13. CENOZOIC PLANKTONIC FORAMINIFERA FROM ANTARCTIC DEEP-SEA SEDIMENTS, LEG 28, DSDP

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INTRODUCTION

In general, the degree of our knowledge of the stratigraphic distribution of planktonic foraminifer assemblages and their species composition is an inverse function of geographic latitude. Whereas the lower latitude faunas have been extensively studied, those of the high-latitude oceanic regions, especially around Antarctica, have remained virtually unknown. This has been due mainly to the inaccessibility of older sediments to piston coring and other sampling techniques prior to the Deep Sea Drilling program. Leg 28, the first venture of *Glomar Challenger* into extremely high southern latitudes, thus promised to be a unique opportunity to study the history of high-latitude planktonic foraminifers and how it has been influenced by the associated environmental parameters of low temperature and high nutrient levels and associated high phytoplankton productivity. Another aim would be to determine how long these environmental conditions have existed and if they have changed with time.

The results were, unfortunately, somewhat disappointing. Foraminifers occur sporadically in the Antarctic sections cored during Leg 28; where present, they make up a minor portion of the microfossil assemblage and are of very low diversity. In addition, most assemblages show the effects of carbonate dissolution. The drill sites in the Ross Sea, which might have been expected to yield less dissolved assemblages, are mostly barren of planktonic foraminifers, apparently for paleoenvironmental reasons.

Nevertheless, two general conclusions seem warranted on the basis of Leg 28 results. (1) Antarctic foraminifer assemblages have had a characteristically polar aspect since the Oligocene. That is, they are of extremely limited diversity, and some of the species present are morphologically similar to *Globigerina pachyderma* (Ehrenberg), which is presently the dominant species in high-latitude waters. (2) The major change in planktonic foraminifer ecology in the Antarctic area took place at or near the Eocene-Oligocene boundary. This is evidenced by the recovery of a diverse upper Eocene assemblage at Hole 267B, at 59° south latitude which is in marked contrast to the sparseness of younger faunas. This change is most likely related to the initiation of glacial conditions on Antarctica (see General Synthesis, Hayes and Frakes, this volume).

Leg 28 drill sites in the Antarctic are shown in Figure 1, and site data are given in Table 1. Site 264, the first Leg 28 site, was drilled on the Naturaliste Plateau, close to port. It was primarily a test site to check the operation of the drill rig and is not included in the present report; a discussion of the planktonic foraminifers at this site can be found in the site report for Site 264 (Chapter 2), and in the report by Kennett (this volume). A distribution chart of planktonic foraminifers at this site is given in Table 2 of the present report.

Distribution charts of planktonic foraminifers are given for Sites 265 and 266 in Tables 3 and 4, respectively. Occurrence data for the other sites (267-274) are given at the end of this chapter in the form of species lists. Selected species are illustrated in Plates 1 and 2.

COMPARISON TO PREVIOUS WORK

Tertiary foraminifer assemblages from the subantarctic Pacific Ocean (north of the Antarctic Convergence) have been described by Riedel and Funnell (1964) and Margolis and Kennett (1971). Margolis and Kennett have, in addition, constructed a paleoenvironmental curve for the Southern Ocean based on trends in foraminifer diversity, expressed as the number of species present. Their results indicate low diversity in the Oligocene which increases to a maximum in the middle Miocene. Although the assemblages seen in the present study are in general less diverse than those from north of the Antarctic Convergence, they exhibit a probable identical diversity pattern. The lower Oligocene assemblage consists of a single species. This increases to two higher in the Oligocene, two to occasionally four in the lower Miocene, and four in the middle Miocene. Upper Miocene assemblages (not recorded by Margolis and Kennett, 1971) have mostly been destroyed by dissolution, but the two samples from which foraminifers were recovered contained one species each. Pliocene assemblages in general are monospecific, while the Pleistocene shows two diversity peaks, one in the lower Pleistocene and one in the upper Pleistocene.

SUMMARY OF ANTARCTIC FAUNAS BY AGE

The following section outlines the general nature of the recovered faunas by age. Not surprisingly, a number of the species seen in Antarctic sediments were originally described from Tertiary rocks of New Zealand. Except in a broad sense, the planktonic foraminifers were not found useful for age determination; for Leg 28 reliance was placed on the siliceous fossil groups (radiolarians, diatoms, and silicoflagellates).

Eocene (Determinations by P.N. Webb)

An upper Eocene planktonic fauna was recovered in Core 10 of Hole 267B. It includes *Chiloguembelina cubensis* (Palmer), *C. martini* (Pijpers), *Catapsydrax echinatus* Bolli, *Globigerina* (*Subbotina*) *linaperta* Finlay, *G.* (*S.*) *angiporoides* Hornibrook, *Globorotalia* (*Turborotalia*) spp., *?Globigerapsis index* (Finlay), and a single broken specimen of *Hantkenina* sp. (perhaps *H.*

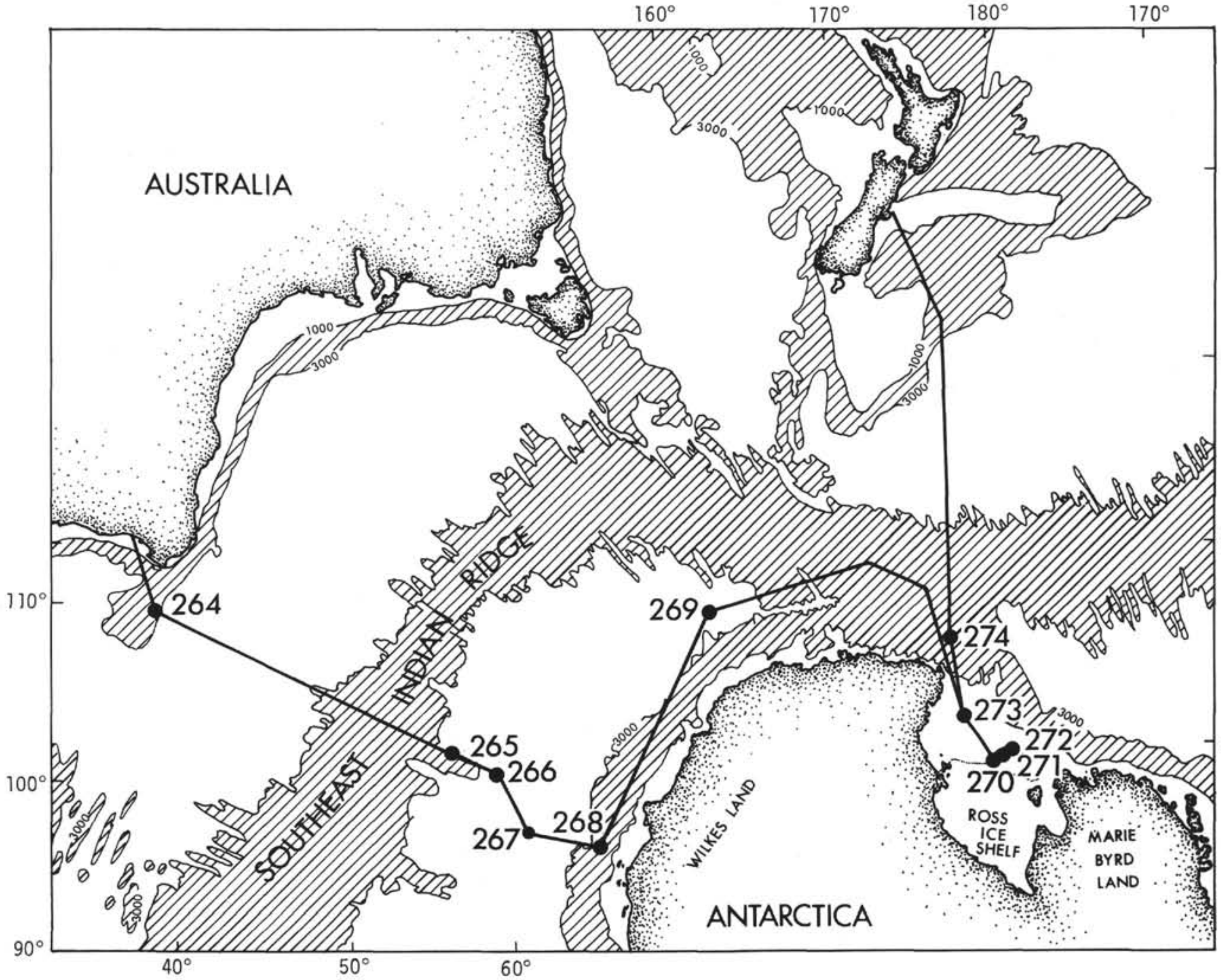

Figure 1. *Location map of sites drilled during DSDP Leg 28.*

alabamensis compressa Parr). This fauna is notable for its high diversity as compared to Oligocene and younger assemblages.

TABLE 1
Site Data

Site	Latitude	Longitude	Water Depth (m)
264	34°58.13'S	112°02.68'E	2873
265	53°32.45'S	109°56.74'E	3582
266	56°24.13'S	110°06.70'E	4173
267, 267A	59°15.74'S	104°29.30'E	4564
267B	59°14.55'S	104°29.94'E	4539
268	63°56.99'S	105°09.34'E	3544
269	61°40.57'S	140°04.21'E	4285
270	77°26.48'S	178°30.19'W	634
271	76°43.27'S	175°02.86'W	554
272	77°07.62'S	176°45.61'W	629
273	74°32.29'S	174°37.57'E	495
274	68°59.81'S	173°25.64'E	3326

Oligocene

The characteristic element of Oligocene Antarctic assemblages is *Globigerina angiporoides* Hornibrook. As pointed out by Hornibrook (1965) in the original description of this species, there is considerable variation in the size and shape of the final chamber. In the present specimens, it ranges in degree of inflation from a bulla to a normal, full-sized chamber (see Plate 1). In addition, the shape of the aperture ranges from a low slit (in the majority of specimens) to a high arch.

G. angiporoides was found in Cores 5 and 6 of Site 267, and Core 21 of Site 274. In Core 5 of Site 267 *Catapsydrax dissimilis* (Cushman and Bermudez) was also found. This is the only other species recorded from Leg 28 Oligocene assemblages. Although there is no way to determine the degree of dissolution these assemblages have undergone, the specimens appear to be fairly well preserved (see Plate 1). Thus, the low diversity probably reflects original faunal composition.

Miocene

Lower Miocene

Lower Miocene assemblages are slightly more diverse than those of the Oligocene. Their characteristic element

TABLE 2
Distribution of Planktonic Foraminifers at Site 264

SAMPLE INTERVAL	75-77	26-28	127-129	126-128	126-128		122-125	126-128	32-34	126-128	18-20	76-78	26-28	26-28		76-78	126-128	26-28	126-128	71-73	26-28	75-77
SECTION	1	2	3	5	6	CC	1	2	3	3	4	4	5	6	CC	1	1	2	2	3	4	4
CORE	1	1A	1A	1A	1A	1A	2A	2A	2A	2A	2A	2A	2A	2A	2A	2	2	2	2	2	2	2
SPECIES																						
Globigerina nepenthes																			X		X	X
G. bulbosa	X	X			X	X		X	X	X	X		X	X	X		X	X	X	X	X	
G. digitata																			X			
G. cf. *G. falconensis*	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X				
G. pachyderma (primitive)											X				X			X	X	X		
G. pachyderma (advanced)			X																			
G. bulloides	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
G. incisa					X	X	X	X	X	X	X	X		X			X	X				cf.
G. woodi							X		X	X	X						X	X				
G. apertura							X				X	X	X									
Globigerinoides mitrus																				X		
G. trilobus	X	X			X	X						X			X	X	X		X			
G. extremus															X	X	X	X	X	X	X	
G. gomitulus																			X	X	X	X
G. sacculifer														X			X		X			
G. ruber	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X					X
G. conglobatus					X																	
G. obliquus												X										
Sphaeroidinella seminulina															X		X		X		X	X
Globigerinella obesa					X	X													X			
G. siphonifera	X	X			X	X			X	X							X					
Orbulina universa	X					X		X			X			X					X	X	X	
Globorotalia miozea conoidea																			X	X	X	X
G. sphericomiozea																X	X		X	X		X
G. conomiozea																				X		X
G. puncticulata									X		X	X	X		X		X	X			X	
G. cf. *G. triangula*															X	X	X					
G. triangula				cf.	X	X	X	X	X	X	X	X	X	X	X							
G. inflata	X	X	X	X	X	X	X	X	X	X	X											
G. crassaformis s.l.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	cf.	cf.
G. crassaformis s.s. (keeled)	X	X	X	X	X	X	X	X	X	X	X	X	X	X								
G. tosaensis								X	X			X										
G. truncatulinoides	X	X	X	X	X	X	cf.		X	X												
G. crassula			X				X	X	X	X	X	X	X									
G. hirsuta							cf.															
G. margaritae																			X	X	X	
G. scitula	X		X	X	X	X		X	X	X	X		X	X	X							
G. bononiensis										X	X											
G. limbata							X		X	X	X				X		X					X
G. menardii	X		X		X						X								X	X	X	
G. tumida										X												
G. acostaensis (cf. *G. pachyderma*)	X	X		X		X	X	X	X				X	X			X	X	X	X		
G. pseudopima					X					X	X											
Globoquadrina dehiscens																						X
G. altispira															X	X	X					
G. conglomerata															X							
Globoquadrina dutertrei	X				X	X		cf.														
Pulleniatina praecursor				X	X		X															
Globigerinita glutinata	X	X	X	X	X	X	X	X			X			X	X		X	X	X			
SERIES	PLEISTOCENE						PLIOCENE															

TABLE 3
Distribution of Planktonic Foraminifers and Other Components of the Coarse Fraction at Site 265

SAMPLE INTERVAL	105-107	115-117	115-117	144-146	43-45	68-70	70-72	100-102	85-87	102-105	80-82	110-112	120-122	21-23	40-42	100-102	68-70	40-42	40-42	40-42	40-42	30-32	30-32	30-32	30-32	30-32	30-32
SECTION	2	3	4	6	3	4	5	6	2	1	2	3	4	1	2	3	1	2	3	4	5	6	2	3	4	2	3
CORE	1								2	3				4			5						6			7	
Globigerina cf. *G. bulloides*																?X											
G. bulloides	X	X		X				X						X		X	X				X						
Globigerina sp.								X																			
G. woodi																											
G. pachyderma	X	X		X		X		X						X	X	X	X		X		X	X				X	X
G. megastoma								X													X						
Globorotalia continuosa																											
G. acostaensis																											
G. conica																											
G. puncticulata														X	X		X										
G. inflata		X		X				X						X													
G. crassaformis																	X										
G. truncatulinoides								X																			
G. scitula								X																			
Globigerinita uvula								X													X	X					
G. glutinata				X				X																			
Turborotalita humilis								X																			
MINERAL GRAINS	Tr	-	-	-	-	-	Tr	-	Tr?	-	Tr	Tr	-	-	C	-	-	-	-	R	-	Tr	-	R	Tr	R	-
SILICEOUS FOSSILS	A	A	A	A	A	A	A	C	A	A	A	A	F	F	A	C	F	A	A	F	R	C	C	F	F	F	F
PLANKTONIC FORAMS	F	C	-	R	-	R	-	A	-	-	-	-	-	A	R	R	A	-	F	-	A	R	-	-	-	F	Tr
BENTHONIC FORAMS	-	-	-	-	Tr	Tr	-	Tr	-	-	-	Tr	-	Tr	-	-		-	-	-	-	-	-	-	-	R	Tr

*probably contamination

is *Catapsydrax dissimilis* (Cushman and Bermudez), which ranges nearly to the top of the lower Miocene. *C. dissimilis* is accompanied through most of the lower Miocene by *Catapsydrax unicavus* Bolli, Loeblich, and Tappan. The latter disappears at a level somewhat lower than the last occurrence horizon of *C. dissimilis*. Other species that occur sporadically in the lower Miocene are *Globorotalia zealandica* Hornibrook, *Globigerina* sp. cf. *G. woodi* Jenkins, *Globorotaloides suteri* Bolli, and *Globigerina* sp. cf. *G. bulloides* d'Orbigny.

It should be noted that *C. dissimilis* seems to have an extended stratigraphic range in the Antarctic as compared to the lower latitude areas from which it was originally described. In warm-water sequences its upper limit is in the mid-lower Miocene while at Site 266 it ranges to nearly the top of the lower Miocene. This seems reasonable in view of its cosmopolitan nature and tolerance for cold-water masses. This has significance in that the *C. dissimilis* last occurrence datum is common to several zonal schemes. On the basis of the present results, however, it appears that this datum may slope stratigraphically upward toward the poles.

Middle Miocene

Middle Miocene assemblages were recovered at Sites 265 and 266. The species composition differs at the two sites. This is probably a result of age difference, as the foraminifer-bearing sediments at Site 265 are younger than those at Site 266, according to the siliceous fossils. However, paleoenvironment may also be a factor since the sites have a north-south separation of about 260 km.

The common element in both assemblages is *Globigerina woodi* Jenkins. Site 266, the higher latitude site, and the older assemblage, contains, in addition, a species of *Globorotalia* that most closely resembles *G. miozea* Finlay, but is more compact. The younger middle Miocene of Site 265 is more diverse, containing in addition to *G. woodi*, *Globigerina bulloides*, *Globigerinita uvula* (Ehrenberg), *Globorotalia conica* Jenkins, *Globorotalia continuosa* Blow, and *Globigerina* sp.

Upper Miocene

Upper Miocene sediments were recovered at Sites 265 and 266. At Site 265 the upper Miocene is represented by only one sample in which a specimen of *Globigerinita uvula* was found. At Site 266, the upper Miocene, though thicker, is mostly barren; a specimen of *Globigerina* similar to *Globorotalia continuosa* was found in one sample. The scarcity of foraminifers in the upper Miocene can most likely be attributed to calcite dissolution.

Pliocene

Pliocene assemblages were seen only at Site 265. Except for a single occurrence of *Globorotalia puncticulata* Deshayes, the fauna consists solely of *Globigerina pachyderma*, the species which presently lives in this area.

TABLE 3 – *Continued*

			8				9						10					13			14					15						16				
4	5	6	2	3	4	5	1	2	3	4	5	6	1	2	3	4	5	1	2	3	1	2	3	4	6	2	3	4	5	6	CC	1	3	4	5	6
30-32	40-42	40-42	40-42	35-37	30-32	30-32	40-42	40-42	30-32	30-32	30-32	30-32	30-32	30-32	30-32	30-32	30-32	3-5	142-144	133-135	58-60	42-44	60-62	122-124	122-124	70-74	60-64	60-64	30-34	60-64		50-54	10-14	90-9	50-54	60-64
																											X	X	X	X	X		X	X	X	X
	X																									X								X		
																											X									
																										X										
X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X																
	X	X																													X					
																											X							X	X	
																																		X	X	
																											X	X			X					
X	X	X	X	X	X	X														X												X*				
	X																																			
	X																								X			X			X					
-	-	-	-	-	-	R	-	R	-	R	Tr	-	-	-	Tr	F	R	-	Tr	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-
C	R	R	C	A	A	A	R	F	F	C	F	C	A	C	A	C	A	A	A	A	C	R	R	R	A	A	A	A	A	A	A	A	A	A	A	A
A	A	A	C	F	A	A	A	F	F	C	-	-	R	A	F	C	F	F	R	F	-	-	-	-	Tr	C	C	C	C	F	C	Tr	C	C	C	R
R	R	R	R		R	F	F	R	R	F	-	-	Tr	R	-	R	-	R	R	F	-	-	-	-	-	R	F	F	F	F	F	Tr	F	F	F	F

Pleistocene

The Pleistocene assemblages of Site 265 are on the whole more diverse than those of the Pliocene. Two diversity peaks occur: one in the middle lower Pleistocene, and another in the middle upper Pleistocene (Table 3). Found along with *G. pachyderma*, the most common species, are *G. bulloides*, *Globigerinita uvula*, *G. quinqueloba* Natland, and *Globorotalia inflata* (d'Orbigny). In addition, lower latitude forms such as *Globigerinita glutinata* (Egger), *Turborotalita humilis* (Brady), *Globorotalia scitula* (Brady), and *G. truncatulinoides* (d'Orbigny) occur in the mid-upper Pleistocene diversity peak, indicating an expansion of mid-latitude water masses at this time. This foraminifer diversity peak occurs in the lower part of the *Emiliania huxleyi* nannofossil Zone and thus is somewhat younger than 170,000 y. (Gartner, 1973). Its correlative may be the interglacial X Zone of Ericson et al. (1961), indicating a significant expansion of warmer water masses at this time.

At Site 266, only three Pleistocene samples contain planktonic foraminifers, and in each case the only species present is *G. pachyderma*.

OCCURRENCE OF FORAMINIFERS AT SITES 267-274

The following isolated occurrences of planktonic foraminifers were noted at Sites 267 through 274. Insofar as could be determined on the basis of core-catcher samples, and other samples which were reported by the shipboard sedimentologists to contain carbonate, the remainder of the sections are barren. Some of these occurrences represent the processing of up to 0.5 kg of sediment and testify to the general scarcity of foraminifers in circum-Antarctic deep-sea sediments. It would be hoped that future drilling in a shallower area such as the Kerguelen Plateau might overcome the dissolution problem and add materially to our knowledge of Antarctic planktonic foraminifers.

Site 267

Core 5, CC: *Globigerina angiporoides*, *Catapsydrax dissimilis* (Age: mid-Oligocene)

Core 6, CC: *Globigerina angiporoides* (Age: mid-Oligocene)

Core 10B, CC: *Chiloguembelina cubensis* (Palmer), *C. martini* (Pijpers), *Catapsydrax echinatus* Bolli, *Globigerina (Subbotina) linaperta* Finlay, *G. (S.) angiporoides* Hornibrook, *Globorotalia (Turborotalia)* spp., *?Globigerapsis index* (Finlay), and a single broken specimen of *Hantkenina* sp. (perhaps *H. alabamensis compressa* Parr). (Determinations by P.N. Webb). (Age: upper Eocene)

Site 268

Core 1: *Globigerina pachyderma* (Age: Quaternary)

Core 8, CC: *Catapsydrax dissimilis*, *C. unicavus* (Age: lower Miocene)

TABLE 4
Distribution of Planktonic Foraminifers and Other Components of the Coarse Fraction at Site 266

Core	Section	Sample Interval	*Globigerina pachyderma*	*G.* sp.	*G. woodi*	*G.* cf. *G. bulloides*	*G.* cf. *G. ampliapertura*	*Globorotalia* cf. *G. siakensis*	*G. zealandica*	*Catapsydrax unicavus*	*C. dissimilis*	*Globorotaloides suteri*	Mineral Grains	Siliceous Fossils	Planktonic Forams	Benthonic Forams	Incertae Sedis*	Series
1	1	90-92											F	A	-	-	-	Pleistocene
	2	110-112											-	A	-	Tr	-	Pleistocene
	3	100-102											Tr	A	-	-	-	Pleistocene
	4	120-122	X										-	A	-	-	-	Pleistocene
2	2	110-112	X										-	C	-	R	-	Pleistocene
	3	110-112	X										C	A	-	-	-	Pleistocene
4	2	110-112											-	A	-	-	-	Pleistocene
	3	110-112											Tr	A	-	Tr	-	Pleistocene
	4	100-102											-	A	-	-	-	Pleistocene
5	1	90-92											C	A	-	-	C	Pliocene
	2	110-112											A	A	-	-	F	Pliocene
	3	110-112											C	A	-	Tr	F	Pliocene
	4	110-112											C	A	-	-	C	Pliocene
	5	110-112											A	A	-	-	C	Pliocene
	6	80-82											Tr	A	-	-	C	Pliocene
6	1	80-82											-	A	-	-	R	Pliocene
	2	80-82											-	A	-	-	-	Pliocene
	3	90-92											-	A	-	-	R	Pliocene
	4	90-92											-	A	-	-	-	Pliocene
	5	80-82											Tr	A	-	-	-	Pliocene
	6	90-92											R	A	-	-	-	Pliocene
7	2	80-82											-	A	-	-	-	Pliocene
	3	80-82											R	A	-	-	C	Pliocene
	4	80-82											Tr	A	-	-	A	Pliocene
	5	80-82											R	A	-	-	F	Pliocene
8	1	80-82											-	A	-	-	Tr	Pliocene
	2	80-82											-	A	-	-	F	Pliocene
	3	80-82											Tr	A	-	Tr	C	Pliocene
	4	80-82											Tr	A	-	-	F	Pliocene
	5	80-82											Tr	A	-	-	Tr	Pliocene
	6	80-82											-	A	-	-	-	Pliocene
9	1	110-112											-	A	-	-	-	Pliocene
	2	120-122											R	A	-	-	-	Pliocene
	3	110-112											R	A	-	-	-	Pliocene
	4	120-122											?	A	-	Tr	-	Pliocene
10	1	110-112											-	A	-	-	-	Upper Miocene
	2	90-92											-	A	-	Tr	-	Upper Miocene
	3	120-122											-	A	-	-	-	Upper Miocene
	4	110-112											-	A	-	R	-	Upper Miocene
	5	90-92											Tr	A	-	F	-	Upper Miocene
	6	120-122											-	A	-	R	-	Upper Miocene
11	1	90-92		X									Tr?	A	Tr	Tr	-	Upper Miocene
	2	90-92											?	A	-	-	-	Upper Miocene
	3	60-62											?	A	-	-	-	Upper Miocene
	4	80-82											-	A	-	-	-	Upper Miocene
	5	90-92											-	A	-	-	-	Upper Miocene
	6	90-92											-	A	-	-	-	Upper Miocene

TABLE 4 – *Continued*

Core	Section	Sample Interval	*Globigerina pachyderma*	*G.* sp.	*G. woodi*	*G.* cf. *G. bulloides*	*G.* cf. *G. ampliapertura*	*Globorotalia* cf. *G. siakensis*	*G. zealandica*	*Catapsydrax unicavus*	*C. dissimilis*	*Globorotaloides suteri*	Mineral Grains	Siliceous Fossils	Planktonic Forams	Benthonic Forams	Incertae Sedis*	Series
12	1	70-72											-	A	-	Tr	-	*
	3	23-25											-	A	-	F	-	*
13	1	110-112			X			X	X				-	C	C	R	-	Middle Miocene
	2	90-92			X				X				-	C	C	R	-	Middle Miocene
	3	110-112		X	X			X	X				-	R	A		-	Middle Miocene
	4	90-92							X				-	A	F	F	-	Middle Miocene
	5	92-94							X				-	A	F	F	-	Middle Miocene
	6	90-92							X				-	R	A	R	-	Middle Miocene
14	1	90-92											-	A	-	-	-	Middle Miocene
	2	90-92											-	A	-	-	-	Middle Miocene
	3	90-92											-	A	-	R	-	Middle Miocene
	4	90-92											-	A	-	-	-	Middle Miocene
15	1	80-82											-	A	-	-	-	Middle Miocene
	2	80-82											-	A	-	R	-	Middle Miocene
	3	80-82											-	A	-	F	-	Middle Miocene
16	1	64-66											-	A	-	Tr	-	Middle Miocene
	2												-	A	-	-	-	Middle Miocene
17	1	120-122			cf.				X				-	C	F	R	-	Middle Miocene
	2	90-92		X								cf.	-	A	R	F	-	Lower Miocene
	3	80-82											-	A	-	R	-	Lower Miocene
	4	80-82								X		X	-	A	F	F	-	Lower Miocene
18	1	90-92			cf.				X	X			-	A	C	F	-	Lower Miocene
	2	90-92			cf.	X			X	X			-	A	C	F	-	Lower Miocene
	3	90-92			cf.								-	A	-	F	-	Lower Miocene
	4	90-92											-	A	-	F	-	Lower Miocene
	5	88-90								X			-	A	R	F	-	Lower Miocene
19	1	90-92											-	A	-	-	-	Lower Miocene
	2	90-92								X	X	X	-	A	F	F	-	Lower Miocene
	3	90-92											-	A	-	R	-	Lower Miocene
	4	90-92								X	X		-	A	F	R	-	Lower Miocene
	5	90-92								X			-	A	R	R	-	Lower Miocene
	6	90-92								X	X		-	A	R	R	-	Lower Miocene
20	1	92-94											-	A	-	R	-	Lower Miocene
	2	80-82								X	X	X	-	A	C	R	-	Lower Miocene
	3	80-82								X	X		-	A	C	F	-	Lower Miocene
	4	80-82								X	X		-	A	F	R	-	Lower Miocene
21	1	80-82											-	A	-	Tr	-	Lower Miocene
	2	80-82									?X		-	A	R	F	-	Lower Miocene
	3	80-82								X	X		-	A	R	F	-	Lower Miocene
	4	90-92									X		-	A	R	F	-	Lower Miocene
	5	80-82								X			-	A	R	R	-	Lower Miocene
	6	80-82								X			-	A	F	R	-	Lower Miocene
22	1	80-82				X				X	X		-	A	F	Tr	-	Lower Miocene
	2	80-82				X	X			X			-	F	A		-	Lower Miocene
	3	80-82				X				X			-	A	C	R	-	Lower Miocene
	4	80-82		X		X				X			-	A	R	F	-	Lower Miocene
23	1	30-32							X				A	A	R	Tr	-	Lower Miocene

* UPPER MIOCENE

Core 12, CC: *Catapsydrax unicavus* (Age: lower Miocene)
Core 17, CC: *Catapsydrax unicavus* (Age: upper middle Oligocene)

Site 269

Core 7A, Section 2, 54-56 cm: *Catapsydrax dissimilis* (one broken specimen), *C. unicavus* (Age: Oligocene to lower Miocene)
Core 12A, Section 5, 71-75 cm: *?Globigerina ampliapertura* (probably reworked) (Age: ?Oligocene)

Site 270

Core 28, CC: *Globigerinoides trilobus* (most probably a contaminant from the shipboard laboratory as no other species were found in this sample, and it is highly unlikely that *G. trilobus* has ever lived at the latitude of this site)
Core 34, CC: *Chiloguembelina cubensis* (Age: ?Oligocene)
Core 36, Section 6, 115-223 cm: *Globigerina* sp.
Core 39, Section 6, 24-26 cm: *Globigerina* sp., *Globorotalia* sp.

Site 271

Core 1, CC: *Globigerina pachyderma* (Age: Quaternary)

Site 272

Insofar as could be determined, the sediments at this site are entirely barren of planktonic foraminifers.

Site 273

Core 4, CC: *Globigerina pachyderma*, *G. megastoma* (Age: Quaternary)
Cores 17, 18, CC: Globigerinid, genus and species indet.

Site 274

Core 21, Section 1, 88-92 cm: *Globigerina angiporoides* (Age: Oligocene)
Core 21, Section 3, 69-73 cm: *Globigerina angiporoides* (Age: Oligocene)

REFERENCES

Ericson, D.B., Ewing, M., Wollin, G., and Heezen, B.C., 1961. Atlantic deep-sea sediment cores: Geol. Soc. Am. Bull., v. 72, p. 193-286.

Gartner, S., 1973. Absolute chronology of the late Neogene calcareous nannofossil succession in the equatorial Pacific: Geol. Soc. Am. Bull., v. 84, p. 2021-2034.

Hornibrook, N. de B., 1965. *Globigerina angiporoides* n. sp. from the upper Eocene and lower Oligocene of New Zealand and the status of *Globigerina angipora* Stache, 1865: New Zealand J. Geol. Geophys., v. 8, p. 834-838.

Margolis, S.V. and Kennett, J.P., 1971. Cenozoic paleoglacial history recorded in subantarctic deep-sea cores: Am. J. Sci., v. 271, p. 1-36.

Riedel, W.R. and Funnell, B.M., 1964. Tertiary sediment cores and microfossils from the Pacific Ocean floor: Quart. J. Geol. Soc. London, v. 120, p. 305-368.

PLATE 1

Globigerina angiporoides Hornibrook

Figures 1-3 Site 267, Core 5, CC.
1. ×185.
2, 3. ×187.

Figures 4-6 Site 274, Core 21, Section 3, 69-73 cm.
4. ×188.
5. ×195.
6. ×183.

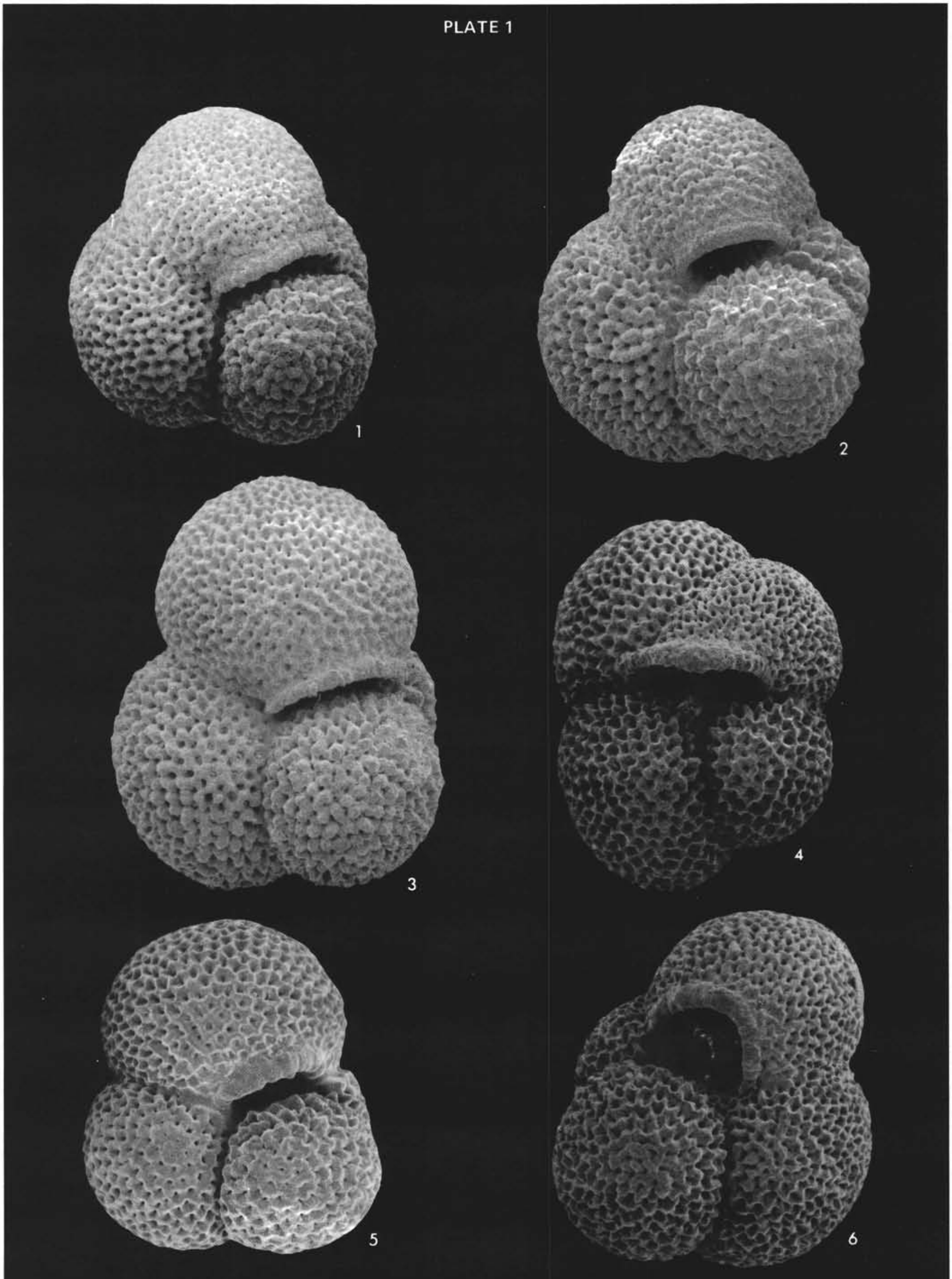
PLATE 1
1
2
3
4
5
6

PLATE 2

Figure 1	*Catapsydrax dissimilis* (Cushman and Bermudez). Site 267, Core 5, CC. ×187.
Figure 2	*Globigerina woodi* Jenkins. Site 265, Core 15, CC. ×195.
Figures 3-5	*Globorotalia conica* Jenkins. Site 265, Core 15, CC. 3. ×212. 4. ×210. 5. ×208.
Figure 6	*Globorotalia puncticulata* (Deshayes). Site 265, Core 7, CC. ×105.
Figure 7	*Globigerina pachyderma* (Ehrenberg). Site 265, Core 7, CC. ×105.
Figure 8	*Globigerina megastoma* Earland. Site 265, Core 7, CC. ×285.
Figure 9	*Globorotalia sp.* Site 265, Core 7, CC. ×235.

PLATE 2