise in sea level (Vail and Hardenbol, 1979) and generally warmer climates. The AABW is thus interpreted as having withdrawn from this part of the slope, to be replaced by the PIW and PDW masses. Tectonic activity and uplift in Central America (Weyl, 1980) could also have contributed to a decrease in water depths, as is suggested by the presence of faunas associated with shallower-water masses and dominance of species from shallower biofacies.

Planktonic foraminiferal and nannofossil ages which bracket the two barren samples in Core 569-12 indicate that this dissolution interval correlates with the NH2 hiatus observed in the deep sea (Keller and Barron, 1983). The dissolution is assumed to be the result of corrosive bottom waters. The fossiliferous sample in Core 569-12



Table 3. Faunal distribution, Hole 569.

Sample (interval in cm)	<i>Alabamina pallida</i>	<i>Amphitegina lessonii</i>	<i>A. cf. A. lessonii</i>	<i>Anomalina flintii</i>	<i>Anomalinoidea globulosa</i>	<i>Astrorionina guadalupae</i>	<i>Bugina dominicana</i>	<i>Boldia rushmanti</i>	<i>Bolivina acuminata</i>	<i>B. advena</i>	<i>B. albaensis</i>	<i>B. argentea</i>	<i>B. cf. B. argentea</i>	<i>B. bicostata</i>	<i>B. bradyi</i>	<i>B. conica</i>	<i>B. foraminata</i>	<i>B. marginata</i>	<i>B. pacifica</i>	<i>B. plicata</i> of Reig	<i>B. pseudoheyrichi</i>	<i>B. pseudopissa</i>	<i>B. seminuda</i>	<i>B. semiperforata</i>	<i>B. cf. B. semiperforata</i>	<i>B. sinuata</i>	<i>B. cf. B. sinuata</i>	<i>B. spissa</i>	<i>B. subadvena</i>	<i>B. quadrilucra</i>	<i>Buccella</i> sp.	<i>Bulimina albaensis</i>	<i>B. bleekeri</i>	<i>B. denudata</i>				
1-1, 91-95								X					1			6				X	12	1			X				X				3					
1,CC								4					X			5	X			X	X	8	X			X							4					
2-1, 62-66													X			1	X			X	X	18	X											4				
2-3, 62-66													X							X	X	4												4				
2-5, 62-66													X							X	X	X																
2,CC																	1					X																
3-1, 40-44																																			4			
3-3, 40-44																																			X			
3,CC																																						
4-1, 30-34										X																												
4-3, 30-34																	2					5													X			
4-5, 30-34										X						X	X			X	X	5	X			4	2	X			X			X	X			
4,CC																X	X				X	2	X												2			
5-1, 21-25																						2														X		
5-3, 21-25																						2														1		
5,CC					X	X																																
6-1, 20-24																																						
6-3, 20-24																																						
6-5, 20-24					X	X																X																
6,CC																																						
7-1, 20-24																																						
7-3, 20-24																	X																			X		
7-5, 20-24																	X																					
7,CC																																					8	
8-1, 18-22																																					12	
8-3, 18-22																																						
9-1, 20-24																																						
10-1, 11-15																																						10
10,CC																																						
11-1, 30-34	X							X																													X	
11,CC	X																																				3	
12-1, 20-24																																						
12,CC																																						1
13-2, 6-10	X																																				4	
13-4, 6-10																																					1	
13,CC																																					1	
14-2, 52-57																																						1
14,CC																																						5
15-3, 104-108																																						11
15,CC																																						
16,CC																																						6
17-3, 87-91																																						
17-5, 58-62																																						
17,CC																																						3
18-1, 38-42																																						
18-3, 38-42																																						
18,CC																																						
19-1, 14-16																																						
19,CC																																						
20-1, 69-73																																						3
20,CC																																						6
21-1, 20-24																																						8
21-1, 43-47	28	7																																				
21,CC	8																																					
22-1, 84-88																																						
22,CC																																						
23-1, 25-29																																						
23,CC																																						
24-3, 30-34																																						
24-6, 70-74																																						
25-1, 22-24																																						
26-1, 65-69																																						
26-3, 65-60																																						
26-6, 65-59																																						
27-1, 16-20																																						
27-3, 16-20																																						
27,CC																																						

Note: Benthic foraminiferal occurrences are given as percent of the total fauna, and X = less than 1%. Biofacies abundances are also given in percent of the total fauna.

as transported middle- to lower-slope faunas are the dominant species. *Martinottiella pallida* is often the only species in the dissolved samples, indicating that deposition occurred at lower bathyal to abyssal depths under the influence of a cold corrosive water mass. This interpretation is further supported by the rare to few occurrences of *Epistominella umbonifera* and *E. exigua* and by common occurrences of *Cibicidoides bradyi* in the better-preserved samples, which indicate the presence of the AABW.

Biofacies patterns continue to suggest deposition at abyssal depths or no shallower than lower bathyal in Samples 569-7,CC and 569-8-1, 18-22 cm, despite the marked age difference indicated by the planktonic foraminiferal age interpretations. The abyssal depths are favored because of the presence of numerous, though not abundant, species characteristic of the AABW. Included in this group are *Epistominella exigua*, *Laticarinina pauperata*, *Pleurostomella praegerontia*, various gyrogoninids, and *Uvigerina hispida*.







Table 3. (Continued).

<i>E. cf. E. pacifica</i>	<i>E. smithi</i>	<i>E. sp. of Resig</i>	<i>E. umbonifera</i>	<i>Fissurina alveolata</i>	<i>F. carteri</i>	<i>F. cucullata</i>	<i>F. fimbriata</i>	<i>F. cf. F. fimbriata</i>	<i>F. marginata</i>	<i>F. kugleri</i>	<i>F. orbignyana</i>	<i>F. solida</i>	<i>F. sp.</i>	<i>F. spp.</i>	<i>F. spinosa</i>	<i>F. staphylearia</i>	<i>F. subformosa</i>	<i>F. cf. F. subformosa</i>	<i>F. ventricosa</i>	<i>F. wiesneri</i>	<i>Fursenkoina bramletti</i>	<i>F. cornuta</i>	<i>F. dibollensis</i>	<i>F. rotundata</i>	<i>F. sp.</i>	<i>Glandulina laevigata</i>	<i>Globobulimina barbata</i>	<i>G. pacifica</i>	<i>G. spinifera</i>	<i>Globocassidulina subglobosa</i>	<i>Guitulina irregularis</i>	<i>Gyroidina altiformis</i>	<i>G. altispina</i>	<i>G. lo</i>	<i>G. lamarckiana</i>	<i>G. multilocula</i>	<i>G. nitidula</i>	
X	X	X		X	X	X	X	X	1	X	3	X		1	X	X	X		X	X	1	2	X	X	X	X	2	2	1	X						1	X	X
				X	X	X	X	X	X	X	2			X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	2	2	X	X	X	X	X	2	1	X					X			
				X</																																		

Table 3. (Continued).

Sample (interval in cm)	<i>G. neosidani</i>	<i>G. perampia</i>	<i>G. planulata</i>	<i>G. quinqueloba</i>	<i>G. soldani</i>	<i>G. spp.</i>	<i>G. rotundica</i>	<i>Hanczoia basiloba</i>	<i>H. concentrica</i>	<i>H. illingi</i>	<i>H. isidrensis</i>	<i>H. elegans</i>	<i>Karreriella chistosoma</i>	<i>Lapena costata</i>	<i>L. cf. L. costata</i>	<i>L. elongata</i>	<i>L. gracillima</i>	<i>L. hexagona</i>	<i>L. hispida</i>	<i>L. larvis</i>	<i>L. mollis</i>	<i>L. venestrata</i>	<i>L. striata</i>	<i>L. vulgaris</i>	<i>Lenticarina pauperata</i>	<i>Lenticulina altolimbata</i>	<i>L. arcuatostrata</i>	<i>L. arcuatostrata caroliniana</i>	<i>L. calcar</i>	<i>L. caritae</i>	<i>L. dicampyla</i>	<i>L. gibba</i>	<i>L. cf. L. gibba</i>	<i>L. gutturostrata cucuensis</i>	<i>L. iona</i>			
	1-1, 91-95										X					X																						
1,CC										6								X																				
2-1, 62-66	X									3			X	X				X																				
2-3, 62-66												1																										
2-5, 62-66	X											4					X																					
2,CC	5												X	X																								
3-1, 40-44	4	X	X	X			1					X	X	X		1							X															
3-3, 40-44				X						X		X		X				X	X																			
3,CC	X			X	X	X	X			X		3			X		X																					
4-1, 30-34	3			X	X		X									X		X		X																		
4-3, 30-34				1			X					6				X																						
4-5, 30-34	3			1												X																						
4,CC	X			3			1					5				X																						
5-1, 21-25	4			1			1					2																										
5-3, 21-25	4			X	X			X				X		X				X	X	X					X												X	
5,CC	2			X								2		X		2			X																			
6-1, 20-24												3																										
6-3, 20-24	X				X	X						1	X																									
6-5, 20-24	1											X		X	X								1															
6,CC	1						X					X		X	X																							
7-1, 20-24	3											X	X			X																						
7-3, 20-24	3			X	X							1				X																						
7-5, 20-24	X											X					X																					
7,CC				X								2																										
8-1, 18-22							2					3																										
8-3, 18-22																																						
9-1, 20-24																																						
10-1, 11-15							2			2																												
10,CC	4											4																										
11-1, 30-34	5																																					
11,CC							X			X		4		X																								
12-1, 20-24												3		8																								
12,CC	X	X		X			X					3		X																								
13-2, 6-10	X			X			X					9																										
13-4, 6-10												9						X																				
13,CC				1								3		X																								
14-2, 52-57				1			1					3		X																								
14,CC												5																										
15-3, 104-108	3											14		3																								
15,CC												5																										
16,CC							6					6																										
17-3, 87-91												5																										
17-5, 58-62												5																										
17,CC																																						
18-1, 38-42																																						
18-3, 38-42																																						
18,CC																																						
19-1, 14-16																																						
19,CC																																						
20-1, 69-73				4																																		
20,CC																																						
21-1, 20-24																																						
21-1, 43-47																																						
21,CC																																						
22-1, 84-88																																						
22,CC																																						
23-1, 25-29																																						
23,CC																																						
24-3, 30-34																																						
24-6, 70-74																																						
25-1, 22-24																																						
26-1, 65-69																																						
26-3, 65-69																																						
26-6, 65-69																																						
27-1, 16-20																																						
27-3, 16-20																																						
27,CC																																						

est dissolved interval (Cores 567A-4 and 567A-3). The benthic and planktonic foraminiferal ages therefore indicate that the barren and dissolved samples, from Sample 567A-4-1, 84-88 cm to 567A-3-6, 76-80 cm, correlate with deep-sea hiatus NH3. The dissolved and lower-diversity assemblages which continue to occur higher in Core 567A-3 contain a mixture of Miocene and younger species, suggesting reworking, and may therefore represent one or several Miocene through Pliocene erosional

events (Fig. 3). Biofacies analysis of Site 567 indicates that deposition in both the early Miocene and in the Pliocene-Pleistocene interval has been within the abyssal biofacies and under the influence of the AABW or its early Miocene equivalent (Fig. 7 [back pocket]; Table 6



Table 3. (Continued).

Sample (interval in cm)	<i>Oridoralis umbonatus</i>	<i>Orthomorphina rohri</i>	<i>Osangularia culteri</i>	<i>O. mexicana</i>	<i>Parafitsurina</i> sp.	<i>Planularia venezuelana</i>	<i>Planulina exorna</i>	<i>P. mexicana</i>	<i>P. ornata</i>	<i>P. renzi</i>	<i>P. sp.</i>	<i>Plectofrondicularia advena</i>	<i>P. californica</i>	<i>P. kejizeri</i>	<i>P. mexicana</i>	<i>P. miocenica</i>	<i>P. morreyae</i>	<i>P. rufivanmurrayi</i>	<i>P. vaughani</i>	<i>P. yumuriana</i>	<i>Pleurostomella acuta</i>	<i>P. alternans</i>	<i>P. bergeri</i>	<i>P. brevis</i>	<i>P. jacksonensis</i>	<i>P. narajoensis</i>	<i>P. praegeronitica</i>	<i>Praglobbulimina affinis</i>	<i>P. auriculata</i>	<i>P. ovula</i>	<i>P. pupoides</i>	<i>Pseudonodosaria conica</i>	<i>P. inflata</i>	<i>P. sp.</i>	<i>Pullenia bulloides</i>			
1-1, 91-95						X																													X			
1,CC	1					X																													X			
2-1, 62-66	1					X																													X			
2-3, 62-66	1					X																													X			
2-5, 62-66	2								2					X																						X		
2,CC				X																																		
3-1, 40-44	3											X																										
3-3, 40-44	6																																					
3,CC	8																																					
4-1, 30-34	2																																					
4-3, 30-34	X							X																														
4-5, 30-34	5																																					
4,CC	4																																					
5-1, 21-25	3																																					
5-3, 21-25	12																																					
5,CC	6	X																																				
6-1, 20-24	6																																					
6-3, 20-24	5																X																					
6-5, 20-24	2																																					
6,CC	8																																					
7-1, 20-24	6																																					
7-3, 20-24	7																																					
7-5, 20-24	13															X																						
7,CC	1																																					
8-1, 18-22	5																	X																				
8-3, 18-22																																						
9-1, 20-24	2																																					
10-1, 11-15	2						2		2																													
10,CC	X																																					
11-1, 30-34																																						
11,CC	1			X																																		
12-1, 20-24																																						
12,CC	3					X																																
13-2, 6-10																																						
13-4, 6-10	2		3																																			
13,CC	5																																					
14-2, 52-57	2																																					
14,CC	14		X																																			
15-3, 104-108	14																																					
15,CC	32																																					
16,CC																																						
17-3, 87-91	10																																					
17-5, 58-62																																						
17,CC	8																																					
18-1, 38-42	40																																					
18-3, 38-42	20																																					
18,CC																																						
19-1, 14-16																																						
19,CC	16																																					
20-1, 69-73	5																																					
20,CC	6																																					
21-1, 20-24																																						
21-1, 43-47	3																																					
21,CC	23																																					
22-1, 84-88																																						
22,CC																																						
23-1, 25-29																																						
23,CC																																						
24-3, 30-34	11																																					
24-6, 70-74																																						
25-1, 22-24																																						
26-1, 65-69																																						
26-3, 65-69	18		5																																			
26-6, 65-69																																						
27-1, 16-20	6		2																																			
27-3, 16-20	11																																					
27,CC																																						

and diversity are low, and biofacies patterns indicate considerable transport from the shelf and upper slope (Core 567A-5 and the upper part of Core 567A-6). In samples 567A-5-1, 65-72 cm through 567A-4-2, 84-88 cm, dissolution decreases and the benthic foraminiferal faunas reappear and are similar to those in Cores 567A-8 and 567A-9. Differences between the two faunas result from evolution and the extinction of the costate uvigerinids. Nevertheless, the faunas continue to suggest that depo-

sition occurred in the abyssal biofacies and under the influence of the early Miocene bottom water. The latter interpretation is based on the presence of species already cited as being associated with early Miocene bottom water, as well as by the appearance of various species of *Pleurostomella* and *Ehrenbergina*.

Barren and dissolved samples in Core 567A-4 (Samples 567A-4-1, 84-88 cm to 567A-3-2, 76-80 cm) and Core 567A-3 are mixed with several fossiliferous sam-



Table 3. (Continued).

Sample (interval in cm)	<i>S. subspinosus</i>	<i>Saggrunda exilis</i>	<i>S. kleinpellii</i>	<i>Trifarina angulosa</i>	<i>T. bradyi</i>	<i>Triloculina globosa</i>	<i>T. trihedra</i>	<i>Trifarina mexicana</i>	<i>Uvigerina boggi</i>	<i>U. carapiana</i>	<i>U. excellens</i>	<i>U. gallowayi</i>	<i>U. gallowayi basicostata</i>	<i>U. hispida</i>	<i>U. hispidocostata</i>	<i>U. incilis</i>	<i>U. peregrina</i>	<i>U. peregrina dirupia</i>	<i>U. rusticus</i>	<i>U. semitrigonia</i>	<i>U. senticosa</i>	<i>U. cf. U. senticosa</i>	<i>U. sp.</i>	<i>U. spp.</i>	<i>U. striata</i>	<i>U. vadescensis</i>	<i>Vaginulinopsis nudicostata</i>	<i>V. saundersi</i>	<i>Valvulineria araucana</i>	<i>V. globra</i>	<i>Valvulina spinosa</i>	
1-1, 91-95		5				2									9						3									X		
1,CC		X						2							18						14										X	X
2-1, 62-66		3				1									9						7										X	X
2-3, 62-66		X				1															28										X	X
2-5, 62-66															4						7										X	X
2,CC						X																										
3-1, 40-44	X					X							6	2	X						1									X	2	
3-3, 40-44							X								X						X									X	2	
3,CC																					19											
4-1, 30-34				X		X	1								X						43	3							X			
4-3, 30-34		X	2					X							8						16					X			1	2		
4-5, 30-34		X	X				X														6					X						
4,CC													1			X					18	5							X	1		
5-1, 21-25							X									X					26								X	X		
5-3, 21-25													3			X					14					1			X	5		
5,CC													2			X					7	1										
6-1, 20-24							X				X										17					1			X	X		
6-3, 20-24																					9					6						
6-5, 20-24																					19					5						
6,CC																					9					5						
7-1, 20-24																					17											
7-3, 20-24																X					16					8				X	1	
7-5, 20-24																					16					8						
7,CC													3								2					5						
8-1, 18-22											1		11	1							5					4						
8-3, 18-22																					10					3						
9-1, 20-24													10																			
10-1, 11-15	2																				10											
10,CC	9																				2											
11-1, 30-34	12																				2											
11,CC	1												7								8											
12-1, 20-24												6									11											
12,CC	X					X			X		2										3					3	X	X			X	
13-2, 6-10																					4											
13-4, 6-10					1								1								7										X	
13,CC									X				1								3											
14-2, 52-57									5				1								4											
14,CC													1								4					8						
15-3, 104-108													14																			
15,CC													18																			
16,CC													17																			
17-3, 87-91									10				5								22											
17-5, 58-62													60								5											
17,CC																					6											
18-1, 38-42																																
18-3, 38-42																																
18,CC																					20											
19-1, 14-16																																
19,CC																																
20-1, 69-73								11					3																			
20,CC																																
21-1, 20-24	8																															
21-1, 43-47																																
21,CC	8																															
22-1, 84-88	20																															
22,CC																																
23-1, 25-29	20												20																			
23,CC																																
24-3, 30-34												11																				
24-6, 70-74																																
25-1, 22-24																																
26-1, 65-69																																
26-3, 65-69													5																			
26-6, 65-69	50																															
27-1, 16-20	2											2	28																			
27-3, 16-20												13	11																			
27,CC	7																															

Similar low-diversity Pliocene faunas continue as high as Sample 567A-2-1, 59-63 cm, with little change other than the first occurrences of species of *Bolivina*, which dominate the Pleistocene faunas.

The shift in the biofacies pattern between Cores 567A-2 and 567A-1 may represent an unconformity or hiatus. Based on planktonic foraminiferal ages and the similarity of the benthic foraminiferal fauna, this shift is believed to represent a major slide or slump originating in the outer shelf-upper slope region, and to be Pliocene.

The change in biofacies pattern between Samples 567-1,CC and 567-H1,CC is correlated with the cold event (glacial) frequently associated with the Pliocene/Pleistocene boundary cold event 1.2 to 2.5 Ma ago (Ingle 1967, 1973; Keller, 1978; Keller and Ingle, 1981). This cold event was caused by intensification of the AABW. The foraminiferal faunas immediately above the sediment record of this event are dominated by lower-slope and abyssal species, particularly *Gyroidina planulata*, *Melonis affinis*, *Uvigerina hispida*, and *U. senticosa*. The



Table 3. (Continued).

Foraminiferal		Biofacies								
Number	Diversity	IS	OS	UB	O <sub>2</sub>	UMB	LMB	LB	A	
314	51	6	28	15	10	28	5	3	2	
298	49	1	45	8	1	17	6	14	1	
388	59	4	19	11	5	38	10	7	—	
276	56	1	2	3	5	28	7	29	9	
283	48	—	5	6	5	26	30	7	8	
304	60	1	2	5	1	24	36	1	8	
223	45	1	1	4	1	20	38	1	11	
419	33	—	3	23	12	23	14	23	1	
394	40	—	1	10	1	15	24	44	—	
331	50	1	6	6	3	22	26	17	4	
298	63	—	19	14	6	26	18	7	2	
440	47	1	3	10	3	17	27	24	2	
315	50	—	2	10	1	19	25	29	9	
267	52	1	1	5	3	29	23	15	—	
447	62	1	3	4	4	24	23	8	8	
331	44	—	1	5	—	18	30	20	2	
300	51	—	1	4	5	22	25	9	8	
154	40	—	1	7	3	19	23	20	3	
314	48	1	2	4	—	22	43	9	5	
289	35	1	—	2	1	24	22	17	4	
339	58	1	1	8	—	19	22	16	9	
370	57	—	2	4	1	18	34	17	3	
407	50	—	1	5	—	32	22	4	19	
199	44	—	1	6	—	13	30	6	13	
102	42	5	5	7	—	20	35	1	4	
1	1	—	—	—	—	—	—	—	100	
21	11	—	—	5	—	24	38	—	14	
41	24	7	5	—	—	19	15	—	7	
139	36	—	8	13	—	12	22	—	1	
59	26	—	4	4	—	21	15	—	—	
355	52	1	10	6	—	9	19	1	1	
36	17	—	20	14	—	9	11	—	—	
424	67	3	18	—	1	22	15	1	1	
117	38	1	10	12	1	26	15	1	2	
92	42	—	12	12	—	23	14	—	5	
202	49	—	13	2	—	9	18	4	1	
291	56	—	11	8	—	29	7	—	2	
22	12	—	5	5	—	27	5	5	—	
29	16	—	7	14	—	27	28	7	3	
22	12	—	5	—	59	—	—	—	—	
18	12	—	—	6	—	22	28	—	6	
21	13	—	5	10	—	19	43	—	—	
5	3	—	—	—	—	—	60	20	20	
37	18	3	3	3	—	19	27	6	—	
5	4	—	—	—	—	60	40	—	—	
5	3	—	—	—	—	40	—	—	—	
1	1	—	—	—	—	—	—	—	—	
3	3	—	—	—	—	—	33	—	—	
25	14	—	—	—	—	24	12	4	4	
37	19	—	—	5	—	16	11	3	—	
17	6	—	—	—	—	18	—	—	—	
13	5	—	—	—	—	8	—	—	8	
29	15	45	14	7	—	15	7	—	—	
13	10	8	—	—	—	38	8	8	—	
15	5	—	20	20	—	20	20	—	—	
2	2	—	—	—	—	100	—	—	—	
5	5	—	20	20	—	20	20	—	—	
3	2	—	—	67	—	33	—	—	—	
9	8	—	—	33	—	22	11	11	11	
3	1	—	—	—	—	—	—	—	—	
1	1	—	—	—	—	—	—	—	—	
2	2	—	50	50	—	—	—	—	—	
22	7	—	—	59	—	23	5	—	5	
2	2	—	—	50	—	—	—	—	—	
54	17	—	—	—	—	23	28	—	—	
46	13	—	2	—	—	40	11	—	—	
14	7	—	—	7	—	—	14	—	—	

first two of these species are associated with the AABW in the Miocene (Woodruff, in press). Thus, deposition of this Pleistocene interval was in the abyssal biofacies and under the influence of the AABW.

#### PALEOCEANOGRAPHIC INTERPRETATION

The early Miocene of the Middle America slope off Guatemala was characterized by improved preservation of the benthic foraminiferal assemblages, increased foraminiferal diversity, decreased influence of the bottom

waters, and decreased water depths. After a period of non-deposition, or erosion and dissolution, in the Oligocene (Thompson, 1982), sediments began accumulating at the base of the slope (lower bathyal biofacies, Fig. 8). Corrosive early Miocene bottom waters initially prevented the accumulation of calcium carbonate, so that the *in situ* faunas were rarely preserved, and transported upper-slope and shelf faunas are only occasionally preserved. As climatic conditions stabilized, the corrosive nature of this bottom water decreased, downslope transport decreased, and both the transported and *in situ* faunas were preserved. Increased dissolution followed this brief period of stabilization, and is correlated with deep-sea hiatus NH1, a major cold event, eustatic lowering of sea level, and a global increase in corrosive bottom waters during the early Miocene (Vail and Hardenbol, 1979; Bukry, 1982; Keller and Barron, 1983).

Benthic foraminiferal faunas characteristic of the deep central Pacific bottom water, which first appeared at Site 570 between 18 and 20 Ma ago (NH1 hiatus), migrated downslope and appeared at Sites 568 and 569 between 18 and 15 Ma ago (Fig. 8). These faunal occurrences represent the first appearance of this new dense bottom water on the Middle America slope, and indicate the presence of a deep-water corridor and presumably a deep-water connection between the Caribbean and the Pacific, as well as the restriction of cold bottom waters to greater depths. Species associated with the early Miocene intermediate water mass are also common to abundant in these assemblages; therefore, deposition probably occurred near the interface between the two water masses. Alternatively, this mixture of assemblages may indicate that the interface between the two water masses was poorly defined because the oceans were not well stratified at this time, and a distinct low-oxygen PIW may not have developed yet, as also suggested by Woodruff (in press). In addition to water-mass changes, benthic foraminifera indicate that the water depth decreased and downslope transport increased. These faunal changes coincide with uplift in Central America, and probably indicate initiation of the closure of the deep marine connection across Panama (van Andel et al., 1975; Weyl, 1980; Keller and Barron, 1983). The shallow-water connection with the Caribbean still exists numerous species with Caribbean affinities appear in the transported upper-shelf and slope assemblages. Predicted warmer temperatures (Douglas and Savin, 1973) are reflected by the high diversity of the benthic foraminifera.

The increased number of deep-sea hiatuses in the middle Miocene is evident on the Middle America slope, where this interval is characterized mostly by missing sections and numerous dissolved intervals. Dissolution at Sites 568 and 569 correlates with NH2 and NH3 and the expansion of the corrosive bottom waters. Hiatus NH2 is not well represented in these sections. Benthic foraminiferal faunas overlying the NH2 dissolution are relatively unchanged from the underlying upper lower Miocene faunas, suggesting a continuation of the warm surface waters. An increase in transported material and further decreases in the water depth suggest that uplift in Central America continued and at least a shallow wa-

ter connection was maintained with the Caribbean. Benthic foraminiferal faunas associated with expanded bottom waters and the NH3 hiatus are characteristic of the AABW. Benthic foraminiferal faunas overlying the NH3 dissolution interval at Site 570 are characteristic of a low-oxygen PIW. These interpretations and the middle Miocene foraminiferal changes corroborate the occurrence of several major paleoceanographic events: (1) development of the AABW and PIW masses, (2) closure of the intermediate and deep-water connection across the isthmus of Panama, and (3) the establishment of modern water masses and circulation patterns.

The late Miocene is represented only at Site 570, where its sediments are characterized by faunas associated with the PIW (Fig. 8). Transported material is moderately well preserved and fairly consistent in abundance, and contains decreasing abundances of species with Caribbean affinities. The latter characteristic implies both a decline in temperatures and a restriction in the shallow water connection with the Caribbean. Expansion of the AABW interrupted this pattern only once during this period, and the resulting dissolution is correlated with NH5. Erosion associated with deep-sea hiatus NH7 and the Miocene/Pliocene boundary appears to have affected all sections on the slope, and is probably responsible for much of the missing sediments at Sites 567, 568, 569, and 570.

Pliocene faunas and sediments are rare, and occur only in the lower-slope sites (Sites 567 and 569; Fig. 8). The strongly dissolved faunas indicate the presence of a corrosive AABW.

Pleistocene sediments are characterized by a general reduction in the AABW, decrease in water depths, and development of the present water-mass configuration on the Middle America margin. Variation in the benthic foraminiferal diversity and biofacies trends suggests glacial-interglacial cycles. The oldest glacial cycle recognized in these Pleistocene faunas corresponds to the cold event dated at 1.2 to 2.5 Ma ago. Lower Pleistocene faunas on the lower slope (Sites 567, 569, and 568) are dissolved as a result of the expansion of the AABW during the glacial maxima. The effect of this water mass decreases markedly between Sites 568 and 570. Site 570, which is interpreted as having been under the influence of the PDW and PIW at this time, contains only rare specimens which could be associated with any deeper water masses.

Although the AABW undoubtedly expanded and impinged on the shallower parts of the slope during the glacial or cold intervals, this water mass appears to have been progressively confined to deeper parts of the slope, finally affecting only the abyssal biofacies. A similar trend occurs in the benthic foraminiferal faunas associated with the PIW and the PDW. Progressive downslope movement of faunas and water masses may have resulted from the contraction of the AABW and a general warming of the climatic conditions in the latter part of the Pleistocene. Uplift of the continental margin and a corresponding decrease in the water depths could also have produced a similar change. The combined effect of some or all of these possibilities resulted in a distribution of

benthic foraminiferal biofacies, water masses, and water depths which approximated those of the present (Fig. 2).

## CONCLUSIONS

Benthic foraminiferal assemblages indicate that each of the Middle America sites considered has been on the landward side of the trench since the early Miocene and has been subjected to a nearly continuous reign of shelf and upper-slope material. These faunas also indicate that water depths on the slope sites have generally decreased from the early Miocene to the present. Deviations from this shallowing trend include the shallow water depths indicated for the late early to early middle Miocene (Fig. 8). Water masses affecting the margin included an early Miocene bottom water, a deep Pacific bottom water, early Miocene intermediate water, Antarctic Bottom Water, Pacific Deep Water, and Pacific Intermediate Water. Periods of erosion or nondeposition are responsible for gaps in the lower Miocene at Sites 567 and 570, the middle upper Miocene at Site 567, and the Pliocene at each of the sites. Dissolution was common at all sites in the early Miocene, early middle Miocene, early Pliocene, and early Pleistocene. These periods of dissolution and erosion can be directly correlated with deep-sea hiatuses and expansion of the corrosive bottom waters. Benthic foraminiferal assemblages and biofacies analysis provide clues to the development of a stratified ocean leading to the present water-mass distribution, the uplift in Central America, the closure of the deep-water connection across Panama, and the later shallow-water closing of this connection.

## ACKNOWLEDGMENTS

I thank John Barron and Peter Thompson for critically reviewing the manuscript and offering valuable suggestions, and Greta Keller for invaluable discussions on Miocene paleoceanography and for critically reviewing the manuscript. Special thanks are given to Christeen Cochran for assistance during all phases of the research.

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## APPENDIX

## Taxonomic Notes

- Alabamina polita* Becker and Dusenbury, 1958, *Cushman Found. Foram. Res. Spec. Publ.*, no. 4, p. 40, pl. 7, figs. 3 a-c. This paper, Pl. 6, Fig. 10.
- Alveolophragmium crassimargo* (Norman)—*Haplophragmoides crassimargo* Norman, 1892, *Museum Normanianum*, Pt. 7-8, p. 17. This paper, Pl. 1, Fig. 3. Ecology: inner shelf (Loeblich and Tappan, 1953).
- Ammonia beccarii* (Linné)—*Nautilus beccarii* Linné, 1758, *Systema naturae* (Vol. 1, 10th Ed.), p. 710, pl. 1, figs. la-c. Ecology: inner shelf (Smith, 1964; Ingle, 1980).
- Amphistegina lessonii* d'Orbigny, 1826, *Ann. Sci. Nat. Paris*, Ser. 1, Vol. 7, p. 304, Modeles no. 98, 4me livraison. Ecology: inner shelf (Murray, 1973).
- Anomalina alazaensis* Nuttall, 1932, *J. Paleontol.*, Vol. 6, p. 31, pl. 8, figs. 5-7.
- Anomalina catricricosus* Schwager, 1966, *Geol. Theil*, Bd. 2, Abt. 2, p. 260, pl. 7, figs. 4, 108.

- Anomalina flintii* Cushman, 1931, *U.S. Nat. Mus. Bull.*, no. 104, p. 108, pl. 18, fig. 5.
- Anomalinoides globulosus* (Chapman and Parr)—*Anomalina globulosa* Chapman and Parr, 1937, *Australasian Antarctic Exped., 1911–1914*, Sci. Repts. Sydney, Australia, Ser. C (Zool., Botany), Vol. 1, p. 117, pl. 9, fig. 27. Ecology: upper middle bathyal (*Anomalina globulosa* of Pflum and Frerichs, 1976).
- Anomalinoides pompilioides* (Galloway and Heminway)—*Anomalina pompilioides* Galloway and Heminway, 1941, *N.Y. Acad. Sci., Sci. Survey Puerto Rico and Virgin Islands*, Vol. 3, p. 389, pl. 22, fig. 3.
- Anomalinoides semicribratus* (Beckman)—*Anomalina pompilioides* Galloway and Heminway *semicribrata* Beckman, 1953, *Eclogae Geol. Helv.*, Vol. 10, pp. 400–401. pl. 27, fig. 3, text-figs. 24–25.
- Astigerina guraboensis* Bermudez, 1949, *Cushman Lab. Forum. Res. Spec. Publ.*, no. 25, pp. 265–266. pl. 19, figs. 34–36.
- Astronionion guadalupae* (Parker)—*Melonis guadalupae* Parker, 1964, *J. Paleontol.*, Vol. 38, p. 633, pl. 100, figs. 13–14.
- Baggina dominicana* Bermudez, 1949, *Cushman Lab. Forum. Res. Spec. Publ.*, no. 25, p. 260, pl. 18, figs. 37–39.
- Boldia cushmani* (Nuttall)—*Cibicides cushmani* Nuttall, 1930, *J. Paleontol.*, Vol. 4, p. 291, pl. 25, figs. 3, 5, 6.
- Bolivina acuminata* Natland—*Bolivina subadvena* var. *acuminata* Natland, 1946, in Cushman, J. A., and Gray, H. B., *Cushman Lab. Forum. Res. Spec. Publ.*, no. 19, p. 34, pl. 5, fig. 46. Ecology: outer shelf (Smith, 1964).
- Bolivina advena* Cushman, 1925, *Contr. Cushman Lab. Forum. Res.*, Vol. 1, p. 29, pl. 5, figs. la–b. Ecology: upper bathyal (Ingle, 1980).
- Bolivina advena striatella* Cushman—*Bolivina advena* Cushman *striatella* Cushman, 1925, *Contr. Cushman Lab. Forum. Res.*, Vol. 1, p. 30, pl. 5, fig. 3. Ecology: upper bathyal (Ingle, 1980).
- Bolivina alazaensis* Cushman, 1926, *Contr. Cushman Lab. Forum. Res.*, Vol. 1, p. 82, pl. 12, fig. 1.
- Bolivina alta* (Sequenza)—*Valvulina alata* Sequenza, 1862, *Att. Acad. Gioenia. Sci. Nat.*, Ser. 22, Vol. 18, p. 115. pl. 2, fig. 5.
- Bolivina argentea* Cushman, 1926, *Contr. Cushman Lab. Forum. Res.*, Vol. 2, pl. 6, fig. 5. Ecology: upper middle bathyal (Smith, 1964).
- Bolivina beyrichi* Reuss, 1851, *Z. Deut. Geol. Ges.* (Berlin), Bd. 3, p. 83, pl. 6, fig. 51. This paper, Pl. 3, Fig. 3. Ecology: outer shelf (Smith, 1964). Smith (1964) synonymizes this species with *Bolivina bradyi*, which ranges from 80 to 450 m (outer shelf to upper bathyal).
- Bolivina bicostata* Cushman—*Bolivina costata* d'Orbigny *bicostata* Cushman, 1926, *Contr. Cushman Lab. Forum. Res.*, Vol. 2, p. 42. This paper, Pl. 3, Fig. 4. Ecology: outer shelf (Smith, 1964).
- Bolivina bradyi* Asano, 1938, *J. Geol. Soc. Japan*, Vol. 45, no. 538, p. 603, pl. 16, fig. 2. This paper, Pl. 3, Fig. 6. Ecology: outer shelf (Smith, 1964).
- Bolivina bramletti* Kleinpell, 1938, *Miocene Stratigraphy of California*: Tulsa, Oklahoma (Am. Assoc. Pet. Geol.), p. 267, pl. 21, figs. 9–11. Ecology: upper bathyal (Ingle, 1980).
- Bolivina californica* Cushman, 1925, *Contr. Cushman Lab. Forum. Res.*, Vol. 1, p. 32, pl. 15, fig. 10.
- Bolivina conica* Cushman, 1925, *Contr. Cushman Lab. Forum. Res.*, Vol. 1, p. 30, pl. 5, fig. 4. Ecology: upper middle bathyal (Ingle, 1980).
- Bolivina decussata* Brady, 1881, *Q., J. Microsc. Sci.*, (London), n. s., Vol. 21, p. 58. Ecology: outer shelf (Smith, 1973).
- Bolivina floridana* Cushman, 1918, *U.S. Geol. Surv. Bull.*, no. 676, p. 49, pl. 10, fig. 4. Ecology: upper middle bathyal (Ingle, 1980).
- Bolivina foraminata* Stewart and Stewart—*Bolivina seminuda* Cushman *foraminata* Stewart and Stewart, *J. Paleontol.*, Vol. 4, p. 66, pl. 8, fig. 5. This paper, Pl. 3, Fig. 7. Ecology: upper bathyal (Resig, 1981).
- Bolivina gasparensis* Bermudez, 1949, *Cushman Lab. Forum. Res. Spec. Publ.*, no. 25, p. 190, pl. 12, figs. 33–34.
- Bolivina globulosa* Cushman, 1933, *Contr. Cushman Lab. Forum. Res.*, Vol. 9, p. 80, pl. 8, fig. 9.
- Bolivina granti* Rankin, 1934—Cushman and Kleinpell, 1934, *Contr. Cushman Lab. Forum. Res.*, Vol. 10, p. 21, pl. 4, figs. 2–3. Ecology: upper middle bathyal (Ingle, 1980).
- Bolivina interjuncta* Cushman—*Bolivina costata* d'Orbigny *interjuncta* Cushman, 1926, *Contr. Cushman Lab. Forum. Res.*, Vol. 2, p. 41, pl. 6, fig. 3. Ecology: upper bathyal–shallow oxygen–minimum zone (Ingle, 1980; Ingle and Keller, 1980).
- Bolivina marginata* Cushman, 1925, *U.S. Geol. Surv. Bull.*, no. 676, p. 48, pl. 10, fig. 1. Ecology: upper bathyal (Ingle, 1980).
- Bolivina obscuranta* Cushman, 1936, *Cushman Lab. Forum. Res. Spec. Publ.*, no. 6, p. 53, pl. 7, fig. 20.
- Bolivina pacifica* Cushman and McCulloch—*Bolivina acerosa* Cushman *pacifica* Cushman and McCulloch, 1942, *Allan Hancock Pacific Exped. Repts.*, (Vol. 6): Los Angeles (University Southern California), p. 185, pl. 21 figs. 2–3. Ecology: upper bathyal–shallow oxygen–minimum zone (Smith, 1964; Ingle, 1980; Ingle and Keller, 1980).
- Bolivina plicata* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): Strasbourg, France (Levrault). Pt. 5, p. 62, pl. 8, figs. 4–7.
- Bolivina plicata* d'Orbigny of Resig, 1981, *Mem. Geol. Soc. Am.*, 154, p. 646, pl. 1, figs. 3–4. This paper, Pl. 3, Fig. 8. Ecology: upper bathyal (Resig, 1981).
- Bolivina pseudobeyrichi* Cushman, 1911, *Contr. Cushman Lab. Forum. Res.*, Vol. 2, p. 45. This paper, Pl. 3, Fig. 9. Ecology: upper bathyal (Smith, 1964; Ingle, 1980).
- Bolivina pseudospissa* Kleinpell, 1938, *Miocene Stratigraphy of California*: Tulsa, Oklahoma (Am. Assoc. Pet. Geol.), p. 279, pl. 21, fig. 6. Ecology: upper middle bathyal (Ingle, 1980).
- Bolivina scabrata* Cushman and Bermudez, 1936, *Contr. Cushman Lab. Forum. Res.*, Vol. 12, p. 29, pl. 5, figs. 11–12.
- Bolivina seminuda* Cushman, 1911, *U.S. Nat. Mus. Bull.*, no. 71, p. 34, tf. 55. Ecology: upper bathyal (Smith, 1964).
- Bolivina semiperforata* Martin, 1952, *Contr. Cushman Found. Forum. Res.*, Vol. 3, p. 129, pl. 21, figs. 10–11. This paper Pl. 3, Fig. 10. Ecology: upper middle bathyal (Smith, 1964; Ingle, 1980).
- Bolivina sinuata* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 71, pl. 11, fig. 9. Comments: Specimens assigned to this species have four ridges, which are formed by the retral processes and by numerous discontinuous costae. Mega- and microspheric forms are recognized in the Middle America Trench Leg 84 samples. Ecology: upper middle bathyal (Ingle, 1980).
- Bolivina* cf. *B. sinuata* Galloway and Wissler. Comments: Specimens included in this species group have a single central ridge rather than four ridges as in *Bolivina sinuata* Galloway and Wissler. Both mega- and microspheric forms have been found in the Middle America Trench Leg 84 samples.
- Bolivina spissa* Cushman, 1926—*Bolivina subadvena* Cushman *spissa* Cushman, 1926, *Contr. Cushman Lab. Forum. Res.*, Vol. 2, p. 29, p. 45, pl. 6, fig. 8. Ecology: upper middle bathyal (Ingle and Keller, 1980).
- Bolivina striatula* Cushman, 1922, *Carnegie Inst. Washington Publ.* no. 311, p. 27, pl. 3, fig. 10. Ecology: inner shelf (Smith, 1964).
- Bolivina subadvena* Cushman, 1926, *Contr. Cushman Lab. Forum. Res.*, Vol. 2, p. 44, pl. 6, fig. 6. Ecology: outer shelf (Smith, 1964).
- Bolivina subadvena sulpherensis* Cushman—*Bolivina subadvena* Cushman *sulpherensis* Cushman, 1926, *Contr. Cushman Lab. Forum. Res.*, Vol. 11, p. 20, pl. 3, fig. 1. Ecology: upper middle bathyal (Ingle, 1980).
- Bolivina tectiformis* Cushman, 1926, *Contr. Cushman Lab. Forum. Res.*, Vol. 1, p. 83, pl. 12, fig. 6.
- Bolivina tongi filacostata* Cushman and McCulloch—*Bolivina tongi* Cushman and McCulloch, 1942, *Allan Hancock Pacific Exped. Repts.* (Vol. 6): Los Angeles (Univ. So. Calif.), p. 214, pl. 27, figs. 7–11. Ecology: inner shelf (Smith, 1964).
- Bolivina woodringi* Kleinpell, 1938, *Miocene Stratigraphy of California*: Tulsa, Oklahoma (Am. Assoc. Pet. Geol.), p. 285, pl. 21, figs. 4–5. Ecology: upper middle bathyal (Ingle, 1980).
- Bolivinita quadrilatera* (Schwager)—*Textilaria quadrilatera* Schwager, 1866, *Novara Exped. 1857–1859, Geol. Theil*, Bd. 2, Abt. 2, p. 253, pl. 7, fig. 103.
- Buccella* sp. Ecology: inner shelf (Murray, 1973).
- Bulimina alazaensis* Cushman, 1927, *J. Paleontol.*, Vol. 1, p. 161, pl. 25, fig. 4. This paper, Pl. 3, Fig. 14. Ecology: lower middle bathyal. *Bulimina alazaensis* is morphologically similar to *B. Corrugata* and *B. rostrata*, which are assigned upper depth limits within the lower middle bathyal biofacies (Ingle, 1980; Ingle and Keller, 1980).
- Bulimina bleekeri* Hedberg, 1937, *J. Paleontol.*, Vol. 11, p. 675, pl. 91, figs. 12–13.
- Bulimina denudata* Cushman and Parker—*Bulimina pagoda* Cushman *denudata* Cushman and Parker, 1938, *Contr. Cushman Lab.*

- Foram. Res.*, Vol. 14, p. 57, pl. 10, figs. 1-2. This paper, Pl. 3, Fig. 13. Ecology: outer shelf (Smith, 1964; Ingle, 1980).
- Bulimina jarvisi* Cushman and Parker, 1936, *Contr. Cushman Lab. Foram. Res.*, Vol. 12, p. 39, pl. 7, fig. 1.
- Bulimina mexicana* Cushman—*Bulimina inflata* Sequenza var. *mexicana* Cushman, 1922, U.S. Nat. Mus. Bull., no. 104, p. 95, pl. 21, fig. 2. This paper, Pl. 3, Fig. 14. Ecology: upper middle bathyal (Ingle and Keller, 1980). Smith (1964) finds that this species occurs no shallower than the lower middle bathyal biofacies off Central America; in this study however, the upper middle bathyal limit will be used.
- Bulimina pagoda* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 152, pl. 2, fig. 16.
- Bulimina rostrata* Brady, 1884, *Rept. Challenger Exped. (Zool.)*, Vol. 9, Pt. 22, p. 408, pl. 51, figs. 14-15. Ecology: lower middle bathyal (Ingle, 1980; Ingle and Keller, 1980).
- Bulimina subaccuminata* Cushman and Stewart, 1930, in Cushman, Stewart, and Stewart, *San Diego Soc. Nat. Hist. Trans.*, Vol. 6, p. 65, pl. 5, figs. 2, 3a-b. Ecology: lower middle bathyal (Resig, 1981).
- Bulimina uvigerinaformis* Cushman and Kleinpell, 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 5, pl. 1, fig. 14. Ecology: lower middle bathyal (Ingle, 1980).
- Buliminella curta* Cushman, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 33, pl. 5, fig. 13. This paper, Pl. 2, Fig. 11. Ecology: outer shelf (Ingle, 1980).
- Buliminella curta basispinata* Stewart and Stewart—*Buliminella curta* Cushman *basispinata* Stewart and Stewart, 1930, *J. Paleontol.*, Vol. 4, p. 63, pl. 8, figs. 6.
- Buliminella subfusiformis* Cushman, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 33, pl. 5, fig. 12. This paper, Pl. 3, Fig. 1. Ecology: upper bathyal (Ingle, 1980).
- Buliminella tenuata* Cushman—*Buliminella subfusiformis* Cushman *tenuata* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 149, pl. 2, fig. 9. Ecology: upper bathyal, shallow oxygen-minimum zone (Ingle and Keller, 1980).
- Cancris auricula* (Fitchel and Moll)—*Nautilus auricula* Fitchel and Moll var.  $\alpha$  and var.  $\beta$  Fitchel and Moll, 1798, *Microscopische und andere kleine Schalthiere aus den Geschlechtern Argonate und Schiffer*, p. 108. Ecology: inner shelf (Ingle, 1980).
- Cancris carmenesis* Natland, 1950, *Mem. Geol. Soc. Am.*, no. 43, p. 32, pl. 9, fig. 1. Ecology: upper bathyal (Resig, 1981). Smith (1964) finds this species occurring at upper middle bathyal depths off Central America.
- Cancris inflatus* (d'Orbigny)—*Valvulina inflata* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): Strasbourg, France (Levrault), Pt. 5, p. 48, pl. 7, figs. 7-9. This paper, Pl. 5, Fig. 3. Ecology: upper bathyal (Smith, 1964).
- Cancris oblonga* (d'Orbigny)—*Valvulina oblonga* d'Orbigny, 1839, in Barker-Webb, P., and Berthelot, S. (Eds.), *Histoire Naturelle des Iles Canaries* (Vol. 2, Foraminifères): Paris (Bethune), p. 136, pl. 1, figs. 40-42. Ecology: upper middle bathyal (Smith, 1964).
- Cancris panamensis* Natland, 1938, *Scripps Inst. Oceanogr. Bull. Tech. Ser.*, Vol. 4, p. 148, pl. 6, fig. 1. Ecology: outer shelf (Smith, 1964).
- Cancris sagra* (d'Orbigny)—*Rotalina (Rotalina) sagra* d'Orbigny, 1839, "Foraminifères," in de la Sagra, R. (Ed.), 1839, *Histoire physique et naturelle de l'île de Cuba* (Vol. 8): Paris (Bertrand), p. 77, pl. 5, figs. 13-15. This paper, Pl. 5, Fig. 2. Ecology: inner shelf (Smith, 1964).
- Cassidulina californica* Cushman and Hughes, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 12, pl. 2, fig. 1. This paper, Pl. 6, Fig. 4. Ecology: upper bathyal (Ingle, 1964).
- Cassidulina caudriæ* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 64, pl. 12, figs. 2-3.
- Cassidulina crassa* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): Strasbourg, France (Levrault), Pt. 5, p. 56, pl. 7, figs. 18-20. Ecology: upper middle bathyal (Smith, 1964; Ingle and Keller, 1980). Smith (1964) does note rare occurrence of this species as shallow as 435 m (upper bathyal) off Central America.
- Cassidulina cushmani* Stewart and Stewart, 1930, *J. Paleontol.*, Vol. 4, p. 71, pl. 9, fig. 5. Ecology: upper middle bathyal (Smith, 1964; Ingle and Keller, 1980).
- Cassidulina delicata* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 168, pl. 6, fig. 5. Ecology: upper middle bathyal (Ingle, 1980).
- Cassidulina depressa* Asano and Nakamura—*Cassidulina subglobosa* Brady *depressa* Asano and Nakamura, 1937, *Japan. J. Geol., Geogr.*, Vol. 14, p. 148, pl. 13, fig. 8.
- Cassidulina laevigata* d'Orbigny, 1826, *Ann. Sci. Nat.*, Ser. 1, Vol. 7, p. 282, pl. 15, figs. 4-5, 5 bis. This paper, Pl. 6, Fig. 7. Ecology: upper bathyal to upper middle bathyal (Smith, 1964; Ingle, 1980). Outer shelf forms with an acute periphery but no carinae were included in this species by Smith (1964) and considered an ecologic variation. Only forms with carinae were recognized in the Leg 84 samples, so the upper bathyal biofacies was used as the upper depth limit for this species.
- Cassidulina laevigata carinata* Silvestri—*Cassidulina laevigata* d'Orbigny *carinata* Silvestri, 1896, *Accad. Pont. Nuovi Lincei* (Italy), Vol. 12, p. 104, pl. 2, figs. 10a-c. Comments: Only forms with a distinct keel described as thin carinae by Cushman (1922) are included in this species. This variation is probably an ecologic variation of *C. laevigata* d'Orbigny, since the trend recognized by Smith (1964) indicates that the periphery becomes more acute and develops a keel as depth increase off Central America. Ecology: upper middle bathyal (Ingle, 1980).
- Cassidulina limbata* Cushman and Hughes, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 12, pl. 2, fig. 2. This paper, Pl. 6, Fig. 5. Ecology: upper bathyal (Ingle, 1980).
- Cassidulina minuta* Cushman, 1933, *Contr. Cushman Lab. Foram. Res.*, Vol. 9, p. 92, pl. 10, fig. 3. Ecology: outer shelf (Smith, 1964).
- Cassidulina oblonga* Reuss, 1850, *K. Akad. Wiss. Wien, Math.-Nat. Cl., Denkschr.*, Vol. 1, p. 376, pl. 48, figs. 5-6. Ecology: outer shelf (Smith, 1964; Ingle, 1980).
- Cassidulina quadrata* Cushman and Hughes—*Cassidulina subglobosa* Brady *quadrata* Cushman and Hughes, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 15, pl. 2, fig. 7.
- Cassidulina reflexa* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 80, pl. 12, fig. 13.
- Cassidulina spinifera* Cushman and Jarvis, 1929, *Contr. Cushman Lab. Foram. Res.*, Vol. 5, p. 17, pl. 3, fig. 1.
- Cassidulina tortuosa* Cushman and Hughes, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 14, pl. 2, fig. 4.
- Cassidulina tricamerata* Galloway and Heminway, 1941, *N.Y. Acad. Sci., Sci. Survey Puerto Rico and Virgin Islands*, Vol. 3, p. 425, pl. 32, fig. 3.
- Cassidulina tumida* Natland, 1938, *Scripps Inst. Oceanogr. Bull. Tech. Ser.*, Vol. 4, p. 148, pl. 6, figs. 2-3. Ecology: upper middle bathyal (Smith, 1964). Smith (1964) also noted that the forms with broadly rounded peripheries were present from 435 to 450 m, and that the forms with serrated keels had an upper depth limit of 800-885 m off Central America. Similar morphologic variations were noted in the Leg 84 samples, and the two forms are indicated on the fossil lists as *C. tumida* and *C. tumida* (keel).
- Cassidulinella renulinaformis* Natland, 1940, *J. Paleontol.*, Vol. 14, p. 571, pl. 69, figs. 1-4.
- Cassidulinoides bradyi* (Norman)—*Cassidulina bradyi* Norman, 1881, *Q. J. Microsc. Sci.* (London), n. s., Vol. 21, p. 59. This paper, Pl. 3, Fig. 12.
- Cassidulinoides tenuis* Phleger and Parker, 1951, *Mem. Geol. Soc. Am.*, no. 46, p. 27, pl. 4, figs. 14-17. Ecology: upper middle bathyal (Smith, 1964).
- Cassidulinoides waltoni* Uchio, 1960, *Cushman Found. Foram. Res. Spec. Publ.*, no. 5, p. 69, pl. 9, figs. 24-27.
- Ceratobulimina alazaensis* Cushman and Harris, 1927, *Contr. Cushman Lab. Foram. Res.*, Vol. 3, p. 174, pl. 29, fig. 5, pl. 30, figs. 3-5.
- Chilostomella fimbrata* Cushman, 1926, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 78, pl. 11, figs. 22a-c.
- Chilostomella globata* Galloway and Heminway, 1941, *N.Y. Acad. Sci., Sci. Survey Puerto Rico and Virgin Islands*, Vol. 3, p. 409, pl. 28, fig. 2.
- Chilostomella oolina* Schwager, 1878, *Uff. Geol. (R. Com. Geol. Ital.) Boll.* (Italy), Vol. 9, p. 527, pl. 1, fig. 16.
- Chilostomella ovoidea* Reuss, 1850, *K. Akad. Wiss. Wien, Math.-Naturwiss. Kl., Denkschr.*, Vol. 1, p. 380, pl. 48, fig. 12. Ecology: upper middle bathyal-shallow oxygen-minimum zone (Ingle, 1980).

- Uchio (1960) reports this species living at depths as shallow as 61 fathoms (+ 112 m, outer shelf) in the California borderland. Ingle's upper depth limit and oxygen-minimum association thus represent the most probable depth at which this species would be preserved, and not an upper depth limit. Similar problems have been noted with thin-walled or delicate species such as *Suggrundia*, which tend to be associated with low-oxygen conditions (Douglas and Heitman, 1979).
- Chrysalogonium breviloculum* Cushman and Jarvis, 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 74, pl. 10, fig. 13.
- Chrysalogonium elongatum* Cushman and Jarvis, 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 73, pl. 10, figs. 10-11.
- Chrysalogonium lanceolum* Cushman and Jarvis, 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 75, pl. 10, fig. 16.
- Chrysalogonium longiscatatum* Cushman and Jarvis, 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 74, pl. 10, fig. 12.
- Chrysalogonium tenuicostatum* Cushman and Bermudez, 1936, *Contr. Cushman Lab. Foram. Res.*, Vol. 12, p. 27, pl. 5, figs. 3-5.
- Cibicides barnetti* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, p. 295, pl. 24, figs. 7-9.
- Cibicides dohmi* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 297, pl. 24, figs. 25-27.
- Cibicides fletcheri* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 64, pl. 10, figs. 8-9. Comments: Specimens included in this species were restricted to forms with a flat spiral side and a convex umbilical side. Ecology: inner shelf (Ingle, 1980).
- Cibicides* cf. *C. fletcheri* Galloway and Wissler. Comments: This group includes forms which deviated from the restrictions already noted (*C. fletcheri*). The primary variation was a concave spiral side, which could indicate that the specimens were attached and that the shape was altered by the surface of attachment.
- Cibicides floridanus* (Cushman)—*Truncatulina floridana* Cushman, 1918, *U.S. Geol. Surv. Bull.*, no. 676, p. 62, pl. 19, fig. 2. Comments: Specimens included in this species are unequally biconvex, and have thickened calcite deposits on the spiral side and sutures which are limbate and slightly raised. These specimens may be confused with *C. yaquatensis* Bermudez; *C. floridanus* is, however, larger and more equally biconvex. Ecology: lower middle bathyal (Ingle, 1980). Smith (1964) finds specimens of *C. floridanus* in the outer-shelf biofacies. Her specimens are not *C. floridanus* as used in this study.
- Cibicides* cf. *C. floridanus* (Cushman). Comments: A few specimens were observed at Site 570 (570-26-1, 14-16 cm and 570-30-1, 10-14 cm) which have thicker calcite umbos than typical. These specimens were separated from the typical forms, because of the probable ecologic significance of this character.
- Cibicides granulosa* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.* no. 25, p. 298, pl. 24, figs. 10-12.
- Cibicides guraboensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 299, pl. 26, figs. 31-33.
- Cibicides hunteri* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 300, pl. 24, figs. 31-33.
- Cibicides heminwayae* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 299, pl. 24, figs. 1-3.
- Cibicides io* Cushman—*Cibicides pseudoungeriana* (Cushman) *io* Cushman, 1931, *U.S. Nat. Mus. Bull.*, no. 104, p. 125, pl. 23, figs. 1-2.
- Cibicides matanzaensis* (Hadley)—*Planulina matanzaensis* Hadley, 1934, *Bull. Am. Paleontol.*, Vol. 20, no. 70A, p. 27, pl. 4, figs. 1-3.
- Cibicides mckannai* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 65, pl. 10, figs. 5-6.
- Cibicides mexicanus* Nuttall, 1932, *J. Paleontol.*, Vol. 6, p. 33, pl. 9, figs. 7-9.
- Cibicides nucleatus* (Sequenza)—*Truncatulina nucleata* Sequenza, 1880, *Mem. R. Accad. Lincei, Cl. Sci. Fis., Mat., Nat.*, Ser. 3, Vol. 6, p. 64, pl. 7, fig. 8.
- Cibicides pseudoungerianus* (Cushman)—*Truncatulina pseudoungeriana* Cushman, 1922, *U.S. Geol. Surv. Prof. Pap.*, 129-E, p. 97, pl. 20, fig. 9.
- Cibicides richarsoni* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 305, pl. 26, figs. 22-24.
- Cibicides spiralis* Natland, 1938, *Scripps Inst. Oceanogr. Bull. Tech. Ser.*, Vol. 4, p. 151, pl. 7, fig. 7. This paper, Pl. 5, Fig. 9. Ecology: upper middle bathyal (Ingle, 1980; Ingle and Keller, 1980).
- Cibicides spirolimbatus* Galloway and Heminway, 1941, *N.Y. Acad. Sci., Sci. Survey Puerto Rico and Virgin Islands*, Vol. 3, p. 397, pl. 25, fig. 1.
- Cibicides trincherasensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 307, pl. 25, figs. 1-3.
- Cibicides umbonatus* Phleger and Parker, 1951, *Mem. Geol. Soc. Am.*, no. 46, p. 31, pl. 17, figs. 7-8, 9a-b. Ecology: outer shelf to upper bathyal (Pflum and Frerichs, 1976).
- Cibicides yaquatensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 308, pl. 26, figs. 16-18. This paper, Pl. 5, Fig. 11.
- Cibicoides bradyi* (Trauth)—*Truncatulina bradyi* Trauth, 1918, *K. Akad. Wiss. Wien, Math.-Naturwiss. Kl., Denkschr.*, Vol. 95, p. 235. Ecology: upper middle bathyal (Ingle and Keller, 1980).
- Cibicoides coryelli* (Bermudez)—*Cibicides coryelli* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, pl. 25, figs. 7-9.
- Cibicoides grimsdalei* (Nuttall)—*Cibicides grimsdalei* Nuttall, 1930, *J. Paleontol.*, Vol. 4, p. 291, pl. 25, figs. 7-8, 11.
- Cibicoides kullenbergi* (Parker)—*Cibicides kullenbergi* Parker, 1953, *Swedish Deep-Sea Exped., 1947-1948, Repts.*, Vol. 7, p. 49, pl. 11, figs. 7-8. Ecology: lower middle bathyal (Pflum and Frerichs, 1976; Ingle and Keller, 1980). Woodruff and Douglas (1981) note that *C. kullenbergi* (Parker) was rare at depths greater than 2.5 km (lower bathyal) before 16 Ma ago and that after 12 Ma ago it was associated with warm waters in the Miocene and Quaternary.
- Cibicoides mundulus* (Brady, Parker and Jones)—*Truncatulina mundulus* Brady, Parker and Jones, 1888, *Trans. Zool. Soc. London*, Vol. 12, p. 228, pl. 45, figs. 25a-c.
- Cibicoides sinistralis* (Coryell and Rivero)—*Cibicoides sinistralis* Coryell and Rivero, 1940, *J. Paleontol.*, Vol. 14, p. 335, p. 44, figs. 12a-c.
- Cibicoides* cf. *C. sinistralis* (Coryell and Rivero). Comments: Specimens assigned to this group have a poorly developed keel and are not sinistrally coiled.
- Cibicoides trinitatis* (Nuttall)—*Truncatulina trinitatis* Nuttall, 1928, *Geol. Soc. Q. J. (London)* Vol. 84, pl. 7, figs. 3, 5-6.
- Cibicoides wuellerstorfi* (Schwager)—*Anomalina wuellerstorfi* Schwager, 1866, *Novara Exped., 1857-1859, Geol. Theil*, Bd. 2, Abt. 2, p. 258, pl. 7, figs. 105, 107. Ecology: upper middle bathyal, depths greater than 3000 ft. ( $\pm 1000$  m) (Pflum and Frerichs, 1976).
- Cyclammina cancellata* Brady, 1879, *Q. J. Microsc. Sci.*, n.s. Vol. 19, p. 62.
- Cyclogyra foliacea* (Philippi)—*Orbis foliaceus* Philippi, 1844, *Enumeratio molluscorum Siciliae cum viventium tum in tellure Tertiaria fossilium quae in itinere suo observavit: Halle, Saxony, Germany* (E. Anton), Vol. 2, p. 147, pl. 24, fig. 26.
- Dentalina baggi* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 49, pl. 8, figs. 14-15.
- Dentalina cocoaensis* (Cushman)—*Nodosaria cocoaensis* Cushman, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 66, pl. 10, figs. 5-6.
- Dentalina consobrina* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiären Beckens von Wien*: (Gide et Comp.), p. 46, pl. 2, figs. 1-3.
- Dentalina cooperensis* Cushman, 1933, *Contr. Cushman Lab. Foram. Res.*, Vol. 9, p. 8, pl. 1, fig. 17.
- Dentalina ittai* Loeblich and Tappan, 1953, *Smithsonian Inst. Misc. Coll.*, Vol. 121, p. 56, pl. 10, figs. 10-12.
- Dentalina nucronata* Neugeboren, 1856, *K. Akad. Wiss., Math.-Naturwiss. Kl., Denkschr.*, Bd. 12, Abt. 2, p. 83, pl. 3, figs. 8-11.
- Dentalina paupertata* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiären Beckens von Wien*: (Gide et Comp.), p. 46, pl. 1, figs. 57-58.
- Dentalina soluta* Reuss, 1851, *Z. Deut. Geol. Ges.*, Bd. 3, p. 60, pl. 3, figs. 4a-b.
- Dentalina spinosa* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiären Beckens von Wien*: (Gide et Comp.), p. 55, pl. 2, figs. 36-37.
- Dentostomina guraboensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 104, pl. 6, fig. 2.
- Dyocibicides perforata* Cushman and Valentine, 1930, *Stanford Univ. Dept. Geol. Contr.*, Vol. 1, p. 31, pl. 10, fig. 3. Ecology: inner shelf (Cushman and Valentine, 1930).

- Eggerella bradyi* (Cushman)—*Verneuillina bradyi* Cushman, 1911, *U.S. Nat. Mus. Bull.*, no. 71, p. 54, tf. 87. Ecology: lower middle bathyal (Ingle and Keller, 1980).
- Eggerella pusilla* (Goes)—*Verneuillina pusilla* Goes, 1896, *Harvard College Mus. Comp. Zool. Bull.*, Vol. 29, p. 39, pl. 5, figs. 6–8. Comments: This species is longer and less flaring than *E. bradyi*. Ecology: lower middle bathyal (Goes, 1896). Type species is from 1990 m in the Pacific off Mexico. No additional information on the occurrence has been found.
- Ehrenbergina*. Species of this genus are most common at depths of 2.3 to 4.2 km in the Atlantic (Lohmann, 1978). This depth association has been adopted for all species of *Ehrenbergina* in this study. Examples of depth associations in the Pacific Ocean are given under the species. Deviations from the lower bathyal to abyssal association are stressed.
- Ehrenbergina amina* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 270, pl. 20, figs. 44–46.
- Ehrenbergina bosoensis* Takayanagi, 1951, *Paleontol. Soc. Japan Trans. Proc.*, n.s., no. 3, p. 87–88, tf. 8.
- Ehrenbergina bradyi* Cushman, 1922, *U.S. Nat. Mus. Bull.*, no. 104, p. 134, pl. 26, fig. 5. This paper, Pl. 6, Fig. 8.
- Ehrenbergina caribbea* Galloway and Heminway, 1941, *N.Y. Acad. Sci., Sci. Survey Puerto Rico and Virgin Islands*, Vol. 3, p. 426, pl. 32, fig. 4.
- Ehrenbergina compressa* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 168, pl. 6, fig. 7. This paper, Pl. 6, Fig. 9. Ecology: upper bathyal (Ingle, 1980).
- Ehrenbergina hystrix* Brady, 1881, *Q. J. Microsc. Sci. London*, n.s., Vol. 21, p. 60.
- Ellipsoglandulina multicostata* (Galloway and Morrey)—*Daucina multicostata* Galloway and Morrey, 1929, *Bull. Am. Paleontol.*, Vol. 15, p. 42, pl. 6, fig. 13.
- Ellipsolagena barri* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 59, pl. 10, fig. 14.
- Ellipsodosaria decurta* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 56, pl. 10, fig. 1.
- Ellipsodosaria mappa* Cushman and Jarvis, 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 73, pl. 10, fig. 8.
- Elphidium sagra* (d'Orbigny)—*Polystomella sagra* d'Orbigny, 1839, in de la Sagra, R. (Ed.), *Histoire physique et naturelle de l'île de Cuba* (Vol. 8): Paris (Bertrand), p. 55, pl. 6, figs. 19–20. Ecology: inner shelf (Murray, 1973).
- Elphidium tumidum* Natland, 1938, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 3, no. 10, chart, line 5. Ecology: inner shelf (Smith, 1964).
- Epistominella bradyana* (Cushman)—*Pulvinulinella bradyana* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 165, pl. 5, figs. 11–13. Ecology: outer shelf (Smith, 1964).
- Epistominella* cf. *E. bradyana* (Cushman). Comments: Specimens assigned to this group have a lobate periphery, more robust test and the sutures on the spiral side are more loosely curved.
- Epistominella exigua* (Brady)—*Pulvinulinella exigua* Brady, 1884, *Rept. Challenger Exped. (Zool.)*, Vol. 9, Pt. 22, p. 696, pl. 103, figs. 13–14.
- Epistominella obesa* Bandy and Arnal, 1957, *Contr. Cushman Lab. Foram. Res.*, Vol. 8, p. 56, pl. 7, fig. 8. Ecology: upper middle bathyal (Smith, 1964).
- Epistominella pacifica* (Cushman)—*Pulvinulinella pacifica* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 165, pl. 5, figs. 14–15. Ecology: upper middle bathyal (Ingle, 1980; Ingle and Keller, 1980).
- Epistominella smithi* (Stewart and Stewart)—*Pulvinulinella smithi* Stewart and Stewart, 1930, *J. Paleontol.*, Vol. 4, p. 70, pl. 9, fig. 4. This paper, Pl. 4, Fig. 12. Ecology: upper middle bathyal (Smith, 1964). Off Central America, this species is associated with temperatures of 3–5°C and salinities of 34.56–34.61‰ (Smith, 1964).
- Epistominella* sp. of Resig, 1981, *Mem. Geol. Soc. Am.*, no. 154, pl. 3, figs. 3, 6.
- Epistominella subperuviana* (Cushman)—*Pulvinulinella subperuviana* Cushman, 1926, *Contr. Cushman Lab. Foram. Res.*, Vol. 2, p. 63, pl. 9, fig. 9. Ecology: upper bathyal (Ingle, 1980; Resig, 1981). Resig (1981) finds this species associated with temperatures of 7–13°C, a salinity range of 34.6‰, and an oxygen content of less than 1 ml/L.
- Epistominella umbonifera* (Cushman)—*Pulvinulinella umbonifera* Cushman, 1933, *Contr. Cushman Lab. Foram. Res.*, Vol. 9, p. 90, pl. 9, fig. 9.
- Eponides repandus* (Fitchell and Moll)—*Nautilus repandus* Fitchell and Moll, 1798, *Microscopische und andere kleine Schalthiere aus den Geschlechtern Argonaute und Schiffer*, p. 35, pl. 3, figs. a–d. Ecology: outer shelf (Smith, 1964). Pflum and Frerichs (1976) also note that this species is characteristic of tropical to warm-temperate shelf seas.
- Fissurina alveolata* (Brady)—*Lagena alveolata* Brady, 1884, *Rept. Challenger Expedition (Zool.)*, Vol. 9, p. 487, pl. 60, figs. 30, 32. This paper, Pl. 2, Fig. 7.
- Fissurina auriculata* (Brady)—*Lagena auriculata* Brady, 1881, *Q. J. Microsc. Sci.*, n.s., Vol. 21, p. 61.
- Fissurina carteri* (McLean)—*Lagena (Entosolenia?) Carteri* McLean, 1956, *Bull. Am. Paleontol.*, Vol. 36, p. 330, pl. 39, fig. 13.
- Fissurina cucullata* Silvestri, 1902, *Accad. Pont., Romana Nuovi Lincei.*, Vol. 19, p. 146, tf. 23–25.
- Fissurina dominicana* (Bermudez)—*Lagena dominicana* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 116, pl. 11, figs. 2–3.
- Fissurina exsculpta* (Brady)—*Lagena exsculpta* Brady, *Q. J. Microsc. Sci.*, n.s., Vol. 21, p. 61.
- Fissurina fimbriata* (Brady)—*Lagena fimbriata* Brady, 1881, *Q. J. Microsc. Sci.*, n.s., Vol. 21, p. 61.
- Fissurina globosa spinulosa* (Reuss)—*Lagena globosa* (Montagu) *spinulosa* Reuss, 1870, *K. Akad. Wiss. Wien, Math.-Naturwiss. Kl. Sitzber.*, Bd. 62, Abt. 1, p. 466.
- Fissurina kugleri* (Cushman and Stainforth)—*Entosolenia kugleri* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 45, pl. 7, fig. 5.
- Fissurina marginata* (Montagu)—*Verminulum marginata* Montagu, 1803, *Testacea Britannica*: Romsey, England (Hollis), p. 524.
- Fissurina orbignyana* Sequenza—*Fissurina (Fissurina) orbignyana* Sequenza, 1862, *Dei terreni Terziarii del distretto di Messina, Parte II*: Italy (T. Capra), p. 66, pl. 2, figs. 25–26.
- Fissurina solida* Sequenza, 1862, *Dei terreni Terziarii del distretto di Messina, Parte II*: p. 56, pl. 1, fig. 42.
- Fissurina spinosa* (Sidebottom)—*Lagena fascinata* (Egger) *spinosa* Sidebottom, 1912, *J. Quekett Microsc. Club*, Ser. 2, Vol. 11 (1910–1912), no. 70, p. 402, pl. 17, figs. 16a–b.
- Fissurina staphylleraria* Schwager, 1866, *Novara Exped. 1857–1859, Geol. Theil*, Bd. 2, Abt. 2, p. 209, pl. 5, fig. 24. This paper, Pl. 2, Fig. 10.
- Fissurina subformosa* Parr, 1950, *Antarctic Research Exped. 1929–1931, Repts.*, Ser. B, Vol. 5, pt. 6, p. 313, pl. 9, figs. 9a–b. This paper, Pl. 2, Fig. 8.
- Fissurina trigonomarginata* (Parker and Jones)—*Lagena sulcata* Walker and Jacob var. *trigono-marginata* Parker and Jones, 1865, *Philos. Trans. R. Soc. London*, Vol. 155, p. 348, 352, 419, pl. 18, figs. 1a–b.
- Fissurina ventricosa* (Wiesner)—*Lagena (Entosolenia) marginata* (Montagu) *ventricosa* Wiesner, 1931, in Drygalski, E. von (Ed.), *Deutsche Sudpolar-Expedition 1901–1903* (Bd. 20 [Zool. Bd. 12]): Berlin u. Leipzig (de Grutter), p. 120, pl. 19, fig. 222.
- Fissurina wiesneri* Barker, 1960, *Taxonomic Notes*, Soc. Econ. Paleontol. Mineral. Spec. Publ., no. 9, p. 24, pl. 59, fig. 23.
- Fronicularia compressa* Costa, 1855, *Mem. Accad. Sci. Napoli*, Vol. 2, p. 372, pl. 3, fig. 2.
- Fronicularia yaquensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 160, pl. 10, fig. 32.
- Fursenkoina bramletti* (Galloway and Morrey)—*Virgulina bramletti* Galloway and Morrey, 1929, *Bull. Amer. Paleontol.*, Vol. 15, no. 55, p. 37, pl. 5, fig. 14. This paper, Pl. 6, Fig. 1. Ecology: upper bathyal (Ingle, 1980).
- Fursenkoina californiensis* (Cushman)—*Virgulina californiensis* Cushman, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, no. 8, p. 32, pl. 5, fig. 11. Ecology: upper bathyal (Ingle, 1980).
- Fursenkoina complanata* (Egger)—*Virgulina schreibersiana* Czjzek *complanata* Egger, 1893, *K. Bayer. Akad. Wiss., Math.-Physik Kl., Abh.*, Bd. 18, Abt., 2, p. 292, pl. 8, figs. 91–92.
- Fursenkoina cornuta* (Cushman)—*Virgulina cornuta* Cushman, 1913, *U.S. Nat. Mus. Proc.*, vol. 44, no. 1973, p. 637, pl. 80, fig. 1. This paper, Pl. 6, Fig. 2.

- Fursenkoina dibollensis* (Cushman and Applin)—*Virgulina dibollensis* Cushman and Applin, 1926, *Am. Assoc. Pet. Geol. Bull.*, Vol. 10, p. 168, pl. 7, fig. 7.
- Fursenkoina fusiformis* (Cushman)—*Virgulina fusiformis* Cushman, 1930, *Florida State Geol. Surv. Bull.*, no. 4, p. 45, pl. 8, fig. 8.
- Fursenkoina punctata* (d'Orbigny)—*Virgulina punctata* d'Orbigny, 1839, in de la Sagra, R. (Ed.), *Histoire physique et naturelle de l'île de Cuba* (Vol. 8): Paris (Bertrand), p. 139, pl. 1, figs. 35–36. Ecology: outer shelf (Smith, 1964).
- Fursenkoina rotundata* (Parr)—*Virgulina rotundata* Parr, 1950, *Antarctic Research Exped. 1929–1931, Repts.* (Adelaide), Ser. B, Vol. 5, Pt. 6, p. 337, pl. 12, fig. 14. This paper, Pl. 6, Fig. 3.
- Fursenkoina seminuda* (Natland)—*Virgulina seminuda* Natland, 1950, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 4, no. 5, p. 145, pl. 5, fig. 12. Ecology: upper middle bathyal (Bandy and Arnal, 1957).
- Fursenkoina squamosa* (d'Orbigny)—*Virgulina squamosa* d'Orbigny, 1826, *Ann. Sci. Nat.*, Ser. 1, Vol. 7, p. 267, modeles no. 64.
- Gaudryina arenaria* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 68, pl. 11, fig. 5. Ecology: outer shelf (Ingle, 1980).
- Gaudryina atlantica* (Bailey)—*Textularia atlantica* Bailey, 1851, *Smithsonian Inst. Contr. Knowledge*, Vol. 2, art. 3, p. 12, figs. 38–43, 67.
- Gaudryina jacksonesis* Cushman, 1926, *Contr. Cushman Lab. Foram. Res.*, Vol. 2, p. 33, pl. 5, fig. 1.
- Glandulina laevigata* (d'Orbigny)—*Nodosaria (Glandulina) laevigata* d'Orbigny, 1826, *Ann. Sci. Nat.*, Ser. 1, Vol. 7, p. 252, pl. 10, figs. 1–3. Ecology: Upper middle bathyal (Ingle, 1980).
- Globobulimina barbata* (Cushman)—*Bulimina barbata* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 151, pl. 2, fig. 11. This paper, Pl. 4, Fig. 2. Ecology: lower middle bathyal (Ingle and Keller, 1980).
- Globobulimina pacifica* Cushman, 1927, *Contr. Cushman Lab. Foram. Res.*, Vol. 3, p. 67, pl. 14, fig. 12. This paper, Pl. 4, Fig. 1. Ecology: upper bathyal, shallow oxygen-minimum zone (Smith, 1964; Ingle, 1980; Ingle and Keller, 1980)
- Globulimina spinifera* (Cushman)—*Bulimina spinifera* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 151, pl. 2, fig. 15. Comments: Specimens assigned to this group have chambers which do not overlap as much as in *G. barbata*. The spines are also heavier and cover more of the test than in *G. barbata*.
- Globocassidulina subglobosa* (Brady)—*Cassidulina subglobosa* Brady, 1881, *Q. J. Microsc. Sci.* (London), n.s., Vol. 21, p. 60. Ecology: upper bathyal. Depth, water-mass and biofacies associations of this species are highly variable. In the Gulf of Mexico, *G. subglobosa* occurs in the upper bathyal biofacies (Pflum and Frerichs, 1976); in the Atlantic Ocean, Lohman (1978) associates this species with a depth of 2.5 km, and in the Pacific, Woodruff (in press) associated this species with shallow, early Miocene assemblages (less than 2.5 km).
- Goesella flintii* Cushman, 1936, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 6, p. 34, pl. 5, fig. 8. Ecology: upper middle bathyal.
- Goesella guraboensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 88, pl. 5, figs. 1–4.
- Guttulina caudata* d'Orbigny, 1826, *Ann. Sci. Nat.*, Vol. 7, p. 266.
- Guttulina irregularis* (d'Orbigny)—*Globulina irregularis* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiären Beckens von Wien*: (Gide et Comp.), p. 226, pl. 13, figs. 9–10.
- Gyroidina altiformis* Stewart and Stewart—*Gyroidina soldanii* d'Orbigny var. *altiformis* Stewart and Stewart, 1930, *J. Paleontol.*, Vol. 4, p. 67, pl. 9, fig. 2. Ecology: lower middle bathyal (Smith, 1964). Ingle (1980) associates this species with the upper bathyal depths.
- Gyroidina altispira* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 61, pl. 11, fig. 1.
- Gyroidina broeckhiana* Karrer, 1878, in Drasche, *Fragmente zu einer Geologie der Insel Luzon (Philippinen)*: (K. Gerold's Sohn), p. 98, pl. 5, fig. 26.
- Gyroidina condoni* (Cushman and Schenck)—*Eponides condoni* Cushman and Schenck, 1928, *Calif. Univ. Dept. Geol. Sci. Bull.*, Vol. 17, p. 313, pl. 44, figs. 6–7.
- Gyroidina girardana* (Reuss)—*Rotalina girardana* Reuss, 1851, *Z. Deut. Geol. Ges.*, Bd. 3, p. 73, pl. 5, fig. 34.
- Gyroidina io* Resig, 1958, *Micropaleontology.*, Vol. 4, p. 304, tf. 15a–c.
- Gyroidina lamarckiana* d'Orbigny, 1839, in Barker-Webb, P. and Berthelot, S. (Eds.), *Histoire Naturelle des îles Canaries* (Vol. 2): (Bethume), Pt. 2, Zool., p. 131, pl. 2, figs. 13–15. Ecology: lower middle bathyal. Pflum and Frerichs (1976) find this species living at 8010 Ft. ( $\pm 2670$  m) in the Gulf of Mexico. Similar depths are noted in the southwest Pacific, where Burke (1981) finds *G. lamarckiana* at depths of 1611–4332 m, associated with the deep oxygen-minimum zone. Off Central America, the deep oxygen-minimum zone impinges on the lower slope (Smith, 1964, Wyrtki, 1966).
- Gyroidina medicea* Emiliani, 1954, *Paleontography.*, Vol. 48 (n.s., vol. 18) (1952–1953), p. 136, pl. 24, figs. 6a–c.
- Gyroidina multilocula* Coryell and Mossman—*Gyroidina soldanii* d'Orbigny *multilocula* Coryell and Mossman, *J. Paleontol.*, Vol. 16, p. 237, pl. 36, fig. 20. Ecology: upper middle bathyal (Smith, 1964). Off the North American coast, this species has an upper depth limit within the lower bathyal biofacies (Ingle, 1980).
- Gyroidina neosoldanii* Brotzen, 1936, *Sver. Geol. Unders. Avh.*, Ser. C, no. 396 (Arsb. 30, no. 3), p. 158.
- Gyroidina nitidula* (Schwager)—*Rotalia nitidula* Schwager, 1866, *Novara Exped. Geol. Theil*, Bd. 2, Abt. 2, p. 263, pl. 7, fig. 110. Ecology: upper bathyal (Smith, 1964).
- Gyroidina orbicularis* d'Orbigny, 1826, *Ann. Sci. Nat.*, Ser. 1, Vol. 7, p. 278, modeles no. 13.
- Gyroidina perampla* Cushman and Stainforth—*Gyroidina girardana* (Reuss) *perampla* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 61, pl. 10, fig. 19.
- Gyroidina planulata* Cushman and Renz, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 23, pl. 4, fig. 1. Ecology: abyssal. *G. planulata* is assigned to abyssal depths because it is associated with the early Miocene and middle-late Miocene bottom water (Woodruff, in press). The bottom water impinges on the Central American slope at depths of 3.5 km and greater.
- Gyroidina quinqueloba* Uchio, 1960, *Cushman Found. Foram. Res. Spec. Publ.*, no. 5, p. 66, pl. 8, figs. 22–25.
- Gyroidina rotundimargo* Stewart and Stewart—*Gyroidina soldanii* d'Orbigny *rotundimargo* Stewart and Stewart, 1930, *J. Paleontol.*, Vol. 4, p. 68, pl. 68, pl. 9, fig. 3.
- Gyroidina soldanii* d'Orbigny, 1826, *Ann. Sci. Nat.*, Ser. 1, Vol. 7, p. 278, modeles no. 36. Ecology: lower bathyal (Ingle, 1980).
- Gyroidina zelandica* Finlay, 1939, *Roy. Soc. New Zealand, Trans. Proc.*, Vol. 69, Pt. 3, p. 323, pl. 28, figs. 138–140.
- Hanzawaia basiloba* (Cushman)—*Truncatulina basiloba* Cushman, 1918, *U.S. Geol. Surv. Bull.*, no. 676, p. 64, pl. 21, fig. 2. Ecology: inner shelf (Ingle, 1980).
- Hanzawaia concentrica* (Cushman)—*Truncatulina concentrica* Cushman, 1918, *U.S. Geol. Surv. Bull.*, no. 676, p. 64, pl. 21, fig. 3. Ecology: inner shelf (Smith, 1964).
- Hanzawaia illingi* (Nuttall)—*Truncatulina illingi* Nuttall, 1928, *Q. J. Geol. Soc. London*, Vol. 84, p. 99, pl. 7, figs. 11, 17, p. 99, tf. 5. Ecology: outer shelf (Ingle, 1980).
- Hanzawaia isidroensis* (Cushman and Renz)—*Cibicides isidroensis* Cushman and Renz, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 26, pl. 4, fig. 10.
- Hanzawaia mantaensis* (Galloway and Morrey)—*Anomalina mantaensis* Galloway and Morrey, 1929, *Bull. Amer. Paleontol.*, Vol. 15, p. 28, pl. 4, figs. 5a–c.
- Hanzawaia nitidula* (Bandy)—*Cibicides basiloba* (Cushman) *nitidula* Bandy, 1953, *J. Paleontol.*, Vol. 27, p. 178, pl. 22, fig. 3.
- Hoeglundina elegans* (d'Orbigny)—*Rotalia elegans* d'Orbigny, 1826, *Ann. Sci. Nat.*, Vol. 7, p. 276, modeles no. 6. Ecology: upper bathyal (Smith, 1964, Ingle 1980).
- Karrerella alticamerata* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 19, pl. 2, fig. 10.
- Karrerella bradyi* (Cushman)—*Gaudryina bradyi* Cushman, 1911, *U.S. Nat. Mus. Bull.*, no. 71, p. 67, tf. 107. This paper, Pl. 1, Fig. 4. Ecology: outer shelf (Pflum and Frerichs, 1976).
- Karrerella chilostoma* (Reuss)—*Textularia chilostoma* Reuss, 1852, *Z. Deut. Geol., Ges.*, Bd. 4, p. 18, tf. a–b.
- Lagena becki* Sullivan, 1962, *Calif. Univ. Publs. Geol. Sci.*, Vol. 37, p. 266, pl. 10, figs. 16a–b.
- Lagena castrensis* Schwager, 1866, *Novara Exped. 1857–1859, Geol. Theil*, Bd. 2, Abt. 2, p. 208, pl. 5, fig. 22.
- Lagena costata* (Williamson)—*Entosolenia costata* Williamson, 1858, *On the Recent Foraminifera of Great Britain*: London (R. Soc.), p. 9, pl. 1, fig. 18. This paper, Pl. 2, Fig. 2.



- Lagena crenulata capistriata* Cushman and Stainforth—*Lagena crenata* Parker and Jones *capistrata* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 30, pl. 4, fig. 16.
- Lagena elongata* (Ehrenberg)—*Miliola elongata* Ehrenberg, 1844, *K. Preuss. Akad. Wiss.* (Berlin), p. 371.
- Lagena gracillima* (Sequenza)—*Amphorina gracillima* Sequenza, 1862, *Dei terreni Terziarii del distretto di Messina, Parte II: Messina, Italy* (T. Capra), p. 51, pl. 1, fig. 37.
- Lagena hexagona* (Williamson)—*Entosolenia squamosa* (Montagu) var.  $\gamma$  *hexagona* Williamson, 1848, *Ann. Mag. Nat. Hist.* (England), Ser. 2, Vol. 1, p. 20, pl. 2, fig. 23.
- Lagena hispida* Reuss, 1863, *K. Akad. Wiss. Wien, Math.-Naturwiss. Kl., Sitzber.*, Bd. 46, Abt. 1, p. 335, pl. 6, figs. 77–79.
- Lagena laevis* (Montagu)—*Vermiculum laeve* Montagu, 1803, *Testacea Britannica*, Romsey, England (Hollis), p. 524.
- Lagena limbata* Matthes, 1939, *Palaeontography*, Bd. 90, Abt. A, p. 81, pl. 6, fig. 112.
- Lagena lineata* (Williamson)—*Entosolenia lineata* Williamson, 1848, *Ann. Mag. Nat. Hist.* (England), Ser. 2, Vol. 1, p. 18, pl. 2, fig. 18.
- Lagena meridionalis* Wiesner—*Lagena gracilis* Williamson *meridionalis* Wiesner, 1931, in Drygalski, E. von (Ed.), *Deutsche Sudpolar-Expedition, 1901–1903* (Bd. 20), (Zool., Bd. 12): p. 117, pl. 18, fig. 211.
- Lagena mollis* Cushman—*Lagena gracillima* (Sequenza) *mollis* Cushman, 1944, *Cushman Lab. Foram. Res. Spec. Publ.* no. 12, p. 21, pl. 3, fig. 3.
- Lagena nuttalli* Galloway and Heminway, 1928, *N. Y. Acad. Sci., Sci. Survey Puerto Rico and Virgin Islands*, Vol. 3, Pt. 4, p. 346, pl. 10, fig. 8.
- Lagena semilineata* Wright, 1886, *Belfast Nat. Field Club Proc.* (Ireland), n.s. Vol. 1, appendix 9, p. 320, pl. 26, fig. 7.
- Lagena semistriata* Williamson—*Lagena striata* (Montagu) var. *semistriata* Williamson, 1848, *Ann. Mag. Nat. Hist.* (England), Ser. 2, Vol. 1, p. 14, pl. 1, figs. 9–10.
- Lagena setigera* Millett—*Lagena clavata* (d'Orbigny) *setigera* Millett, 1901, *J. R. Microsc. Soc. London*, p. 491, pl. 8, fig. 9.
- Lagena striata* (d'Orbigny)—*Oolina striata* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminiferes* (Vol. 5): p. 21, pl. 5, fig. 12. This paper, Pl. 2, Fig. 4.
- Lagena vulgaris* Williamson, 1858, *On the Recent Foraminifera of Great Britain*: London (R. Soc.), p. 3, pl. 1, figs. 5–5a.
- Laticarinina pauperata* (Parker and Jones)—*Pulvinulina repanda menardii pauperata* Parker and Jones, 1865, *Philos. Trans. R. Soc. London*, Vol. 155, p. 395, pl. 16, figs. 50, 51a–b. This paper, Pl. 4, Fig. 13. Ecology: lower middle bathyal (Ingle, 1980). In the early Miocene, Douglas (1980) and Woodruff (in press) associate this species with depths of greater than 3000 m and the Antarctic Bottom Water.
- Lenticulina alatolimbatus* (Gumbel)—*Robulina alato-limbata* Gumbel, 1868, *K. Bayer. Akad. Wiss. München, Math.-Physik. Kl. Abh.*, Bd. 10, Abt. 2, p. 641, pl. 1, fig. 70.
- Lenticulina arcuatostrata* (Hantken)—*Cristellaria* (*Robulina*) *arcuato-strata* Hantken, 1868, *Magyarh. Foldt. Tars., Munk* (Pest, Magyarorszag), Vol. 4, p. 93, pl. 2, figs. 30a–c.
- Lenticulina arcuatostratus carolinianus* (Cushman)—*Robulus arcuato-stratus* (Hantken) *carolinianus* Cushman, 1933, *Contr. Cushman Lab. Foram. Res.*, Vol. 9, p. 4, pl. 1, fig. 9.
- Lenticulina calcar* (Linné)—*Nautilus calcar* Linné, 1758, *Systema Naturae* (Vol. 1, 10th Ed.), p. 709.
- Lenticulina caritae* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 122, pl. 7, figs. 35–36. This paper, Pl. 1, Fig. 10.
- Lenticulina colorata* (Stache)—*Cristellaria* (*Cristellaria*) *colorata* Stache, 1865, *Novara Exped. 1857–1859, Geol. Theil.*, Bd. 1, Abt. 2, p. 229, pl. 23, fig. 9.
- Lenticulina convergens* (Bornemann)—*Cristellaria convergens* Bornemann, 1855, *Z. Deut. Geol. Ges.*, Bd. 7, Heft 2, p. 327, pl. 13, figs. 16–17.
- Lenticulina crassa* d'Orbigny, 1846, *Die fossilen foraminiferen des tertiären Beckens von Wien*: (Gide et Comp.), p. 90, pl. 4, figs. 1–3.
- Lenticulina cushmani* (Galloway and Wissler)—*Robulus cushmani* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 51, pl. 8, fig. 11. Ecology: outer shelf (Uchio, 1960).
- Lenticulina dicampyla* (Franzenau)—*Cristellaria dicampyla* Franzenau, *Math. term. Kozl.* (Hungary), Kot. 26, szam 1, p. 13, pl. 1, figs. 8a–b. This paper, Pl. 1, Fig. 10.
- Lenticulina gibba* d'Orbigny—*Cristellaria gibba* d'Orbigny, 1839, in de la Sagra, R. (Ed.), 1839, *Histoire physique et naturelle de l'île de Cuba*, (Vol. 8): Paris (Bertrand), p. 40, (plate published separately) pl. 7, figs. 20–21.
- Lenticulina gutticolatus cocoaensis* (Cushman)—*Cristellaria gutticolatus* (Gumbel) *cocoaensis* Cushman, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 67, pl. 10, fig. 11.
- Lenticulina iota* (Cushman)—*Cristellaria iota* Cushman, 1923, *U.S. Nat. Mus. Bull.*, 104, p. 111, pl. 29, fig. 2, pl. 30, fig. 1. This paper, Pl. 1, Fig. 11.
- Lenticulina limbosa* (Reuss)—*Robulus limbosus* Reuss, 1863, *K. Akad. Wiss., Math.-Naturwiss., Kl.*, Bd. 48, Abt. 1, p. 55, pl. 6, figs. 69a–b.
- Lenticulina melvilli* (Cushman and Renz)—*Robulus melvilli* Cushman and Renz, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 12, pl. 2, fig. 12.
- Lenticulina miocenica* (Chapman)—*Cristellaria miocenica* Chapman, 1900, *Calif. Acad. Sci., Proc., Geol.*, Ser. 3, Vol. 1 (1897–1904), p. 250, pl. 30, figs. 1–1a.
- Lenticulina nikobarensis* (Schager)—*Cristellaria nikobarensis* Schwager, 1866, *Novara Exped., 1857–1859, Geol. Theil.*, Bd. 2, Abt. 2, p. 243, pl. 6, fig. 87.
- Lenticulina occidentalis* (Cushman)—*Cristellaria occidentalis* Cushman, 1923, *U.S. Nat. Mus. Bull.*, no. 104, p. 102, pl. 25, fig. 2, pl. 26, figs. 1–2.
- Lenticulina occidentalis glabrata* (Cushman)—*Cristellaria occidentalis* Cushman *glabrata* Cushman, 1923, *U.S. Nat. Mus. Bull.*, no. 104, p. 103, pl. 25, fig. 3.
- Lenticulina occidentalis torrida* (Cushman)—*Cristellaria occidentalis* Cushman *torrida* Cushman, 1923, *U.S. Nat. Mus. Bull.*, no. 104, p. 105, pl. 25, fig. 1.
- Lenticulina peregrina matanzana* (Palmer and Bermudez)—*Cristellaria peregrina* (Schwager) *matanzana* Palmer and Bermudez, 1936, *Mem. Soc. Cubana Hist. Nat.*, Vol. 10, p. 254, pl. 13, fig. 5.
- Lenticulina plummerae* (Cole)—*Robulus plummerae* Cole, 1928, *Bull. Amer. Paleontol.*, Vol. 14, p. 208, pl. 34, fig. 10.
- Lenticulina rotulata* Lamarck—*Lenticulinites rotulata* Lamarck, 1804, *Paris Mus. Nat. hist. Nat. Ann.*, (An XIII), tome 5, Vol. 8, p. 188, pl. 62, fig. 11.
- Lenticulina subkubinyii* (Nuttall)—*Cristellaria subkubinyii* Nuttall, 1932, *J. Paleontol.*, Vol. 6, p. 11, pl. 1, fig. 16.
- Lenticulina submamilligera* (Cushman)—*Cristellaria submamilligera* Cushman, 1917, *U.S. Nat. Mus. Proc.*, Vol. 51, p. 657.
- Lenticulina subpappilosa* (Nuttall)—*Cristellaria subpappilosa* Nuttall, 1932, *J. Paleontol.*, Vol. 6, p. 12, pl. 1, fig. 12.
- Lenticulina terryi* (Coryell and Embich)—*Robulus terryi* Coryell and Embich, 1937, *J. Paleontol.*, Vol. 11, p. 299, pl. 41, figs. 17a–b.
- Lenticulina texana* (Cushman and Applin)—*Cristellaria articulata* Reuss *texana* Cushman and Applin, 1926, *Am. Assoc. Pet. Geol. Bull.*, Vol. 10, p. 129, pl. 8, figs. 1a–b, 2.
- Lenticulina vauhani* (Cushman)—*Cristellaria vauhani* Cushman, 1918, *U.S. Nat. Mus. Bull.*, no. 103, p. 61, pl. 22, fig. 3.
- Lenticulina yaquensis* (Bermudez)—*Robulus yaquensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 5, p. 132, 132, pl. 6, figs. 61–66.
- Marginulina abbreviata* Neugeboren, 1851, *Siebenb. Ver. Naturwiss. Hermannstadt, Verh. Mitt.* (Hermannstadt, Hungary), Jahrg. 2, no. 8, p. 129, pl. 5, fig. 4.
- Marginulina alazaensis* Nuttall, 1932, *J. Paleontol.*, Vol. 6, p. 13, pl. 3, figs. 3 and 7.
- Marginulina asperuliformis* (Nuttall)—*Cristellaria asperuliformis* Nuttall, 1930, *J. Paleontol.*, Vol. 4, p. 282, pl. 23, figs. 9–10.
- Marginulina dominicana* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 140, pl. 9, fig. 26.
- Marginulina dubia* Neugeboren, 1851, *Siebenb. Ver. Naturwiss. Hermannstadt* (Hungary), Jahrg. 2, p. 120, pl. 4, fig. 1.
- Marginulina exima* Neugeboren, 1851, *Siebenb. Ver. Naturwiss. Hermannstadt* (Hungary), Jahrg. 2, p. 129, pl. 4, fig. 17.
- Marginulina senni* (Cushman and Renz)—*Robulus senni* Cushman and Renz, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 12, pl. 2, figs. 14–15.
- Marginulina subbullata* Hantkeni, 1875, *K. Ungar. Geol. Anst., Mitt. Jahrb.* (Hungary), Bd. 4, Heft 1, p. 46, pl. 4, figs. 9–10, pl. 5, fig. 9.
- Marginulina sublituus* (Nuttall)—*Cristellaria sublituus* Nuttall, 1932, *J. Paleontol.*, Vol. 6, p. 11, pl. 1, figs. 13–14.

- Marginulina subrecta* Franke, 1927, *Danmarks Geol. Unders.*, Raekke 2, Nr. 46, p. 19, pl. 1, fig. 28.
- Marginulina yaquatensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 142, pl. 9, fig. 29.
- Martinotiella bradyana* (Cushman)—*Listerella bradyana* Cushman, 1936, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 6, p. 40, pl. 6, fig. 11. Ecology: abyssal (Ingle and Keller, 1980).
- Martinotiella communis* (d'Orbigny)—*Clavulina communis* d'Orbigny, 1846, *Die Fossilen Foraminiferes des Tertiaeren Beckens von Wien*: (Gide et Comp.), p. 196, pl. 12, figs. 1–2. Ecology: upper bathyal, shallow oxygen-minimum zone (Ingle and Keller, 1980).
- Martinotiella pallida* (Cushman)—*Clavulina communis* (d'Orbigny) *pallida* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 138, pl. 2, fig. 1.
- Melonis affinis* (Reuss)—*Nonionina affinis* Reuss, 1851, *Z. Deut. Geol. Ges.*, Bd. 3, p. 72, pl. 5, fig. 32. Ecology: lower middle bathyal (Smith, 1964). Woodruff and Douglas (1981) note that *M. barleanus* (*M. affinis* of this study) is found at depths greater than 3.5 km before 15.5 Ma and 1.5–4.0 km after 14 Ma ago. This depth change has been included in the Leg 84 faunal analysis.
- Melonis soldanii* (d'Orbigny)—Frerichs, 1969, *Contr. Geol. Univ. Wyoming*, Vol. 8, figs. 1a–c, 4, 5.
- Melonis pompilioides* (Fitchell and Moll)—*Nautilus pompilioides* Fitchell and Moll, 1798, *Testacea Microscopia Aliaque Minuta ex Generibus Argonauta et Nautilus* (Austria), p. 31, pl. 2, figs. a–c. Ecology: lower bathyal (Ingle, 1980; Ingle and Keller, 1980).
- Milliammina fusca* (Brady)—*Quinqueloculina fusca* Brady, 1870, *Ann. Mag. Nat. Hist.* (England), Ser. 4, Vol. 6, p. 286, pl. 11, figs. 2–3.
- Miliolinella circularis* (Bornemann)—*Triloculina circularis* Bornemann, 1855, *Z. Deut. Geol. Ges.*, Bd. 7, Heft 2, p. 349, pl. 19, fig. 4. Ecology: inner shelf (Poag, 1981).
- Nodogenerina challengeriana* Thalmann, 1937, *Eclogae Geol. Helv.*, Vol. 30, p. 341.
- Nodogenerina laevigata* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 179, pl. 11, fig. 59.
- Nodosarella subnodosa* (Guppy)—*Ellipsoidina subnodosa* Guppy, 1894, *Proc. Zool. Soc. London*, p. 650, pl. 41, fig. 12.
- Nodosaria calomorpha* Reuss, 1866, *K. Akad. Wiss. Wien. Math.-Naturwiss. Kl., Denkschr.*, Bd. 25, Abt. 1, p. 129, pl. 1, figs. 15–19.
- Nodosaria caribbeana* Hedberg—*Nodosaria raphanistum* (Linné) *caribbeana* Hedberg, 1937, *J. Paleontol.*, Vol. 11, p. 671, pl. 91, fig. 1.
- Nodosaria elegantissima* Hantken, 1875, *K. Ungar. Geol. Anst. Mitt. Jahrb.* (Hungary), Bd. 4, Heft. 1, p. 24, pl. 12, fig. 16.
- Nodosaria fistuca* Schwager, 1866, *Novara Exped. 1837–1839, Geol. Theil*, Bd. 2, Abt. 2, p. 216, pl. 5, figs. 36–37.
- Nodosaria hispida* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiaeren Beckens von Wien*: (Gide et Comp.), p. 35, pl. 1, figs. 24–25.
- Nodosaria lamellata* Cushman and Jarvis, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 24.
- Nodosaria latejugata* Gumbel, 1868, *K. Bayer. Akad. Wiss. München, Math.-Physik. Kl., Abh.*, Bd. 10, Abt. 2, p. 619, pl. 1, fig. 32.
- Nodosaria longiscata* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiaeren Beckens von Wien*: (Gide et Comp.), p. 32, pl. 1, figs. 10–12.
- Nodosaria nuttalli* Hedberg, 1937, *J. Paleontol.*, Vol. 11, p. 673, pl. 91, fig. 6.
- Nodosaria obliqua* (Linné)—*Nautilus obliquus* Linnaeus, 1767, *Systema Naturae* (Vol. 1, 10th Ed.), 1758, p. 710.
- Nodosaria parvixilis* Cushman and Stewart, 1930, in Cushman, Stewart and Stewart, 1930, *San Diego Soc. Nat. Hist. Trans.*, Vol. 6, p. 55.
- Nodosaria* cf. *N. perversa* (Schwager) of Uchio, 1960, *Cushman Found. Foram. Res. Spec. Publ.*, no. 5, pl. 4, fig. 1.
- Nodosaria pyrula* d'Orbigny, 1826, *Ann. Sci. Nat. France*, Ser. 1, tome 7, p. 253.
- Nodosaria stainforthia* Cushman and Renz, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 15, pl. 3, fig. 4.
- Nodosaria vertebralis* (Batsch)—*Nautilus (Ortoceras) vertebralis* Batsch, 1791, *Sechs Kupfertafeln mit Conchylien des Seesandes Jena*: University Press, p. 2, 5, pl. 2, figs. 6a–b.
- Nonionella auricula* Heron-Allen and Earland, 1930, *J. Microsc. Soc.* (London), Ser. 3, Vol. 50, p. 192, pl. 5, figs. 68–70.
- Nonionella basispinata* (Cushman and Moyer)—*Nonion pizarrense* Berry *basispinata* Cushman and Moyer, 1930, *Contr. Cushman Lab. Foram. Res.*, Vol. 6, p. 54, pl. 7, fig. 18. Ecology: inner shelf (Smith, 1964; Ingle, 1980).
- Nonionella incisa* (Cushman)—*Nonionina incisa* Cushman, 1926, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 90. Ecology: inner shelf (Ingle, 1980).
- Nonionella labradorica* (Dawson)—*Nonionina labradorica* Dawson, 1860, *Can. Nat.*, Vol. 5, p. 191, tf. 4.
- Nonionella miocenica* Cushman, 1926, *Contr. Cushman Lab. Foram. Res.*, Vol. 2, p. 64. Ecology: inner shelf (Smith, 1964; Ingle, 1980).
- Nonionella puchella* Hada, 1931, *Tohoku Imp. Univer. Sci. Repts.* (Sendai, Japan), Ser. 4 (Biol.), Vol. 6, p. 120, tf. 79a–c.
- Nonionella stella* Cushman and Moyer—*Nonionella miocenica* Cushman *stella* Cushman and Moyer, 1930, *Contr. Cushman Lab. Foram. Res.*, Vol. 6, p. 56, pl. 7, fig. 17. Ecology: inner shelf (Ingle, 1980). Ingle and Keller (1980) associate this species with shallow oxygen-minimum zone. The shallower upper depth limit was used in this study.
- Oolina caudigera* (Weisner)—*Lagena (Entosolenia) globosa* (Montagu) *caudiger* Weisner, 1931, in Drygalski, *Deutsche Sudpolar-Expedition 1901–1903* (Bd. 20 [Zool. Bd. 12]): Berlin u. Leipzig (de Gruyter), p. 119, pl. 18, figs. 214.
- Oolina desmophora* (Rymer Jones)—*Lagena vulgaris desmophora* Rymer Jones, 1874, *Linnaean Soc. London Trans.*, Vol. 30, p. 54, pl. 19, figs. 23–24.
- Oolina melo* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): (Levrault), 1839, p. 20, pl. 5, fig. 9.
- Oolina squamosa* (Montagu)—*Vermiculum squamosum* Montagu, 1893, *Testacea Britannica*: p. 526, pl. 14, fig. 2.
- Oolina striatopunctata* (Parker and Jones)—*Lagena sulcata* (Walker and Jacob) *striatopunctata* Parker and Jones, 1865, *Philos. Trans. R. Soc. London*, Vol. 155, p. 350, pl. 13, figs. 25–27.
- Oridorsalis multiseptus* (Koch)—*Pulvinulina umbonata* (Reuss) *multisepta* Koch, 1926, *Eclogae Geol. Helv.*, Vol. 19, p. 749, tf. 25.
- Oridorsalis subtenera* (Galloway and Wissler)—*Rotalia subtenera* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 60, pl. 10, fig. 4. Ecology: upper middle bathyal (Ingle, 1980).
- Oridorsalis umbonatus* (Reuss)—*Rotalia umbonata* Reuss, 1851, *Z. Deut. Geol. Ges.*, Bd. 3, p. 75, pl. 5, fig. 35. This paper, Pl. 6, Fig. 11.
- Orthomorphina rohri* (Cushman and Stainforth)—*Nodogenerina rohri* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 39, pl. 5, fig. 26.
- Osangularia culteri* (Parker and Jones)—*Planorbulina farcta* (Fitchell and Moll) *ungeriana* (d'Orbigny) *culteri* Parker and Jones, 1865, *Philos. Trans. R. Soc. London*, Vol. 155, p. 382, 421, pl. 19, figs. 1a–b. This paper, Pl. 6, Fig. 12. Ecology: upper middle bathyal (Pflum and Frerichs, 1976).
- Osangularia mexicana* (Cole)—*Pulvinulina culteri* (Parker and Jones) *mexicana* Cole, 1927, *Bull. Amer. Paleontol.*, Vol. 14, p. 31, pl. 1, figs. 15–16.
- Parafissurina* cf. "*Lagena*" *fistulifera* Buchner of Parker, 1964, *J. Paleontol.*, Vol. 38, p. 627, pl. 99, fig. 17.
- Parafissurina fusuliformis* Loeblich and Tappan, 1953, *Smithsonian Inst. Misc. Coll.*, Vol. 121, p. 79, pl. 14, figs. 18–19.
- Palmerinella thalmani* Stainforth and Stevenson, 1946, *J. Paleontol.*, Vol. 20, p. 563, pl. 86, figs. 7–10.
- Palnularia caribbeana* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 136, pl. 8, figs. 49–50.
- Planularia crepidula* (Fitchell and Moll)—*Nautilus crepidulus* Fitchell and Moll, 1798, *Testacea Microscopia Aliaque Minuta ex-Generibus Argonauta et Nautilus*: p. 107, pl. 19, figs. g–i.
- Planularia venezuelana* Hedberg, 1937, *Jour. Paleol.*, vol. 11, p. 670, pl. 90, fig. 14.
- Planulina exorna* Phleger and Parker, 1951, *Mem. Geol. Soc. Am.*, no. 46, p. 32, pl. 18, figs. 5–7. This paper, Pl. 5, Fig. 6. Ecology: outer shelf (Smith, 1964).
- Planulina marialana* Hadley, 1934, *Bull. Am. Paleontol.*, Vol. 20, p. 27, pl. 4, figs. 4–6.
- Planulina mexicana* Cushman, 1927, *Contr. Cushman Lab. Foram. Res.*, Vol. 3, p. 113, pl. 23, fig. 5.
- Planulina ornata* (d'Orbigny)—*Truncatulix ornata* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): p. 40,

- pl. 6, figs. 7-9. This paper, Pl. 5, Fig. 7. Ecology: upper middle bathyal (Smith, 1964). Ingle (1980) uses an upper depth limit of outer shelf, but the deeper limit was used in this study.
- Planulina* cf. *P. ornata* d'Orbigny. Comments: Specimens assigned to this group are smaller, less perforate, and have more limbate sutures than typical.
- Planulina renzi* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 72, pl. 15, fig. 1. This paper, Pl. 5, Fig. 8.
- Plectofrondicularia advena* (Cushman)—*Fronidularia advena* Cushman, 1922, *U.S. Nat. Mus. Bull.*, no. 104, p. 141, pl. 20, figs. 1-2. Ecology: lower bathyal (Cushman, 1922).
- Plectofrondicularia californica* Cushman and Stewart, 1926, *Contr. Cushman Lab. Foram. Res.*, Vol. 2, p. 39, pl. 6, figs. 9-11. This paper, Pl. 2, Fig. 5.
- Plectofrondicularia keijzeri* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 175, pl. 11, figs. 49, 51.
- Plectofrondicularia miocenica* Cushman, 1926, *Contr. Cushman Lab. Foram. Res.*, Vol. 2, p. 58, pl. 7, figs. 10-11, pl. 8, figs. 11-12. Ecology: lower bathyal (Ingle, 1980).
- Plectofrondicularia morreyae* Cushman, 1929, *Contr. Cushman Lab. Foram. Res.*, Vol. 5, p. 92, pl. 13, fig. 23.
- Plectofrondicularia nuttalli* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 38, pl. 5, figs. 21-23.
- Plectofrondicularia ruthvanmurrayi* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 37, pl. 5, fig. 14.
- Plectofrondicularia vaughani* Cushman, 1927, *Contr. Cushman Lab. Foram. Res.*, Vol. 3, p. 112, pl. 23, fig. 3. This paper, Pl. 2, Fig. 6.
- Plectofrondicularia yumuriana* Palmer, 1940, *Mem. Soc. Cubana Hist. Nat.*, Vol. 14, p. 294, pl. 53, figs. 3-4.
- Pleurostomella*. Most modern species of *Pleurostomella* occur at abyssal depths (Pflum and Frerichs, 1976). Unless otherwise noted, this is the depth-association adopted in this study.
- Pleurostomella acuminata* Cushman, 1922, *U.S. Nat. Mus. Bull.*, no. 104, p. 50, pl. 19, fig. 6.
- Pleurostomella acuta* Hatken, 1875, *K. Ungar. Geol. Anst., Mitt. Jahrb.* (Hungary), Bd. 4, Heft 1, p. 44, pl. 13, fig. 18.
- Pleurostomella alternans* Schwager, 1866, *Novara Exped. 1857-1859, Geol. Theil*, Bd. 2, Abt. 2, p. 238, pl. 6, figs. 79-80.
- Pleurostomella bierigi* Palmer and Bermudez, 1936, *Mem. Soc. Cubana Hist. Nat.*, Vol. 10, p. 294, pl. 17, figs. 7-8.
- Pleurostomella brevis* Schwager, 1866, *Novara Exped. 1857-1859, Geol. Theil*, Bd. Abt. 2, p. 239, pl. 6, fig. 81.
- Pleurostomella elliptica* Galloway and Heminway, 1941, *N.Y. Acad. Sci., Sci. Survey Puerto Rico and Virgin Islands*, Vol. 3, p. 438, pl. 35, fig. 3.
- Pleurostomella jacksonensis* Cushman and Applin, 1926, *Am. Assoc. Pet. Geol. Bull.*, Vol. 10, p. 168, pl. 7, fig. 9.
- Pleurostomella naraeoensis* Cushman and Bermudez, 1937, *Contr. Cushman Lab. Foram. Res.*, Vol. 13, p. 16, pl. 1, figs. 59-60.
- Pleurostomella praegerontica* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 52, pl. 8, figs. 13-14.
- Praeglobulimina affinis* (d'Orbigny)—*Bulimina affinis* d'Orbigny, 1839, in de la Sagra, R. (Ed.), *Histoire physique et naturelle de l'île de Cuba* (Vol. 8): Paris (Bertrand), p. 105, pl. 2, figs. 25-26. This paper, Pl. 4 Figs. 3-4. Ecology: upper middle bathyal (Ingle, 1980).
- Praeglobulimina auriculata* (Bailey)—*Bulimina auriculata* Bailey, 1851, *Smithsonian Inst. Contr. Knowledge*, Vol. 2, art. 3, p. 12, figs. 25-27.
- Praeglobulimina ovata* (d'Orbigny)—*Bulimina ovata* d'Orbigny, 1846, *Foraminifères fossiles du bassin tertiaire de Vienne (Autriche)* (Die fossile foraminiferen des tertiären Beckens von Wien): Paris (Gide et Comp.), p. 185, pl. 11, figs. 13-14.
- Praeglobulimina ovula* (d'Orbigny)—*Bulimina ovula* d'Orbigny, 1839, *Voyage dans l'Amérique Méridionale: Foraminifères* (Vol. 5): Pt. 5, p. 51, pl. 1, figs. 10-11. Ecology: upper middle bathyal (*Globulimina ovula* of Ingle, 1980).
- Praeglobulimina pupoides* (d'Orbigny)—*Bulimina pupoides* d'Orbigny, 1846, *Foraminifères fossiles du bassin tertiaire de Vienne*: (Gide et Cie), p. 185, pl. 11, figs. 11-12.
- Pseudonodosaria conica* (Neugeboren)—*Glandulina conica* Neugeboren, 1850, *Siebenb. Ver. Naturwiss. Hermannstadt* (Hungary), Jahrg. 1, no. 4, p. 51, pl. 1, fig. 5a-b.
- Pseudonodosaria inflata* (Bornemann)—*Glandulina inflata* Bornemann, 1855, *Z. Deut. Geol. Ges.*, Bd. 7, Heft 2, p. 320, pl. 12, figs. 6-7.
- Pseudonodosaria obsoleta* (Acosta)—*Nodogerina obsoleta* Acosta, 1940, *Algunos Foraminíferos Nuevos de las Costas Cubanas*: La Habana (Torreia), num. 5, p. 5, pl. 1, fig. 8.
- Pullenia alazaensis* Cushman, 1927, *J. Paleontol.*, Vol. 1, p. 168, pl. 26, figs. 14-15.
- Pullenia bulloides* (d'Orbigny)—*Nonionina bulloides* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiären Beckens von Wien*: (Gide et Comp.), p. 107, pl. 5, figs. 9-10. Ecology: lower middle bathyal (Smith, 1964; Ingle, 1980; Ingle and Keller, 1980). Pflum and Frerichs (1976) also reported rare occurrences of this species at upper bathyal depths.
- Pullenia duplicata* Stainforth, 1949, *J. Paleontol.*, Vol. 23, p. 436. Ecology: lower middle bathyal. This species has been assigned to the lower middle bathyal biofacies because of its morphological similarity to *Pullenia bulloides*.
- Pullenia malkinae* Coryell and Mossman, 1942, *J. Paleontol.*, Vol. 16, p. 234, pl. 36, figs. 3-4. Ecology: outer shelf (Ingle, 1980).
- Pullenia quadriloba* (Sequenza)—*Nonionina quadriloba* Sequenza, 1880, *Mem. R. Accad. Lincei, Rome, Cl. Sci. Fis., Mat., Nat.*, Ser. 3, Vol. 6, p. 430, and errata, pl. 17, fig. 15.
- Pullenia quinqueloba* (Reuss)—*Nonionina quinqueloba* Reuss, 1851, *Z. Deut. Geol. Ges.*, Bd. 3, p. 71, pl. 5, fig. 31. Ecology: upper middle bathyal (Pflum and Frerichs, 1976; Ingle, 1980).
- Pullenia riveroi* Bermudez, 1949, *Mem. Soc. Cubana Hist. Nat.*, Vol. 13, p. 11, pl. 2, figs. 1-6.
- Pullenia* cf. *P. riveroi* Bermudez. Comments: Specimens assigned to this group have  $\pm 7$  chambers. Chambers are very inflated, and increase in size as added. Test is asymmetric instead of smoothly rounded as in the typical form. Test is also more robust and fatter than *P. trinitatis*.
- Pullenia salisburyi* Stewart and Stewart, 1930, *J. Paleontol.*, Vol. 4, p. 72, pl. 8, fig. 2. Ecology: upper bathyal (Smith, 1964). Ingle (1980) cites the upper depth limit of this species as outer shelf; the deeper limit was used in this study.
- Pullenia trinitatis* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 66, pl. 12, fig. 11. Ecology: middle bathyal (Pflum and Frerichs, 1976).
- Pyrgo depressa* (d'Orbigny)—*Biloculina depressa* d'Orbigny, 1826, *Ann. Sci. Nat. (France)*, Ser. 1, tome 7, p. 298, modeles no. 91. This paper, Pl. 1, Fig. 8. Ecology: upper middle bathyal (Pflum and Frerichs, 1976).
- Pyrgo murrhina* (Schwager)—*Biloculina murrhina* Schwager, 1866, *Novara Exped. 1857-1859, Geol. Theil*, Bd. 2, Abt. 2, p. 203, pl. 4, fig. 15. Ecology: lower middle bathyal (Bandy and Arnal, 1957).
- Pyrgo* cf. *P. murrhina* (Schwager). Ecology: In addition to the two basal spines, specimens assigned to this group have 2-3 spines on each side of the basal spines.
- Pyrgo rotalaria* Loeblich and Tappan, 1953, *Smithsonian Inst. Misc. Coll.*, Vol. 121, p. 47, pl. 6, figs. 5-6.
- Pyrgo serrata* (Bailey)—*Biloculina serrata* Bailey, 1861, *Boston J. Nat. Hist.*, Vol. 7, p. 350, pl. 8, fig. E. Ecology: upper middle bathyal (Pflum and Frerichs, 1976).
- Pyrgo williamsoni* (Silvestri)—*Biloculina williamsoni* Silvestri, 1923, *Accad. Pont. Romana Nuovi Lincei*, Vol. 76, p. 73, pl. 6, figs. 169-170., pl. 7, fig. 171.
- Pyrulina fusiformis* (Roemer)—*Polymorphina (Globulinen) fusiformis* Roemer, 1838, *Neues Jahrb. Min. Geol. Petref.-Kunde* (Germany), p. 386, pl. 3, fig. 37a-b.
- Quinqueloculina auberiana* d'Orbigny, 1839, in de la Sagra, R. (Ed.), *Histoire physique et naturelle de l'île de Cuba* (Vol. 8): Paris (Bertrand), p. 193, pl. 12, figs. 1-3.
- Quinqueloculina compacta* Serova, 1960, *Voprosy Mikropal.*, no. 3, p. 93, pl. 1, fig. 2a-c.
- Quinqueloculina lamarckiana* d'Orbigny, 1839, in de la Sagra, R. (Ed.), *Histoire physique et naturelle de l'île de Cuba* (Vol. 8): (Bertrand), p. 189, (plates published separately), pl. 11, figs. 14-15. Ecology: inner shelf (Ingle, 1980).
- Quinqueloculina venusta* Karrer, 1868, *K. Akad. Wiss. Math.-Naturwiss. Kl., Sitzber.*, Bd. 58, Abt. 1, p. 147, pl. 2, fig. 6. This paper, Pl. 1, Fig. 6. Ecology: abyssal (*Triloculina* sp. of Burke, 1981). Woodruff (in press) finds this species in association with the mid-

- dle-late Miocene bottom water and the early Miocene bottom water.
- Rectobolivina gasparensis* Bermudez, 1949, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 25, p. 197, pl. 12, fig. 54.
- Rectobolivina mexicana* (Cushman)—*Siphogenerina mexicana* Cushman, 1926, *U.S. Nat. Mus. Proc.*, Vol. 67, p. 15, pl. 5, fig. 4.
- Recurvoides turbinatus* (Bandy)—*Haplophragmoides turbinatum* Brady, 1881, *Q. J. Microsc. Sci. London*, n.s., Vol. 21, p. 50. Ecology: lower middle bathyal. Burke (1981) reports this species at depths of 1670 (rare) to 3057 m, with highest abundances at 2660 m. The shallow occurrences are associated with the deep oxygen-minimum zone which impinges on the Central American slope at lower middle bathyal depths. The more abundant deeper occurrences noted by Burke (1981) are associated with the deeper water masses (AABW, for example).
- Reophax bilocularis* Flint, 1899, *U.S. Nat. Mus. Ann. Rept.*, Pt. 1, p. 273, pl. 17, fig. 2. Ecology: inner shelf (Loeblich and Tappan, 1953).
- Reophax curtus* Cushman, 1920, *U.S. Nat. Mus. Bull.*, no. 104, p. 8, pl. 2, figs. 2-3. Ecology: inner shelf (Loeblich and Tappan, 1953; McDougall, 1982).
- Reophax dentaliniformis* (Brady)—*Lituola (Reophax) dentaliformis* Brady, 1881, *Q. J. Microsc. Sci. London*, n. s., Vol. 21, p. 49. Ecology: inner shelf (Loeblich and Tappan, 1953; McDougall, 1982).
- Reophax scorpiurus* Montfort, 1808, *Conchyliologie systematique et classification methodique des coquilles* (Vol. 1); (Schoell), pp. 330, 331. Ecology: inner shelf (Loeblich and Tappan, 1953; McDougall, 1982).
- Reophax subfusiformis* Earland, 1933, *Discovery Repts.* (England), Vol. 7, p. 74, pl. 2, figs. 16-19. Ecology: inner shelf (Loeblich and Tappan, 1953; McDougall, 1982).
- Reusella pacifica* Cushman and McCulloch, 1948, *Allan Hancock Pacific Exped. Repts.* (Vol. 6): Los Angeles (Univ. So. Calif.), p. 251, pl. 31, fig. 6. Ecology: inner shelf (Pflum and Frerichs, 1976).
- Rosalina columbiensis* (Cushman)—*Discorbis columbiensis* Cushman, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 43, pl. 6, fig. 13. This paper, Pl. 5, Fig. 1. Ecology: outer shelf (Smith, 1964).
- Rotorbinella lomaensis* Bandy, 1953, *J. Paleontol.*, Vol. 27, p. 179, pl. 22, fig. 6.
- Rotorbinella tholus* (Galloway and Heminway)—*Rotalia tholus* Galloway and Heminway, 1941, *N. Y. Acad. Sci., Sci. Survey Puerto Rico and Virgin Islands*, Vol. 3, p. 382, pl. 20, fig. 2.
- Rotorbinella versiformis* Bandy, 1953, *J. Paleontol.*, Vol. 27, p. 177, pl. 22, fig. 5.
- Saracenaria acutaucularis* (Fitchel and Moll)—*Nautilus acutaucularis* Fitchel and Moll, 1798, *Microscopische und andere kleine Schalthiere aus den Geschlechtern Argonaute und Schiffer*: Austria, p. 102, pl. 18, figs. g-i.
- Saracenaria schencki* Cushman and Hobson, 1935, *Contr. Cushman Lab. Foram. Res.*, Vol. 11, p. 57, pl. 8, fig. 11.
- Saracenaria senni* Hedberg, 1937, *J. Paleontol.*, Vol. 11, p. 674, pl. 90, fig. 18.
- Schenckiella petrosa* (Cushman and Bermudez)—*Listerella petrosa* Cushman and Bermudez, 1937, *Contr. Cushman Lab. Foram. Res.*, Vol. 13, p. 5, pl. 1, figs. 24-26.
- Schenckiella suteri* Cushman and Stainforth, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 14, p. 19, pl. 2, fig. 26.
- Sigmoilina schlumbergeri* Silvestri, 1904, *Mem. Accad. Pont. Romana Nuovi Lincei*, Vol. 22, pp. 267, 269. Ecology: upper middle bathyal (Pflum and Frerichs, 1976).
- Sigmoilina sigmoidea* (Brady)—*Planispirina sigmoidea* Brady, 1884, *Rept. Challenger Exped.* (Zool.), Vol. 9, Pt. 22, p. 197, pl. 2, figs. 1-3, p. 194, tf. 5c.
- Sigmoilina tenuis* (Czjzek)—*Quinqueloculina tenuis* Czjzek, 1848, *Naturwiss. Abh.* (Austria), Bd. 2, Abt. 1, p. 149, pl. 13, figs. 31-34. This paper, Pl. 1, Fig. 7. Ecology: upper middle bathyal (Ingle, 1980).
- Siphogenerina basispinata* Cushman and Jarvis, 1929, *Contr. Cushman Lab. Foram. Res.*, Vol. 5, p. 13, pl. 3, figs. 4-5. This paper, Pl. 4, Fig. 9. Ecology: upper middle bathyal (Ingle, 1980).
- Siphogenerina multicostata* Cushman and Jarvis, 1929, *Contr. Cushman Lab. Foram. Res.*, Vol. 5, p. 14, pl. 3, fig. 6. This paper, Pl. 4, Fig. 11. Ecology: upper middle bathyal (Ingle, 1980).
- Siphogenerina senni* Cushman and Renz, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 22, pl. 3, figs. 21-22.
- Siphogenerina tenuis* Cushman and Kleinpell, 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 13, pl. 2, fig. 13.
- Siphogenerina transversa* Cushman—*Siphogenerina raphanus* (Parker and Jones) *transversus* Cushman, 1918, *U.S. Nat. Mus. Bull.*, no. 103, p. 64, pl. 22, fig. 8. This paper, Pl. 4, Fig. 11. Ecology: upper middle bathyal (Ingle, 1980).
- Siphonia pulchra* Cushman, 1919, *Carnegie Inst. Washington Publ.*, no. 291, p. 42, pl. 14, figs. 7a-c. Ecology: outer shelf. This species is morphologically similar to *S. bradyana*, which has an upper depth limit in the outer shelf (Bandy, 1956; Phleger, 1960).
- Siphonodosaria abyssorum* (Brady)—*Nodosaria abyssorum* Brady, 1881, *Q. J. Microsc. Sci.* (England), n. s., Vol. 21, p. 63.
- Siphonodosaria gracillima* (Cushman and Jarvis)—*Ellipsonodosaria nuttalli* Cushman and Jarvis *gracillima* Cushman and Jarvis 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, pl. 10, fig. 7.
- Siphonodosaria paucistriata* (Galloway and Morrey)—*Nodosarella paucistriata* Galloway and Morrey, 1929, *Bull. Am. Paleontol.*, Vol. 15, p. 42, pl. 6, fig. 12.
- Siphonodosaria verneuilla* (d'Orbigny)—*Dentalina verneuilla* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiaeren Beckens von Wien*: (Gide et Comp.), p. 48, pl. 2, figs. 7-8.
- Siphotextularia catenata* (Cushman)—*Textularia catenata* Cushman, 1911, *U.S. Nat. Mus. Bull.*, no. 71, p. 23, tf. 39-40.
- Sphaeroidina bulloides* d'Orbigny, 1826, *Ann. Sci. Nat.* (France), Ser. 1, tome 7, p. 267, modeles no. 65. This paper, pl. 3, fig. 2. Ecology: upper middle bathyal (Ingle, 1980).
- Spiroloculina texana* Cushman and Ellisor, 1944, *Contr. Cushman Lab. Foram. Res.*, Vol. 20, p. 51, pl. 8, figs. 14-15.
- Stilostomella advena* (Cushman and Laiming)—*Nodogenerina advena* Cushman and Laiming, 1931, *J. Paleontol.*, Vol. 5, p. 106, pl. 11, fig. 19. Ecology: lower middle bathyal (Ingle, 1980).
- Stilostomella adolphina* (d'Orbigny)—*Dentalina adolphina* d'Orbigny, 1846, *Die Fossilen Foraminiferen des Tertiaeren Beckens von Wien*: (Gide et Comp.) p. 51. Ecology: lower middle bathyal (Ingle, 1980).
- Stilostomella caribbaea* Palmer and Bermudez, 1945, *Bull. Am. Paleontol.*, Vol. 29, p. 53, pl. 1, fig. 6.
- Stilostomella gracilis* (Palmer and Bermudez)—*Ellipsonodosaria gracilis* Palmer and Bermudez, 1936, *Mem. Soc. Cubana Hist. Nat.*, Vol. 10, p. 296, pl. 18, figs. 18-19. This paper, Pl. 3, Fig. 17.
- Stilostomella lepidula* (Schwager)—*Nodosaria lepidula* Schwager, 1866, *Novara Exped. 1857-1859, Geol. Theil*, Bd. 2, Abt. 2, p. 210, pl. 5, figs. 27-28. Ecology: lower middle bathyal (Ingle, 1980).
- Stilostomella subspinosa* (Cushman)—*Ellipsonodosaria subspinosa* Cushman, 1943, *Contr. Cushman Lab. Foram. Res.*, Vol. 19, p. 92, pl. 16, figs. 6-7. This paper, Pl. 3, Fig. 16.
- Suggrundia californica* Kleinpell, 1938, *Miocene Stratigraphy of California*: Tulsa, Oklahoma (Am. Assoc. Pet. Geol.), p. 287, pl. 18, figs. 8-10. Ecology: upper bathyal, shallow oxygen-minimum zone (Ingle, 1980).
- Suggrundia eckisi* Natland, 1950, *Mem. Geol. Am.*, no. 43, p. 23, pl. 9, fig. 12. This paper, Pl. 5, Fig. 12. Ecology: upper bathyal, shallow oxygen-minimum zone (Ingle, 1980; Ingle and Keller, 1980). Smith (1964) also notes that the length of this species decreases with increasing water depths.
- Suggrundia kleinpelli* Bramletti, 1951, in Woodring, W. P., and Bramlette, M. N., *Prof. Pap. U.S. Geol. Surv.*, no. 222, p. 59, pl. 23, figs. 4-5, 9. Ecology: upper bathyal, shallow oxygen-minimum zone (Ingle, 1980).
- Textularia agglutinans* d'Orbigny, 1839, in de la Sagra, R. (Ed.) *Histoire physique et naturelle de l'ile de Cuba* (Vol. 8): Paris (Bertrand), p. 144, pl. 1, figs. 17-18.
- Textularia leuzingeri* Cushman and Renz, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 3, pl. 1, fig. 2.
- Textularia panamensis* Cushman, 1918, *U.S. Nat. Mus. Bull.*, no. 103, p. 53, pl. 20, fig. 1. Ecology: inner shelf. This biofacies assignment is based on morphologic similarity of this species to *T. schencki*.
- Textularia schencki* Cushman and Valentine, 1930, *Stanford Univ. Dept. Geol. Contr.*, Vol. 1, p. 8, pl. 1, fig. 3. Ecology: inner shelf (Golik and Phleger, 1977).
- Trifarina angulosa* (Williamson)—*Uvigerina angulosa* Williamson, 1858, *R. Soc.* (England), p. 67, pl. 5, fig. 140. Ecology: outer shelf (Ingle, 1980).
- Trifarina bradyi* Cushman, 1923, *U.S. Nat. Mus. Bull.*, no. 104, p. 99, pl. 22, figs. 3a-b, 4a-b, 5-8, and 9a-b.

- Trifarina carinata* (Cushman)—*Angulogerina carinata* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 159, pl. 4, fig. 3. Ecology: upper bathyal (Smith, 1964; Ingle, 1980; Resig, 1981).
- Trifarina hannai* (Beck)—*Angulogerina hannai* Beck, 1943, *J. Paleontol.*, Vol. 17, pp. 607–607, pl. 108, figs. 26, 28.
- Trifarina occidentalis* (Cushman)—*Uvigerina occidentalis* Cushman, 1923, *U.S. Nat. Mus. Bull.*, no. 104, p. 169. Ecology: outer shelf to upper bathyal (Ingle, 1980).
- Triloculina globosa* (Hanna and Hanna)—*Quinqueloculina globosa* Hanna and Hanna, 1924, *Washington Univ. Publ. Geol.*, Vol. 1, p. 58, pl. 13, figs. 1–2.
- Triloculina oblongata* (Montagu)—*Vermiculum oblongum* Montagu, 1803, *Testacea Britannica*: (Hollis), p. 522, pl. 14, fig. 9.
- Triloculina trihedra* Loeblich and Tappan, 1953, *Smithsonian Inst. Misc. Coll.*, Vol. 121, p. 45, pl. 4, fig. 10. This paper, Pl. 1 Fig. 5. Ecology: lower middle bathyal. Although Loeblich and Tappan (1953) associate this species with neritic depths in the Arctic Ocean, Burke (1981) and Woodruff (in press) associate this form (*Triloculina* sp. B of Burke, 1981; *Triloculina* sp. of Woodruff, in press) with deep oxygen-minimum zone and deeper water masses in the central Pacific.
- Tritaxilina colei* Cushman and Seigfus, 1935, *Contr. Cushman Lab. Foram. Res.*, Vol. 11, p. 92, pl. 14, figs. 5–6.
- Tritaxilina mexicana* Cushman, 1925, *Contr. Cushman Lab. Foram. Res.*, Vol. 1, p. 64, pl. 10, fig. 4.
- Uvigerina baggi* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 75, pl. 11, fig. 19. Ecology: outer shelf to upper bathyal (*Trifarina baggi* of Ingle, 1980).
- Uvigerina carapitana* Hedberg, 1937, *J. Paleontol.*, Vol. 11, p. 677, pl. 91, fig. 20.
- Uvigerina excellens* Todd, 1948, in Cushman, J. A., and McCulloch, I., *Allan Hancock Pacific Exped.* (Vol. 6): Los Angeles (Univ. So. Calif.), p. 258, pl. 33, fig. 2. Ecology: upper bathyal (Smith, 1964).
- Uvigerina gallowayi* Cushman, 1929, *Contr. Cushman Lab. Foram. Res.*, Vol. 5, p. 94, pl. 13, figs. 33–34. Ecology: upper bathyal (Ingle, 1980).
- Uvigerina gallowayi basicordata* Cushman and Renz—*Uvigerina gallowayi* Cushman *basicordata* Cushman and Renz, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 21, pl. 3, fig. 18.
- Uvigerina hispida* Schwager, 1866, *Novara Exped. 1857–1859, Geol. Theil*, Bd. 2, Abt. 2, p. 249, pl. 7, fig. 95. This paper, Pl. 4, Fig. 5. Ecology: lower middle bathyal (Ingle, 1980; Ingle and Keller, 1980).
- Uvigerina hispidocostata* Cushman and Todd, 1945, *Cushman Lab. Foram. Res. Spec. Publ.*, no. 15, p. 51, pl. 7, figs. 27, 31. Ecology: upper middle bathyal (Ingle, 1980).
- Uvigerina hootsi* Rankin, 1934, in Cushman, J. A., and Kleinpell, R. M., *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 22, pl. 3, figs. 8–9. Ecology: upper middle bathyal (Ingle, 1980).
- Uvigerina incilis* Todd, 1948, in Cushman, J. A., and McCulloch, I., *Allan Hancock Pacific Exped.* (Vol. 6): Los Angeles (Univ. So. Calif.), p. 260, pl. 33, fig. 4. Ecology: outer shelf (Smith, 1964).
- Uvigerina juncea* Cushman and Todd, 1941, *Contr. Cushman Lab. Foram. Res.*, Vol. 17, p. 78, pl. 20, figs. 4–11. Ecology: outer shelf to upper bathyal (Ingle, 1980).
- Uvigerina peregrina* Cushman, 1923, *U.S. Nat. Mus. Bull.*, no. 104, p. 166, pl. 42, figs. 7–10. Ecology: upper bathyal (Ingle, 1980).
- The upper depth limit of this species has been noted at a variety of depths along the East Pacific Margin (Smith, 1964; Ingle and Keller, 1980).
- Uvigerina peregrina dirupta* Todd, 1948, in Cushman, J. A., and McCulloch, I., *Allan Hancock Pacific Exped.* (Vol. 6): Los Angeles (Univ. So. Calif.), p. 267, pl. 34, fig. 3. Ecology: upper middle bathyal (Ingle, 1980; Ingle and Keller, 1980).
- Uvigerina rustica* Cushman and Edwards, 1938, *Contr. Cushman Lab. Foram. Res.*, Vol. 14, p. 83, pl. 14, fig. 6. Ecology: lower middle bathyal (Pflum and Frerichs, 1976).
- Uvigerina semitrigonia* Galloway and Wissler, 1927, *J. Paleontol.*, Vol. 1, p. 77, pl. 11, fig. 21. Ecology: outer shelf (*Angulogerina semitrigonia* of Smith, 1964).
- Uvigerina senticosa* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 159, pl. 3, fig. 14. Ecology: lower bathyal (Ingle, 1964).
- Uvigerina segeundoensis* Cushman and Galliher, 1934, *Contr. Cushman Lab. Foram. Res.*, Vol. 10, p. 26, pl. 4, fig. 11.
- Uvigerina striata* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): p. 53, pl. 7, fig. 16. Ecology: upper bathyal (Resig, 1981).
- Uvigerina vaderescens* Cushman—*Uvigerina probiscidea* Schwager *vaderescens* Cushman, 1933, *Contr. Cushman Lab. Foram. Res.*, Vol. 9, p. 85, pl. 8, figs. 14–15.
- Vaginulina americana* Cushman, 1923, *U. S. Nat. Mus. Bull.*, no. 104, p. 135, pl. 38, figs. 3–4.
- Vaginulinopsis nudicostata* (Cushman and Hanna)—*Cristellaria mexicana* Cushman subspecies *nudicostata* Cushman and G. D. Hanna, 1927, p. 216, pl. 14, fig. 2.
- Vaginulinopsis saundersi* (Hanna and Hanna)—*Cristellaria saundersi* Hanna and Hanna, 1924, *Wash. Univ. (Seattle) Publ. Geol.*, Vol. 1, p. 61, pl. 13, figs. 5–6.
- Valvulineria araucana* (d'Orbigny)—*Rosalina araucana* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): p. 44, pl. 6, figs. 16–18. Ecology: upper middle bathyal (Ingle, 1980).
- Valvulineria glabra* Cushman—*Valvulineria vilardeboana* (d'Orbigny) *glabra* Cushman, 1927, *Scripps Inst. Oceanogr. Tech. Ser.*, Vol. 1, p. 161, pl. 4, figs. 5–6. This paper, Pl. 5, Fig. 4. Ecology: upper middle bathyal (Smith, 1964).
- Valvulineria inaequalis* (d'Orbigny)—*Valvulina inaequalis* d'Orbigny, 1839, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): Strasbourg, France (Levrault), p. 48, pl. 7, figs. 10–12. This paper, Pl. 5, Fig. 5. Ecology: outer shelf (Uchio, 1960).
- Valvulineria malagaensis* Kleinpell, 1938, *Miocene Stratigraphy of California: (Am. Assoc. Pet. Geol.)*, p. 308, pl. 22, figs. 10–12. Ecology: upper middle bathyal (Ingle, 1980).
- Valvulineria minuta* (Schubert)—*Discorbina rugosa* (d'Orbigny) *minuta* Schubert, 1904, *Geol. Reichsanst. Jahrb.* (Austria), Bd. 53, Heft 3, p. 420.
- Valvulineria venezuelana* Hedberg, 1937, *J. Paleontol.*, Vol. 11, p. 678, pl. 91, fig. 21.
- Valvulineria vilardeboana* (d'Orbigny)—*Rosalina vilardeboana* d'Orbigny, 1939, *Voyage dans l'Amerique Meridionale: Foraminifères* (Vol. 5): Strasbourg, France (Levrault), p. 44, pl. 6, figs. 13–15. Ecology: upper middle bathyal (Smith, 1964).
- Valvulina spinosa* Cushman, 1927, *Contr. Cushman Lab. Foram. Res.*, Vol. 3, p. 111, pl. 23, fig. 1. This paper, Pl. 1, Fig. 2.





















Table 6. (Continued).

P. spp.	<i>Quinqueloculina lamarckiana</i>	<i>Q. sp.</i>	<i>Q. venusta</i>	<i>Rotorbiniella tholus</i>	<i>R. cf. R. tholus</i>	<i>Saracenaria schencki</i>	<i>Schenkella petrosa</i>	<i>Signolina tenuis</i>	<i>Siphogenerina basispinata</i>	<i>S. multicostata</i>	<i>S. senni</i>	<i>S. sp.</i>	<i>S. transversa</i>	<i>Siphonia pulchra</i>	<i>Siphonodasaria abyssorum</i>	<i>S. gracillima</i>	<i>S. paucistriata</i>	<i>S. verneulli</i>	<i>S. sp.</i>	<i>Sphaeroidina bulboides</i>	<i>Stilosomella advena</i>	<i>S. adolphina</i>	<i>S. lepidula</i>	<i>S. subspinosa</i>	<i>Sugrandia eckisi</i>	<i>S. klempfeli</i>	<i>Textularia leuzingeri</i>	<i>Trifarina angulosa</i>	<i>T. bradyi</i>	<i>T. carinata</i>	<i>Triloculina oblongata</i>	<i>T. sp.</i>	<i>T. trihedra</i>	<i>Triaxilina mexicana</i>	<i>Uvigerina corapitana</i>	<i>U. baggi</i>			
2	X																																						
1																																							
3																																							
8																																							
1																																							

Table 6. (Continued).

<i>U. gallowayi</i>	<i>U. cf. U. gallowayi</i>	<i>U. gallowayi basicordata</i>	<i>U. hispida</i>	<i>U. hispidocostata</i>	<i>U. huonisi</i>	<i>U. incilis</i>	<i>U. peregrina</i>	<i>U. rustica</i>	<i>U. senticosa</i>	<i>U. sequendoensis</i>	<i>Vulvulinera glabra</i>	<i>Vulvulina spinosa</i>	Foraminiferal		Biofacies							
													Number	Diversity	IS	OS	UB	O <sub>2</sub>	UMB	LMB	LB	A
															= inner shelf	= outer shelf	= upper bathyal	= oxygen-minimum zone	= upper middle bathyal	= lower middle bathyal	= lower bathyal	= abyssal
									22				310	50	4	32	21	1	24	5	4	—
									1				121	13	4	—	2	—	5	49	—	12
													4	17	—	5	5	2	2	55	2	5
		48											134	33	4	3	18	4	12	22	22	2
		5					8						145	49	1	6	16	3	17	31	1	1
		20					3						103	31	—	46	5	—	18	15	—	1
		10			1	28	1						316	29	1	68	6	1	14	2	—	1
						37				1			8	6	—	—	12	—	25	25	13	—
													45	22	—	5	2	—	36	25	—	9
		7					2						4	4	—	—	25	—	25	—	—	—
							25						16	11	—	6	6	6	13	25	6	—
		25					8	1	1				121	52	3	14	5	2	26	14	4	2
		8											5	5	—	—	—	—	40	—	—	—
		15											46	10	—	—	—	7	26	—	—	—
													24	7	—	—	—	4	4	—	—	—
													14	5	—	—	—	50	7	—	—	—
													103	27	—	2	9	—	18	9	—	2
							7	5					197	62	2	9	12	—	25	8	1	2
							5						440	79	1	5	8	—	16	16	4	1
							1	4	4				1	1	—	—	—	100	—	—	—	—
		11											9	8	—	—	—	11	22	11	11	
													12	7	—	8	—	16	42	—	16	—
													39	20	—	3	8	—	29	—	—	5
													5	4	—	—	40	—	20	—	—	20
													3	1	—	—	—	—	—	—	—	—
													13	9	8	—	38	—	8	8	—	—
													33	7	—	—	9	—	3	24	—	—
													1	1	—	—	—	—	—	—	—	—
													55	24	—	4	2	2	18	15	—	2
													110	27	3	3	40	—	18	19	1	—
													590	71	1	29	6	—	8	14	6	1
		1				21	6	X	3	4	X	X	430	68	4	10	9	1	11	24	1	1
							1						162	35	1	4	10	—	19	16	—	4
		4											194	47	—	3	27	—	21	12	2	—
		6					13	2					229	48	—	7	13	—	31	7	—	2
		1					4	X					216	60	2	7	13	1	15	15	2	1
		2					3	2					86	43	—	4	5	1	24	17	—	1
		X					2	2					169	37	—	10	21	2	18	4	1	1
													2	2	—	—	—	—	—	—	—	—
													17	8	—	—	—	—	53	—	—	6
													31	14	—	—	—	6	7	10	—	4
													35	27	—	21	—	—	25	9	—	6
		4					3						285	73	1	8	8	1	24	7	4	1
							X						413	82	—	11	12	1	22	7	1	1



Table 7. Samples barren of benthic foraminifers, Leg 84.

Site 566	Site 569 (Hole 569) (Cont.)
566-5,CC	569-16-1, 98-102
566-6,CC	569-17-1, 47-51
566-6-1, 46-50	569-24-1, 30-34
566-7,CC	569-24,CC
566-8,CC	569-25-3, 20-24
	569-25,CC
Site 567	569-26,CC
567-6-3, 71-75	Site 569 (Hole 569A)
567-6-5, 34-35	
567-6,CC	569A-2-1, 25-29
567-7-1, 50-52	569A-4,CC
567-7,CC	569A-6,CC
	569A-7,CC
Site 568	569A-9,CC
	569A-10-1, 0-5
568-22-5, 32-36	
568-23-1, 92-96	
568-23-3, 92-96	Site 570
568-24-1, 120-134	
568-24-6, 130-134	570-36-2, 48-50
568-25-6, 51-55	570-36,CC
	570-37-1, 88-90
Site 569 (Hole 569)	570-37-1, 28-30
	570-37,CC
569-8,CC	570-38-1, 55-57
569-9,CC	570-38,CC
569-12-3, 20-24	570-39-1, 70-76
569-12-5, 20-24	570-39,CC
569-15-1, 104-108	

Note: Sample intervals in cm.

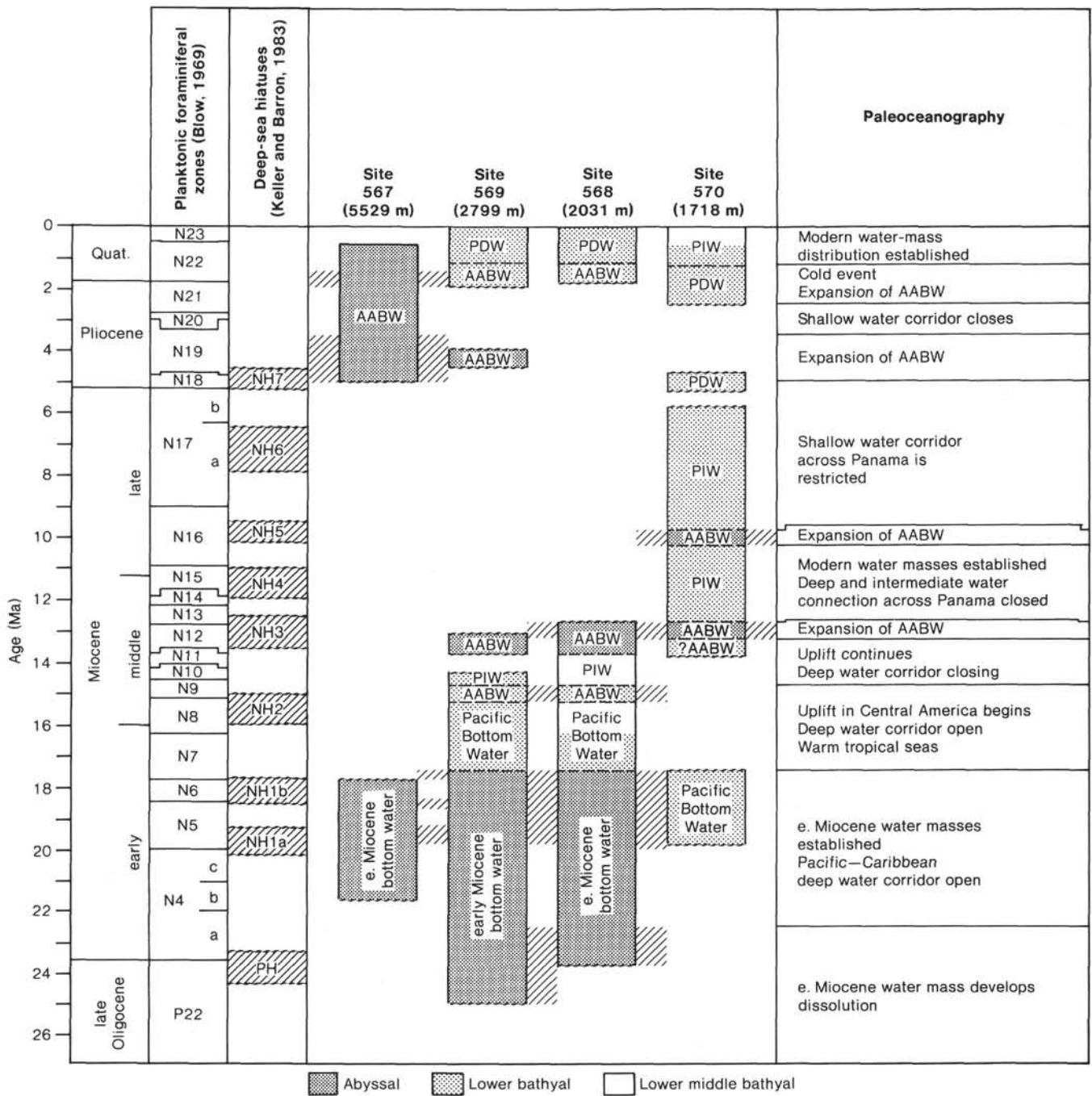


Figure 8. Biofacies, water mass, and paleoceanographic interpretations of DSDP Leg 84 sites. DSDP Leg 84 sites and the deep-sea hiatuses of Keller and Barron (1983) are plotted against the planktonic time scale as in Figure 3. Biofacies and water masses which were interpreted from the benthic foraminiferal analysis are shown in each of the site columns. Dissolution intervals are indicated by hachure lines. Events related to paleoceanography are summarized in the last column and discussed in the text.

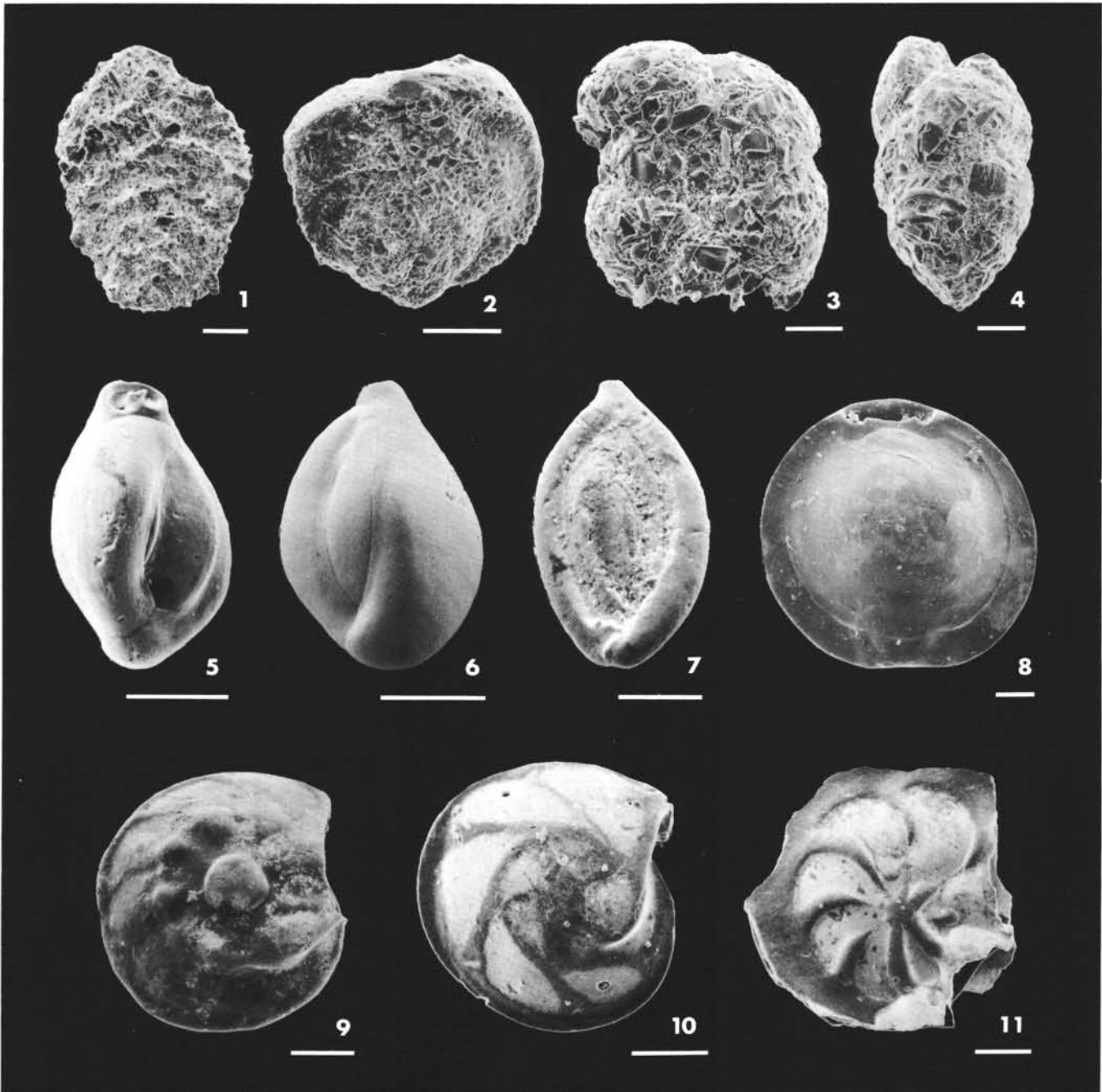


Plate 1. (Scale bars = 100  $\mu\text{m}$ .) 1. *Textularia leuzingeri* Cushman and Renz, Sample 568-35-5, 97-99 cm. 2, 9. Sample 568-38-1, 80-85 cm, (2) *Vulvulina spinosa* Cushman, (9) *Lenticulina caritae* Bermudez. 3-4. Sample 568-2-1, 80-84 cm, (3) *Alveolophragmium crassimargo* (Norman), (4) *Karriella bradyi* (Cushman). 5, 7, 10-11. Sample 568-41-3, 123-127 cm, (5) *Triloculina trihedra* Loeblich and Tappan, (7) *Sigmoilina tenuis* (Czjzek), (10) *Lenticulina dicampyla* (Franzenau), (11) *Lenticulina iota* (Cushman). 6. *Quinqueloculina venusta* Karrer, Sample 570-1, CC. 8. *Pyrgo depressa* (d'Orbigny), Sample 570-4-1, 40-44 cm.

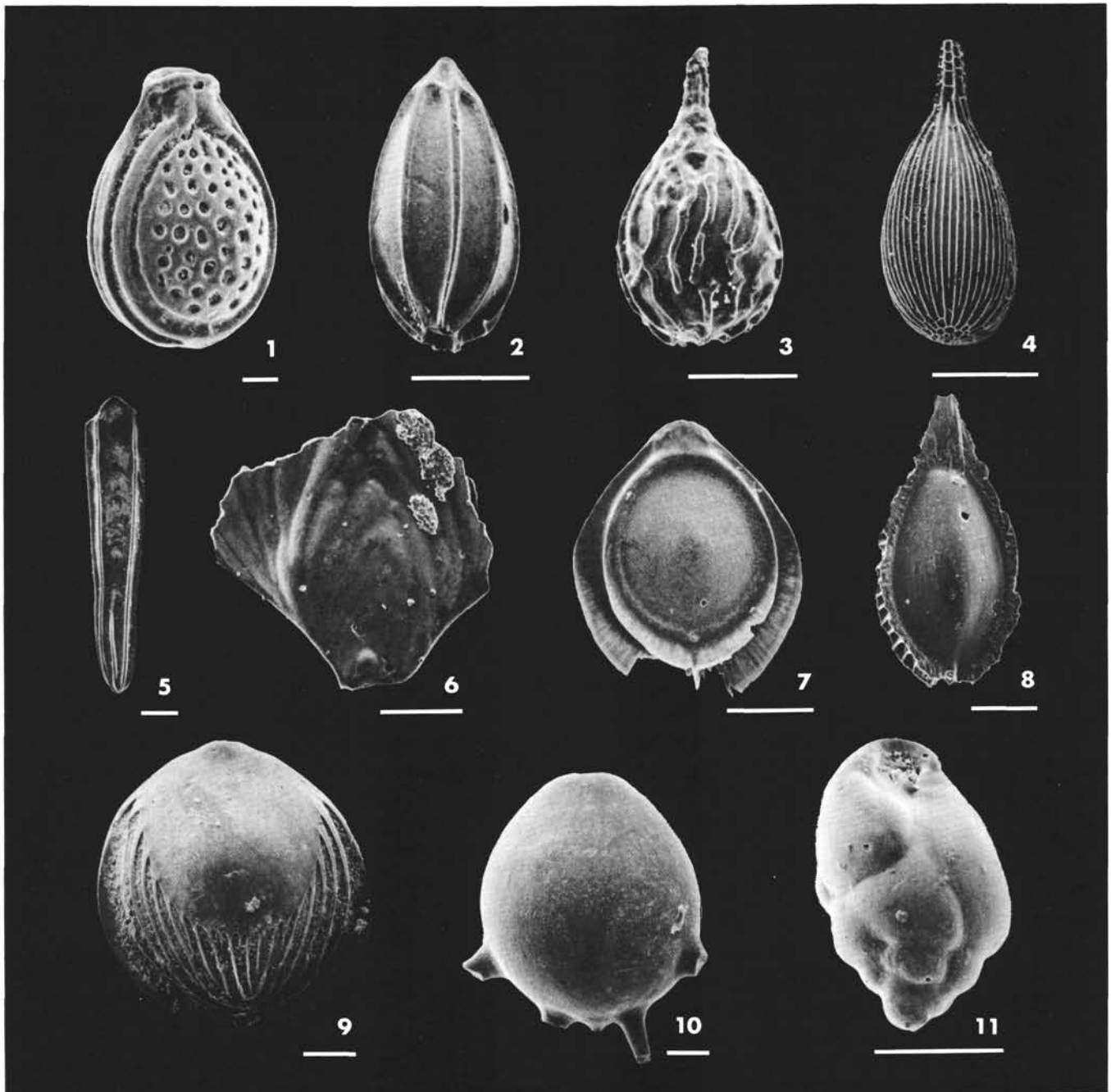


Plate 2. (Scale bars = 100  $\mu\text{m}$  unless otherwise indicated.) 1, 3, 10. Sample 570-5, CC, (1) *Lagena castrensis* Schwager, bar = 30  $\mu\text{m}$ , (3) *Lagena* sp., (10) *Fissurina staphylleraria* Schwager. 2, 4, 8-9, 11. Sample 570-4-1, 40-44 cm, (2) *Lagena costata* (Williamson), (4) *Lagena striata* (d'Orbigny), (8) *Fissurina subformosa* Parr, (9) *Fissurina* cf. *F. kugleri* (Cushman and Stainforth), (11) *Buliminella curta* Cushman, bar = 3  $\mu\text{m}$ . 5. *Plectofrondicularia californica* Cushman and Stewart, Sample 568-39-3, 84-88 cm. 6. *Plectofrondicularia vaughani* Cushman, Sample 568-41-3, 123-127 cm. 7. *Fissurina alveolata* (Brady), Sample 568-2-1, 80-84 cm.

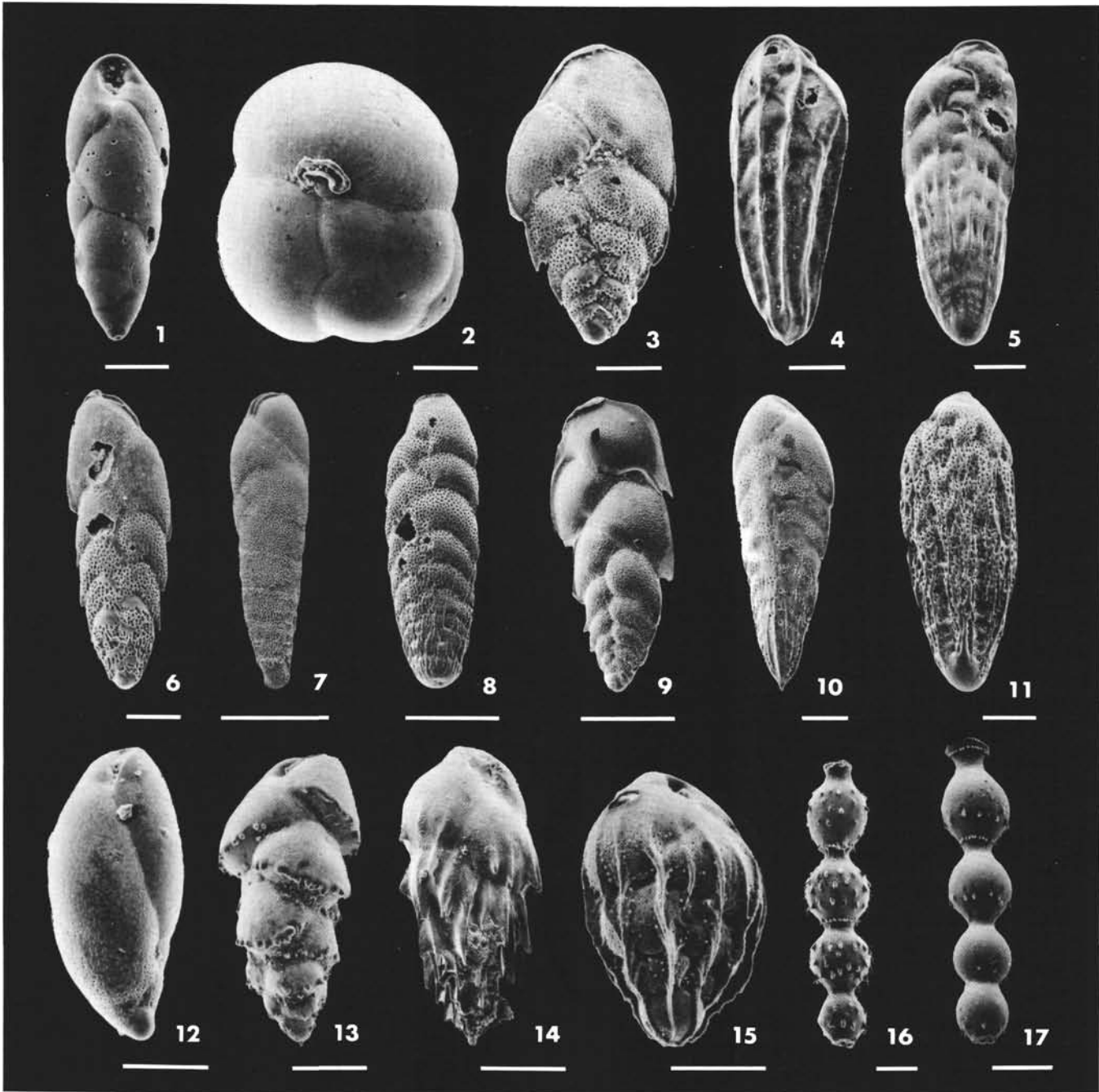


Plate 3. (Scale bars = 100  $\mu\text{m}$  unless otherwise indicated.) 1, 4, 6, 8, 13. Sample 570-5, CC, (1) *Buliminella subfusiformis* Cushman, (4) *Bolivina bicostata* Cushman, (6) *Bolivina bradyi* Asano, (8) *Bolivina plicata* d'Orbigny of Resig, bar = 300  $\mu\text{m}$ , (13) *Bulimina denudata* Cushman and Parker. 2, 17. Sample 568-41-3, 123-127 cm, (2) *Sphaeroidina bulloides* d'Orbigny, (17) *Stilostomella gracilis* (Palmer and Bermudez). 3, 7, 11-12, 14. Sample 570-4-1, 40-44 cm, (3) *Bolivina beyrichi* Reuss, *Bolivina foraminata* Stewart and Stewart, bar = 300  $\mu\text{m}$ , (11) *Bolivina subadvena sulpherensis* Cushman, (12) *Cassidulinoides bradyi* (Norman), (14) *Bulimina mexicana* Cushman, bar = 300  $\mu\text{m}$ . 5. *Bolivina* cf. *B. bicostata* Cushman, Sample 570-1, CC. 9-10. Bar = 300  $\mu\text{m}$ . Sample 570-2-3, 20-24 cm, (9) *Bolivina pseudobeyrichi* Cushman, (10) *Bolivina semiperforata* Martin. 15. *Bulimina alazaensis* Cushman, Sample 568-38-1, 80-85 cm. 16. *Stilostomella subspinoso* (Cushman), Sample 568-38, CC.

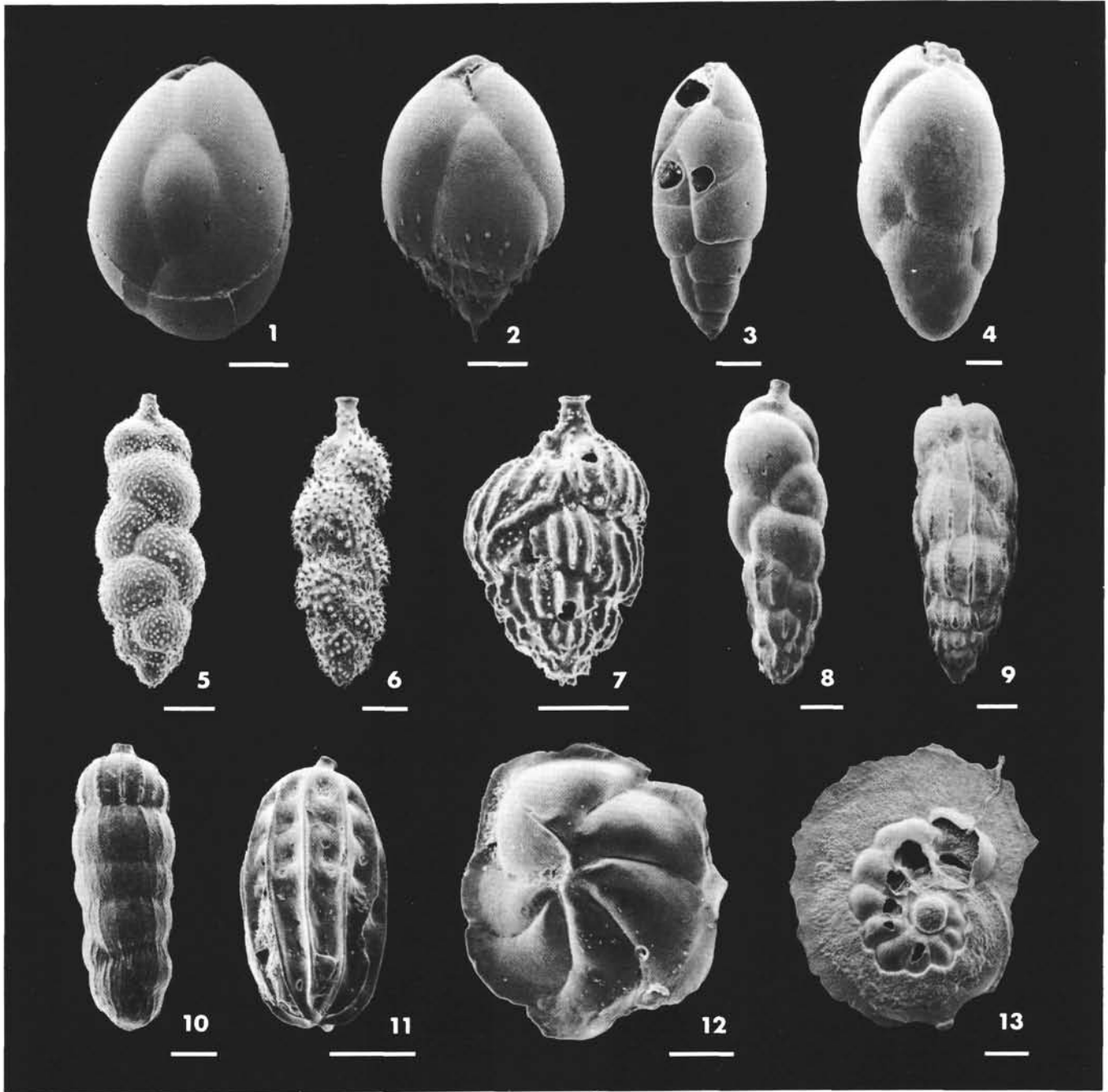


Plate 4. (Scale bars = 100  $\mu$ m unless otherwise indicated.) 1-2, 6, 8, 12. Sample 570-4-1, 40-44 cm, (1) *Globobulimina pacifica* (Cushman), (2) *Globobulimina barbata* Cushman, (6) *Uvigerina rustica* Cushman and Edwards, (8) *Uvigerina* sp., (12) *Epistominella smithi* (Stewart and Stewart). 3. *Praeglobobulimina affinis* (d'Orbigny), Sample 568-2-1, 80-84 cm. 4-5, 13. Sample 570-5, CC, (4) *Praeglobobulimina affinis* (d'Orbigny), (5) *Uvigerina hispida* Schwager, (13) *Laticarinina pauperata* (Parker and Jones), bar = 300  $\mu$ m. 7. *Uvigerina* sp., Sample 568-39-3, 82-84 cm. 9. *Siphogenerina basispinata* Cushman and Jarvis, Sample 568-37-3. 10. *Siphogenerina multicostata* Cushman and Jarvis, Sample 568-39-3, 84-88 cm. 11. *Siphogenerina transversa* Cushman, bar = 300  $\mu$ m, Sample 568-41-3, 123-127 cm.

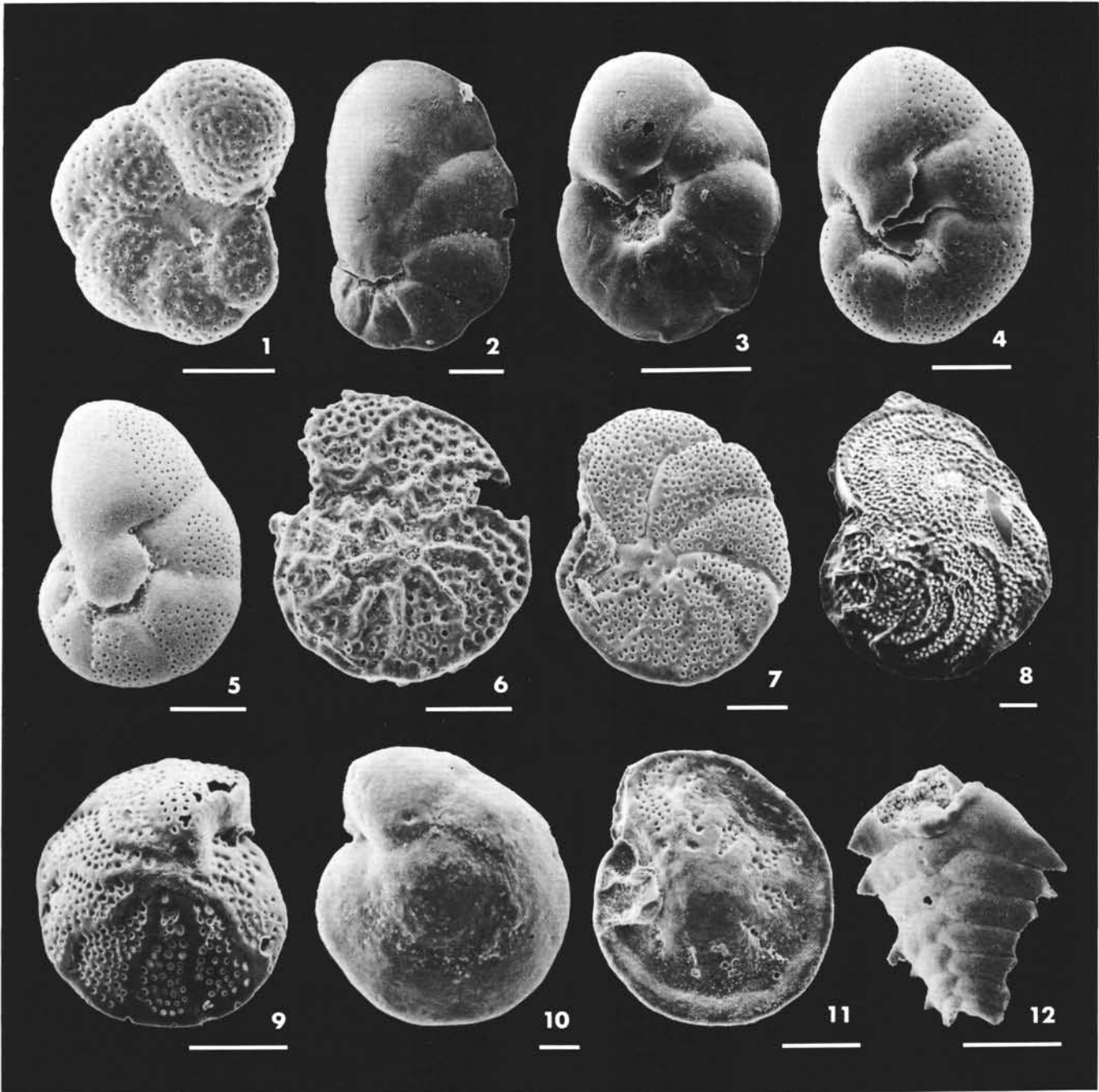


Plate 5. (Scale bars = 100  $\mu\text{m}$  unless otherwise indicated.) 1-3. Sample 570-4-1, 40-44 cm, (1) *Rosalina columbiensis* (Cushman), (2) *Cancris sagra* (d'Orbigny), (3) *Cancris inflatus* (d'Orbigny), bar = 300  $\mu\text{m}$ . 4, 6-7, 12. Sample 570-5, CC, (4) *Valvulineria glabra* Cushman, (6) *Planulina exorna* Phleger and Parker, (7) *Planulina ornata* (d'Orbigny), (12) *Suggrundia eckisi* Natland. 5. *Valvulineria inaequalis* (d'Orbigny), Sample 570-2-3, 20-24 cm. 8-9. Sample 568-41-3, 123-127 cm, (8) *Planulina renzi* Cushman and Stainforth, (9) *Cibicides spiralis* Natland. 10. *Cibicides* sp., bar = 30  $\mu\text{m}$ , Sample 570-1, CC. 11. *Cibicides yaqatensis* Bermudez, Sample 568-39-3, 84-88 cm.

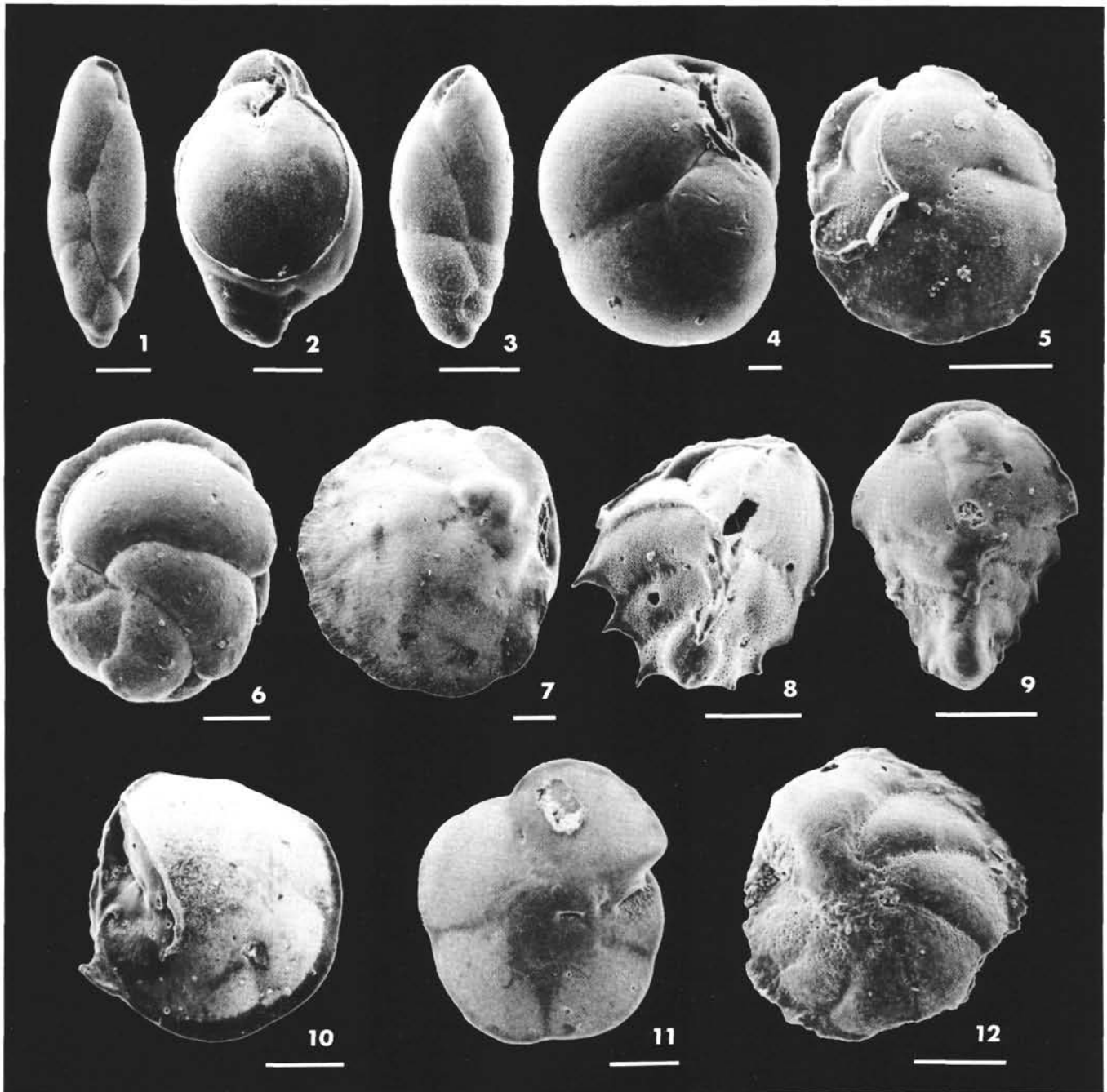


Plate 6. (Scale bars = 100  $\mu\text{m}$  unless otherwise indicated.) 1, 11. Sample 568-2-1, 80–84 cm, (1) *Fursenkoina bramletti* (Galloway and Morrey), (11) *Oridorsalis umbonatus* (Reuss). 2–3, 5–7, 9. Sample 570-4-1, 40–44 cm, (2) *Fursenkoina cornuta* (Cushman), (3) *Fursenkoina rotundata* (Parr), (5) *Cassidulina limbata* Cushman and Hughes, (6) *Cassidulina* cf. *C. delicata* Cushman, (7) *Cassidulina laevigata* d'Orbigny, (9) *Ehrenbergina compressa* Cushman. 4, 8, 10, 12. Sample 568-41-3, 123–127 cm, (4) *Cassidulina californica* Cushman and Hughes, bar = 30  $\mu\text{m}$ , (8) *Ehrenbergina bradyi* Cushman, (10) *Alabama polita* Becker and Dusenbury, (12) *Osangularia culteri* (Parker and Jones).