34. CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY—LEG 31, DSDP

C. Howard Ellis, Marathon Oil Company, Littleton, Colorado

INTRODUCTION

Leg 31 of the Deep Sea Drilling Project occupied 13 sites and drilled 17 holes in the western Pacific region from June to August 1973 (Figure 1). Thirteen holes were drilled at nine sites in the Philippine Sea and five holes at four sites in the Sea of Japan. The light microscope was used to examine 825 samples, and from these, 43 critical samples were selected for further study with the scanning electron microscope. The samples range in age from middle or late Eocene to late Pleistocene with continuous core coverage through the Pleistocene, Pliocene, Miocene, and Oligocene.

NANNOFOSSIL ZONATION

The zonation used for nannofossil age determinations throughout this report is that proposed by Bukry (1973a, 1973b) for low latitudes (Figure 2). This scheme was found to apply to most of the assemblages observed in samples from the Philippine Sea. Samples from Sites 294 and 295 in the northern portion of the West Philippine Basin could not be assigned to specific zones because indigenous age-diagnostic nannofossils were not recovered; only sparse reworked Eocene forms were observed. Three Pleistocene zones can be recognized in areas of higher latitude (Sea of Japan) where nannofossils were recovered. However, very few nannofossil assemblages older than early Pleistocene were observed in these samples because of cold-water influence and adverse depositional conditions.

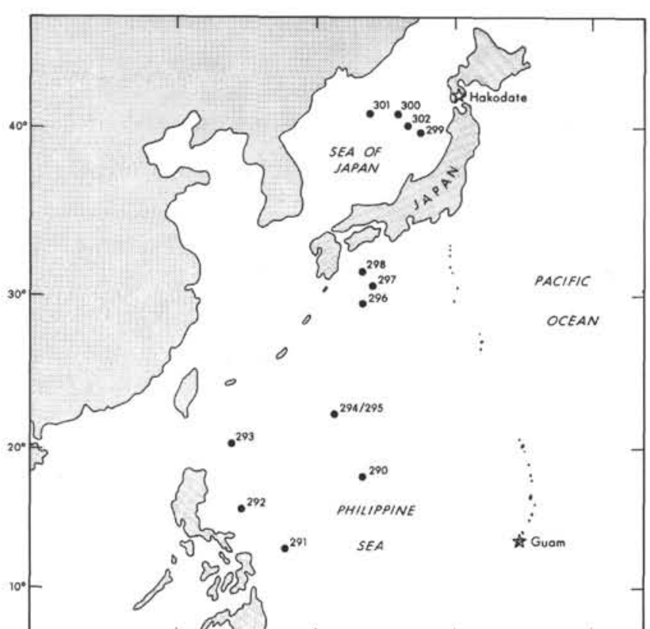

Figure 1. *Location of sites cored in the Philippine Sea and the Sea of Japan during DSDP Leg 31.*

AGE		ZONE	SUBZONE
HOLOCENE		*Emiliania huxleyi*	
PLEISTOCENE	L.	*Gephyrocapsa oceanica*	
	E.	*Gephyrocapsa doronicoides*	*Gephyrocapsa caribbeanica*
			Emiliania annula
PLIOCENE	LATE	*Discoaster brouweri*	*Cyclococcolithina macintyrei*
			Discoaster pentaradiatus
			Discoaster tamalis
	EARLY	*Reticulofenestra pseudoumbilica*	*Discoaster asymmetricus*
			Sphenolithus neoabies
		Ceratolithus tricorniculatus	*Ceratolithus rugosus*
			Ceratolithus acutus
MIOCENE	LATE		*Triquetrorhabdulus rugosus*
		Discoaster quinqueramus	*Ceratolithus primus*
			Discoaster berggrenii
		Discoaster neohamatus	*Discoaster neorectus*
			Discoaster bellus
	MIDDLE	*Discoaster hamatus*	
		Catinaster coalitus	
		Discoaster exilis	*Discoaster kugleri*
			Coccolithus miopelagicus
		Sphenolithus heteromorphus	
	EARLY	*Helicopontosphaera ampliaperta*	
		Sphenolithus belemnos	
		Triquetrorhabdulus carinatus	*Discoaster druggii*
			Discoaster deflandrei
OLIGOCENE	LATE		*Cyclicargolithus abisectus*
		Sphenolithus ciperoensis	
		Sphenolithus distentus	
	EARLY	*Sphenolithus predistentus*	
		Helicopontosphaera reticulata	*Reticulofenestra hillae*
			Cyclococcolithina formosa
			Coccolithus subdistichus
EOC.	L.	*Discoaster barbadiensis*	
	M.	*Reticulofenestra umbilica*	*Discoaster saipanensis*
			Discoaster bifax

Figure 2. *Calcareous nannofossil zonation scheme used for Leg 31.*

An attempt has been made to compare the zonation scheme used in this report with that of Martini (1971). In Figure 3 these zonations have been placed in a radiometric age framework compiled from Berggren (1972) and Berggren and Van Couvering (1973).

BIOSTRATIGRAPHY

The nannofossil zones represented in the core samples recovered from the Philippine Sea are listed in Table 1, and those from the Sea of Japan are listed in Table 2. Nearly complete zonal coverage is present in samples from Site 292 which was continuously cored from the Holocene to the late Eocene. Site 296, another biostratigraphic control hole, was cored continuously from the Holocene to the late Oligocene; the remainder of the hole was cored intermittently to the basal part of the late Oligocene or upper part of the early Oligocene. Virtually all of the zones described for the interval penetrated at Site 296 can be recognized.

Only fair nannofossil recovery was observed in the holes drilled in the Sea of Japan. Good Pleistocene zonal representation was recognized in the biostratigraphic control Site 299 and at Site 301. However, nannofossil recovery from pre-Pleistocene intervals in all of the Sea of Japan holes was poor at best, or entirely lacking.

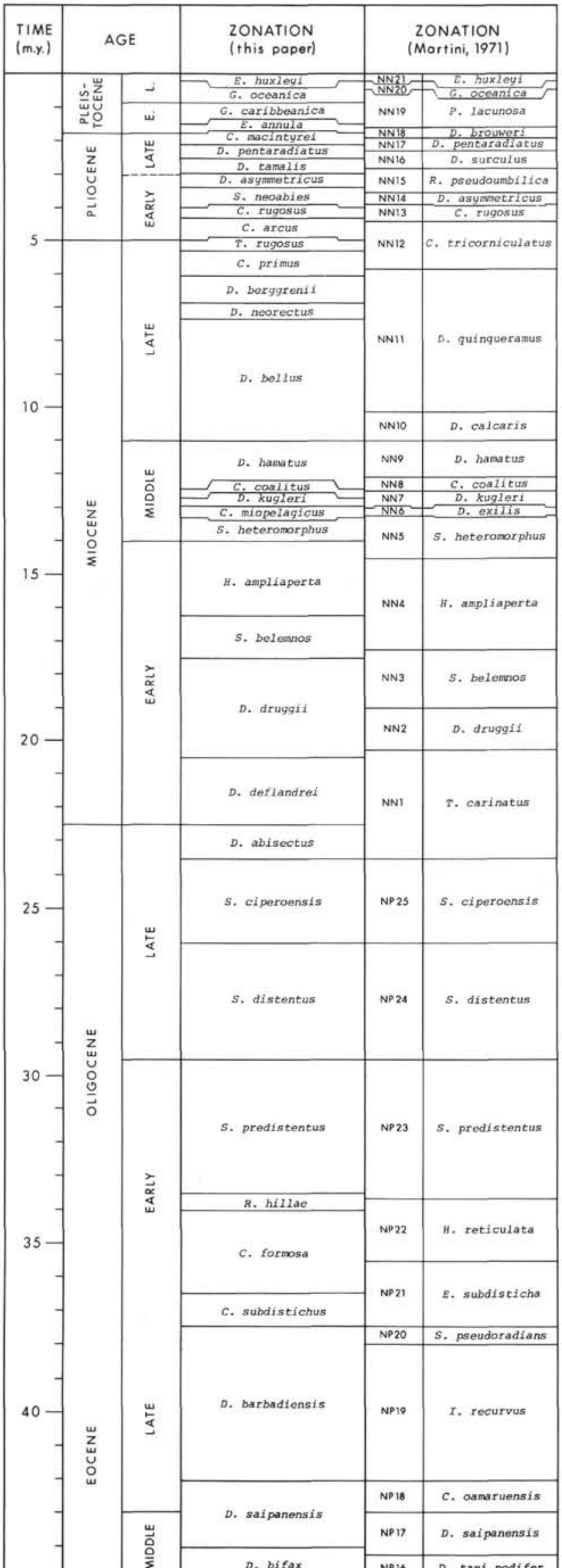

Figure 3. *Comparison of calcareous nannofossil zonation schemes with radiometric time.*

SYSTEMATIC PALEONTOLOGY

Twenty-six genera and 105 species were recognized during the study of the core samples from the Leg 31 holes.

Bibliographic references of previously described species can be found in Loeblich and Tappan (1966, 1968, 1969, 1970a, 1970b, 1971, 1973); Bukry (1973a); and Roth (1973). Frequent reference was made to Bramlette and Wilcoxon (1967a, b), Roth (1970), and Roth et al. (1971) in the study of Oligocene and Miocene sphenoliths. Haq (1973) provided valuable information regarding the biostratigraphic occurrences of helicopontosphaerids.

Genus ANGULOLITHINA Bukry, 1973

Angulolithina arca Bukry

Angulolithina arca Bukry, 1973a, p. 675, pl. 1, fig. 1-5.

Genus ASPIDORHABDUS Hay and Towe, 1962

Aspidorhabdus stylifer (Lohmann)

Rhabdosphaera stylifer Lohmann, 1902, p. 143, pl. 5, fig. 65.
Aspidorhabdus stylifer (Lohmann). Boudreaux and Hay, 1969, p. 269, pl. 5, fig. 11-15.

Genus BRAARUDOSPHAERA Deflandre, 1947

Braarudosphaera bigelowi (Gran and Braarud)

Pontosphaera bigelowi Gran and Braarud, 1935, p. 389, fig. 67.
Braarudosphaera bigelowi (Gran and Braarud). Deflandre, 1947, p. 439, fig. 1-5.

Braarudosphaera discula Bramlette and Riedel

Braarudosphaera discula Bramlette and Riedel, 1954, p. 394, pl. 38, fig. 7.

Genus BRAMLETTEIUS Gartner, 1969

Bramletteius serraculoides Gartner

Bramletteius serraculoides Gartner, 1969a, p. 31, pl. 1, fig. 1-3.

Genus CATINASTER Martini and Bramlette, 1963

Catinaster coalitus Martini and Bramlette

Catinaster coalitus Martini and Bramlette, 1963, p. 851, pl. 103, fig. 7-10.

Genus CERATOLITHUS Kamptner, 1950

Ceratolithus cristatus Kamptner

Ceratolithus cristatus Kamptner, 1954, p. 43, fig. 44, 45.

Ceratolithus primus Bukry and Percival

Ceratolithus primus Bukry and Percival, 1971, p. 126, pl. 1, fig. 12-14. Bukry, 1973a, p. 676, pl. 1, fig. 11.

Ceratolithus rugosus Bukry and Bramlette

Ceratolithus rugosus Bukry and Bramlette, 1968, p. 152, pl. 1, fig. 5-9.
Ceratolithus tricorniculatus Gartner
Ceratolithus tricorniculatus Gartner, 1967, p. 5, pl. 10, fig. 4-6. Bukry, 1973a, p. 676.

Genus COCCOLITHUS Schwarz, 1894

Coccolithus eopelagicus (Bramlette and Riedel)

Tremalitus eopelagicus Bramlette and Riedel, 1954, p. 392, pl. 38, fig. 2a, b.
Coccolithus eopelagicus (Bramlette and Riedel). Bramlette and Sullivan, 1961, p. 141. Roth, 1973, p. 730, pl. 8, fig. 2, 4; pl. 9, fig. 3, 4, 6; pl. 10, fig. 4; pl. 11, fig. 3.

Coccolithus miopelagicus Bukry

Coccolithus miopelagicus Bukry, 1971a, p. 310, pl. 2, fig. 6-9.

Coccolithus pelagicus (Wallich)

Coccosphaera pelagica Wallich, 1877, p. 348, pl. 17, fig. 1, 2, 5, 11, 12.
Coccolithus pelagicus (Wallich). Schiller, 1930, p. 246, fig. 123, 124.

TABLE 1
Geologic and Zonal Age of Leg 31 Cores from the Philippine Sea

SERIES OR SUBSERIES	ZONE OR SUBZONE	DSDP HOLES 290	290A	291	291A	292	293	294	295	296	297	298	298A
HOLOCENE	*Emiliania huxleyi*					1-1/1-2	1 cc ?			1-1/3-1		1cc/4-1	1
PLEISTOCENE	*Gephyrocapsa oceanica*					1-3/2cc	3-5			3-3/5-2	1cc/5-6	4cc/7-1	
	Gephyrocapsa caribbeanica					3-1				5-4/7-2	5cc/11-3	7cc/16cc	
	Emiliania annula									7-4/7cc	11-4		
UPPER PLIOCENE	*Cyclococcolithina macintyrei*	1		1		3-2/3-3	8-2/9cc			8-1/8-3	11 cc		
	Discoaster pentaradiatus									8-4/10-4			
	Discoaster tamalis					3-4/4-4				10-5/11cc			
LOWER PLIOCENE	*Discoaster asymmetricus*					4-5/5-1				12-1/15-4	17/18?		
	Sphenolithus neoabies					5-2	20-1/23cc ?			15cc/16-1			
	Ceratolithus rugosus					5-3/5cc				16-2/17cc			
	Ceratolithus acutus					6-1/6-2		NO NANNOFOSSIL ZONES IDENTIFIED	NO NANNOFOSSIL ZONES IDENTIFIED				
UPPER MIOCENE	*Triquetrorhabdulus rugosus*					6-3							
	Ceratolithus primus					6-4/8cc				18-1/19-4			
	Discoaster berggrenii									19-5/22-6			
	Discoaster neorectus									22cc/23-2			
	Discoaster bellus												
MIDDLE MIOCENE	*Discoaster hamatus*					9-1/9cc				23-3/24 cc			
	Catinaster coalitus					10-1				25-1/25-4	24/26 ?		
	Discoaster kugleri					10-2/10cc				25cc/27cc			
	Coccolithus miopelagicus					11-1/11-5							
	Sphenolithus heteromorphus					11-6/12-5				28-1/28cc	27		
LOWER MIOCENE	*Helicopontosphaera ampliaperta*									29-1/31-3			
	Sphenolithus belemnos					12cc/13-5				31-4/32-3			
	Discoaster druggii					13-6/14-2				32-4/33-1			
	Discoaster deflandrei					14-3/16cc				33-2/33cc			
OLIGOCENE	*Cyclicargolithus abisectus*					17-1/18-1				34-1/37cc			
	Sphenolithus ciperoensis	3-1/5-1	1/2			18-3/25-1				38-1/52cc			
	Sphenolithus distentus	5-3/6 cc		2/3-1		25cc/32-1				53cc/56cc? 57cc/63cc			
	Sphenolithus predistentus					32cc/34-2							
	Reticulofenestra hillae	7-1/8-5				34 cc?							
	Cyclococcolithina formosa					35-1/36-1							
	Coccolithus subdistichus	9?											
UPPER EOCENE	*Discoaster barbadiensis*			3-1/4 cc	1/3	36-2/39cc							
MIDDLE EOCENE	*Discoaster saipanensis*			5?									
	Discoaster bifax												

TABLE 2
Geologic and Zonal Age of Leg 31 Cores from the Sea of Japan

SERIES OR SUBSERIES	ZONE OR SUBZONE	DSDP HOLES			
		299	300	301	302
HOLOCENE	*Emiliania huxleyi*	1/8	1/2	2-3/2-5	
PLEISTOCENE	*Gephyrocapsa oceanica*	9/15-2		2 cc	1/3
	Gephyrocapsa caribbeanica	15-4/30cc		4	—4—
	Emiliania annula				
UPPER PLIOCENE	*Cyclococcolithina macintyrei*				
	Discoaster pentaradiatus			6 ?	
	Discoaster tamalis				
LOWER PLIOCENE	*Discoaster asymmetricus*				
	Sphenolithus neoabies				—5 ?—
	Ceratolithus rugosus				
	Ceratolithus acutus				
UPPER MIOCENE	*Triquetrorhabdulus rugosus*				
	Ceratolithus primus	38-6?			
	Discoaster berggrenii				10/17?
	Discoaster neorectus				
	Discoaster bellus				

Genus CORONOCYCLUS Hay, Mohler, and Wade, 1966

Coronocyclus serratus Hay, Mohler, and Wade

Coronocyclus serratus Hay, Mohler, and Wade, 1966, p. 394, pl. 11, fig. 1-5.

Genus CYCLICARGOLITHUS Bukry, 1971

Cyclicargolithus abisectus (Müller)

Coccolithus? abisectus Müller, 1970, p. 92, pl. 9, fig. 9, 10; pl. 12, fig. 1.
Cyclicargolithus abisectus (Müller). Bukry, 1973b, p. 703.
Reticulofenestra abisecta (Müller). Roth, 1973, p. 731, pl. 6, fig. 5; pl. 7, fig. 2.

Cyclicargolithus floridanus (Roth and Hay)

Coccolithus floridanus Roth and Hay, *in* Hay, Mohler, Roth, Schmidt, and Boudreaux, 1967, p. 445, pl. 6, fig. 1-4.
Cyclococcolithus neogammation Bramlette and Wilcoxon, 1967a, p. 104, pl. 3, fig. 1-3; pl. 4, fig. 3-5.
Cyclicargolithus floridanus (Roth and Hay). Bukry, 1971a, p. 312-313.

Genus CYCLOCOCCOLITHINA Wilcoxon, 1970

Cyclococcolithina formosa (Kamptner)

Cyclococcolithus formosus Kamptner, 1963, p. 163, pl. 2, fig. 8.
Coccolithus lusitanicus Black, 1964, p. 308, pl. 50, fig. 1, 2.
Cyclococcolithina formosa (Kamptner). Wilcoxon, 1970, p. 82.

Cyclococcolithina leptopora (Murray and Blackman)

Coccosphaera leptopora Murray and Blackman, 1898, p. 430, pl. 15, fig. 1-7.
Cyclococcolithus leptopora (Murray and Blackman). Boudreaux and Hay, 1969, p. 263, 264, pl. 2, fig. 13, 14; pl. 3, fig. 1-6.
Cyclococcolithus macintyrei Bukry and Bramlette, 1969, p. 132, pl. 1, fig. 1-3.
Cyclococcolithina leptopora (Murray and Blackman). Wilcoxon, 1970, p. 82. Ellis, Lohman, and Wray, 1972, p. 15-17, pl. 1, fig. 2-6; text-fig. 5.

Remarks: The species *Cyclococcolithina macintyrei* was not differentiated from *C. leptopora* as discussed by Ellis, Lohman, and Wray (1972). However, in their discussion of the two species, samples from the Pliocene and late Miocene intervals were used to provide the statistical data. Subsequent studies have shown that *C. macintyrei* and *C. leptopora* have somewhat different stratigraphic ranges, so recognition of the two species may be perfectly valid in the early Miocene and the early Pleistocene. Except for end members of the two species, they are still very difficult to separate in the late Miocene and Pliocene.

Genus DICTYOCOCCITES Black, 1967

Dictyococcites bisectus (Hay, Mohler, and Wade)

Syracosphaera bisecta Hay, Mohler, and Wade, 1966, p. 393, pl. 10, fig. 1-6.
Coccolithus bisectus (Hay, Mohler, and Wade). Bramlette and Wilcoxon, 1967a, p. 102, pl. 4, fig. 11-13.
Dictyococcites bisectus (Hay, Mohler, and Wade). Bukry and Percival, 1971, p. 127, pl. 2, fig. 12, 13.
Reticulofenestra bisecta (Hay, Mohler, and Wade). Roth, 1973, p. 732, pl. 4, fig. 1; pl. 7, fig. 4, 5; pl. 9, fig. 1, 2; pl. 10, fig. 2.

Dictyococcites scrippsae Bukry and Percival

Dictyococcites scrippsae Bukry and Percival, 1971, p. 128, pl. 2, fig. 7, 8.

Genus DISCOASTER Tan Sin Hok, 1927

Discoaster aster Bramlette and Riedel

Discoaster aster Bramlette and Riedel, 1954, p. 400, pl. 39, fig. 7.

Discoaster asymmetricus Gartner

Discoaster asymmetricus Gartner, 1969b, p. 598, pl. 1, fig. 1-3.

Discoaster aulakos Gartner

Discoaster aulakos Gartner, 1967, p. 2, pl. 4, fig. 4, 5.

Discoaster barbadiensis Tan Sin Hok

Discoaster barbadiensis Tan Sin Hok, 1927, p. 119. Bramlette and Riedel, 1954, p. 398, pl. 39, fig. 5.

Discoaster bellus Bukry and Percival

Discoaster bellus Bukry and Percival, 1971, p. 128, pl. 3, fig. 1, 2.

Discoaster berggrenii Bukry

Discoaster berggrenii Bukry, 1971b, p. 45, pl. 2, fig. 4-6.

Discoaster binodosus Martini

Discoaster binodosus Martini, 1958, p. 361, pl. 4, fig. 18b. Hay and Mohler, 1967, p. 1538.

Discoaster blackstockae Bukry

Discoaster blackstockae Bukry, 1973c, p. 307, pl. 1, fig. 1-4.

Discoaster bollii Martini and Bramlette

Discoaster bollii Martini and Bramlette, 1963, p. 851, pl. 105, fig. 1-4, 7.

Discoaster braarudii Bukry

Discoaster braarudii Bukry, 1971b, p. 45, pl. 2, fig. 10.

Discoaster brouweri Tan Sin Hok

Discoaster brouweri Tan Sin Hok, 1927, p. 120, fig. 8a-b. Bramlette and Riedel, 1954, p. 402, pl. 39, fig. 12; text-fig. 3a-b.

Discoaster brouweri rutellus Gartner

Discoaster brouweri rutellus Gartner, 1967, p. 2, pl. 1, fig. 1, 2.

Discoaster calcaris Gartner

Discoaster calcaris Gartner, 1967, p. 2, pl. 2, fig. 1-3.

Discoaster challengeri Bramlette and Riedel

Discoaster challengeri Bramlette and Riedel, 1954, p. 401, pl. 39, fig. 10.

Discoaster decorus (Bukry)

Discoaster variabilis decorus Bukry, 1971b, p. 48, pl. 3, fig. 5, 6.
Discoaster decorus (Bukry). Bukry, 1973a, p. 677, pl. 2, fig. 8, 9; pl. 4, fig. 11.

Discoaster deflandrei Bramlette and Riedel

Discoaster deflandrei Bramlette and Riedel, 1954, p. 399, pl. 39, fig. 6; text-fig. 1a-c.

Discoaster druggii Bramlette and Wilcoxon

Discoaster druggii Bramlette and Wilcoxon, 1967a, p. 110, pl. 8, fig. 2-8. Bramlette and Wilcoxon, 1967b, p. 220.

Discoaster exilis, Martini and Bramlette

Discoaster exilis, Martini and Bramlette, 1963, p. 852, pl. 104, fig. 1-3.

Discoaster hamatus Martini and Bramlette

Discoaster hamatus Martini and Bramlette, 1963, p. 852, pl. 105, fig. 8, 10, 11.

Discoaster intercalaris Bukry

Discoaster intercalaris Bukry, 1971a, p. 315, pl. 3, fig. 12; pl. 4, fig. 1, 2.

Discoaster kugleri Martini and Bramlette

Discoaster kugleri Martini and Bramlette, 1963, p. 853, pl. 102, fig. 11-13.

Discoaster loeblichii Bukry

Discoaster loeblichii Bukry, 1971a, p. 315-316, pl. 4, fig. 3-5.

Discoaster neohamatus Bukry and Bramlette

Discoaster neohamatus Bukry and Bramlette, 1969, p. 133, pl. 1, fig. 4-6.

Discoaster neorectus Bukry

Discoaster neorectus Bukry, 1971a, p. 316-318, pl. 4, fig 6, 7.

Discoaster nodifer (Bramlette and Riedel)

Discoaster tani nodifer Bramlette and Riedel, 1954, p. 397, pl. 38, fig. 2.
Discoaster nodifer (Bramlette and Riedel). Bukry, 1973a, p. 678, pl. 4, fig. 24.

Discoaster pentaradiatus Tan Sin Hok

Discoaster pentaradiatus Tan Sin Hok, 1927, p. 120, fig. 2.

Discoaster prepentaradiatus Bukry and Percival

Discoaster prepentaradiatus Bukry and Percival, 1971, p. 129, pl. 3, fig. 6, 7.

Discoaster pseudovariabilis Martini and Worsley

Discoaster pseudovariabilis Martini and Worsley, 1971, p. 1500, pl. 3, fig. 2-8.

Discoaster quadramus Bukry

Discoaster quadramus Bukry, 1973c, p. 307, pl. 1, fig. 5, 6.

Discoaster quinqueramus Gartner

Discoaster quinqueramus Gartner, 1969b, p. 598, pl. 1, fig. 6, 7.
Discoaster quintatus Bukry and Bramlette, 1969, p. 133, pl. 1, fig. 6-8.

Discoaster saipanensis Bramlette and Riedel

Discoaster saipanensis Bramlette and Riedel, 1954, p. 398, pl. 39, fig. 4.

Discoaster signus Bukry

Discoaster signus Bukry, 1971b, p. 48, pl. 3, fig. 3, 4.

Discoaster surculus Martini and Bramlette

Discoaster surculus Martini and Bramlette, 1963, p. 854, pl. 104, fig. 10-12.

Discoaster tamalis Kamptner

Discoaster tamalis Kamptner, 1967, p. 166, pl. 24, fig. 131; text-fig. 28.

Discoaster tani Bramlette and Riedel

Discoaster tani Bramlette and Riedel, 1954, p. 397, pl. 39, fig. 1.

Discoaster toralus Ellis, Lohman, and Wray

Discoaster toralus Ellis, Lohman, and Wray, 1972, p. 53, pl. 16, fig. 2-6.

Discoaster triradiatus Tan Sin Hok

Discoaster triradiatus Tan Sin Hok, 1927, p. 417.

Discoaster variabilis Martini and Bramlette

Discoaster variabilis Martini and Bramlette, 1963, p. 854, pl. 104, fig. 4-8.

Genus EMILIANIA Hay and Mohler, 1967

Emiliania annula (Cohen)

Coccolithites annulus Cohen, 1964, p. 237, pl. 3, fig. 1a-c.
Pseudoemiliania lacunosa (Kamptner). Gartner, 1969b, p. 598, pl. 2, fig. 9, 10.
Emiliania annula (Cohen). Bukry, 1973a, p. 678.

Remarks: The genus and species *Pseudoemiliania lacunosa* have been judged invalid (Loeblich and Tappan, 1970b). Taxonomic assignment of these taxa in this report to *Emiliania annula* follows the suggestion of Bukry (1973a, p. 678).

Emiliania huxleyi (Lohmann)

Pontosphaera huxleyi Lohmann, 1902, p. 130, pl. 4, fig. 1-6; pl. 6, fig. 69.
Coccolithus huxleyi (Lohmann). Kamptner, 1943, p. 44.
Emiliania huxleyi (Lohmann). Hay and Mohler, *in* Hay, Mohler, Roth, Schmidt, and Boudreaux, 1967, p. 447, pl. 10, 11, fig. 1, 2.

Emiliania ovata Bukry

Emiliania ovata Bukry, 1973a, p. 678, pl. 2, fig. 10-12.

Genus GEPHYROCAPSA Kamptner, 1943

Gephyrocapsa aperta Kamptner

Gephyrocapsa aperta Kamptner, 1963, p. 173, pl. 6, fig. 32, 35.

Gephyrocapsa caribbeanica Boudreaux and Hay

Gephyrocapsa caribbeanica Boudreaux and Hay, *in* Hay, Mohler, Roth, Schmidt, and Boudreaux, 1967, p. 447, pl. 12, 13, fig. 1-4.

Gephyrocapsa doronicoides (Black and Barnes)

Coccolithus doronicoides Black and Barnes, 1961, p. 142, pl. 25, fig. 3.
Gephyrocapsa doronicoides (Black and Barnes). Bukry, 1973a, p. 678.
Remarks: Although this species lacks a diagonal bar across the central area, it does possess the rim structure, form, and crystallography of the genus *Gephyrocapsa.*

Gephyrocapsa oceanica Kamptner

Gephyrocapsa oceanica Kamptner, 1943, p. 43-49.

Genus HAYASTER Bukry, 1973

Hayaster perplexus (Bramlette and Riedel)

Discoaster perplexus Bramlette and Riedel, 1954, p. 400, pl. 39, fig. 9.
Hayaster perplexus (Bramlette and Riedel). Bukry, 1973c, p. 308.
Remarks: This combination became apparent after the nannofossil occurrence tables had been completed for this report; consequently, the original name for this taxon, *Discoaster perplexus*, appears in the tables.

Genus HELICOPONTOSPHAERA Hay and Mohler, 1967

Helicopontosphaera ampliaperta (Bramlette and Wilcoxon)

Helicosphaera ampliaperta Bramlette and Wilcoxon, 1967a, p. 105, pl. 6, fig. 1-4.
Helicopontosphaera ampliaperta (Bramlette and Wilcoxon). Bukry, 1970, p. 377.

Helicopontosphaera compacta (Bramlette and Wilcoxon)

Helicosphaera compacta Bramlette and Wilcoxon, 1967a, p. 105, fig. 5-8.
Helicopontosphaera compacta (Bramlette and Wilcoxon). Hay, 1970, p. 458.

Helicopontosphaera euphratis (Haq)

Helicosphaera euphratis Haq, 1966, p. 33, pl. 2, fig. 1, 3.
Helicopontosphaera euphratis (Haq). Martini, 1969, p. 136.

Helicopontosphaera hyalina (Gaarder)

Helicosphaera hyalina Gaarder, 1970, p. 113-114, text-fig. 1-3.
Helicopontosphaera hyalina (Gaarder). Haq, 1973, p. 37.

Helicopontosphaera intermedia (Martini)

Helicosphaera intermedia Martini, 1965, p. 404, pl. 35, figs. 1, 2.
Helicopontosphaera intermedia (Martini). Hay and Mohler, *in* Hay, Mohler, Roth, Schmidt, and Boudreaux, 1967, p. 448.

Helicopontosphaera kamptneri Hay and Mohler

Helicopontosphaera kamptneri Hay and Mohler, *in* Hay, Mohler, Roth, Schmidt, and Boudreaux, 1967, p. 448, pl. 10, 11, fig. 5.

Helicopontosphaera reticulata (Bramlette and Wilcoxon)

Helicosphaera reticulata Bramlette and Wilcoxon, 1967a, p. 106, pl. 6, fig. 15.
Helicopontosphaera reticulata (Bramlette and Wilcoxon). Roth, 1970, p. 863, pl. 10, fig. 5.

Helicopontosphaera sellii Bukry and Bramlette

Helicopontosphaera sellii Bukry and Bramlette, 1969, p. 134, pl. 2, fig. 3-7.

Genus PONTOSPHAERA Lohmann, 1902

Pontosphaera multipora (Kamptner)

Discolithus multiporus Kamptner, 1948, p. 5, pl. 1, fig. 9.
Discolithina multipora (Kamptner). Martini, 1965, p. 400.
Pontosphaera multipora (Kamptner). Roth, 1970, p. 860-861. Ellis, Lohmann, and Wray, 1972, p. 30, pl. 6, figs. 4-6; pl. 7, fig. 1, 2.

Genus RETICULOFENESTRA Hay, Mohler, and Wade, 1966

Reticulofenestra hillae Bukry and Percival

Reticulofenestra hillae Bukry and Percival, 1971, p. 136, pl. 6, fig. 1-3.

Reticulofenestra laevis Roth and Hay

Reticulofenestra laevis Roth and Hay, *in* Hay, Mohler, Roth, Schmidt, and Boudreaux, 1967, p. 449, pl. 7, fig. 11.

Reticulofenestra pseudoumbilica (Gartner)

Coccolithus pseudoumbilicus Gartner, 1967, p. 4, pl. 6, fig. 3.
Reticulofenestra pseudoumbilica (Gartner). Gartner, 1969b, p. 587-598.

Reticulofenestra reticulata (Gartner and Smith)

Cyclococcolithus reticulatus Gartner and Smith, 1967, p. 4, pl. 5, fig. 1-4.
Reticulofenestra reticulata (Gartner and Smith). Roth, *in* Roth and Thierstein, 1972, p. 436.

Reticulofenestra umbilica (Levin)

Coccolithus umbilicus Levin, 1965, p. 265, pl. 41, fig. 2.
Reticulofenestra caucasica Hay, Mohler, and Wade, 1966, p. 386, pl. 3, fig. 1, 2; pl. 4, fig. 1, 2.
Reticulofenestra umbilica (Levin). Martini and Ritzkowski, 1968, p. 245, pl. 1, fig. 11, 12.

Genus RHABDOSPHAERA Haeckel, 1894

Rhabdosphaera clavigera Murray and Blackman

Rhabdosphaera clavigera Murray and Blackman, 1898, p. 438, pl. 15, fig. 13-15.

Genus SCYPHOSPHAERA Lohmann, 1902

Scyphosphaera apsteini Lohmann

Scyphosphaera apsteini Lohmann, 1902, p. 132, pl. 4, fig. 26-30.

Scyphosphaera pulcherrima Deflandre

Scyphosphaera pulcherrima Deflandre, 1942, p. 133, fig. 28-31.

Scyphosphaera recurvata Deflandre

Scyphosphaera recurvata Deflandre, 1942, p. 132, fig. 17-20.

Genus SPHENOLITHUS Deflandre, 1952

Sphenolithus abies Deflandre

Sphenolithus abies Deflandre, *in* Deflandre and Fert, 1954, p. 164, pl. 10, fig. 1-4.

Sphenolithus belemnos Bramlette and Wilcoxon

Sphenolithus belemnos Bramlette and Wilcoxon, 1967a, p. 118, pl. 2, fig. 1-3.

Sphenolithus ciperoensis Bramlette and Wilcoxon

Sphenolithus ciperoensis Bramlette and Wilcoxon, 1967a, p. 120, pl. 2, fig. 15-18.

Sphenolithus dissimilis Bukry and Percival

Sphenolithus dissimilis Bukry and Percival, 1971, p. 140, pl. 6, fig. 7-9.

Sphenolithus heteromorphus Deflandre

Sphenolithus heteromorphus Deflandre, 1953, p. 1785-86, fig. 1, 2.

Sphenolithus moriformis (Brönnimann and Stradner)

Nannoturbella moriformis Brönnimann and Stradner, 1960, p. 368, fig. 11-16.
Sphenolithus pacificus Martini, 1965, p. 407, pl. 36, fig. 7-10.
Sphenolithus moriformis (Brönnimann and Stradner). Bramlette and Wilcoxon, 1967a, p. 124-126, pl. 3, fig. 1-6.

Sphenolithus neoabies Bukry and Bramlette

Sphenolithus neoabies Bukry and Bramlette, 1969, p. 140, pl. 3, fig. 9-11.

Sphenolithus predistentus Bramlette and Wilcoxon

Sphenolithus predistentus Bramlette and Wilcoxon, 1967a, p. 126, pl. 1, fig. 6; pl. 2, fig. 10, 11.

Sphenolithus pseudoradians Bramlette and Wilcoxon

Sphenolithus pseudoradians Bramlette and Wilcoxon, 1967a, p. 126-128, pl. 2, fig. 12-14.

Sphenolithus radians Deflandre

Sphenolithus radians Deflandre, *in* Grassé, 1952, p. 466, fig. 343J-K, 363A-G.

Sphenolithus tribulosus Roth

Sphenolithus tribulosus Roth, 1970, p. 870-871, pl. 14, fig. 5, 7, 8.

Genus SYRACOSPHAERA Lohmann, 1902

Syracosphaera pulchra Lohmann

Syracosphaera pulchra Lohmann, 1902, p. 134, pl. 4, fig. 33, 36, 37.

Genus THORACOSPHAERA Kamptner, 1927

Thoracosphaera saxea Stradner

Thoracosphaera saxea Stradner, 1961, p. 84, fig. 71.

Genus TRIQUETRORHABDULUS Martini, 1965

Triquetrorhabdulus carinatus Martini

Triquetrorhabdulus carinatus Martini, 1965, p. 408, pl. 36, fig. 1-3.

Triquetrorhabdulus milowii Bukry

Triquetrorhabdulus milowii Bukry, 1971a, p. 325, pl. 7, fig. 9-12.

Triquetrorhabdulus rugosus Bramlette and Wilcoxon

Triquetrorhabdulus rugosus Bramlette and Wilcoxon, 1967a, p. 128-129, pl. 9, fig. 17, 18.

Genus UMBELLOSPHAERA Paasche, 1955

Umbellosphaera tenuis (Kamptner)

Coccolithus tenuis Kamptner, 1937, p. 311, pl. 17, figs. 41, 42.
Umbellosphaera tenuis (Kamptner). Paasche, *in* Markali and Paasche, 1955, p. 96.

Genus UMBILICOSPHAERA Lohmann, 1902

Umbilicosphaera cricota (Gartner)

Cyclococcolithus cricotus Gartner, 1967, p. 5, pl. 7, fig. 5-7.
Umbilicosphaera cricota (Gartner). Cohen and Reinhardt, 1968, p. 296, pl. 19, fig. 1, 5; pl. 21, fig. 3; text-fig. 6.

Umbilicosphaera sibogae (Weber van Bosse)

Coccosphaera sibogae Weber van Bosse, 1901, p. 137, 140, pl. 17, fig. 1, 2.
Umbilicosphaera mirabilis Lohmann, 1902, p. 139, pl. 5, fig. 66, 66a.
Umbilicosphaera sibogae (Weber van Bosse). Gaarder, 1970, p. 126.

SUMMARY OF NANNOFOSSIL STRATIGRAPHY

Tables of nannofossil occurrences have been prepared for those sites containing significant assemblages. The state of preservation is designated as follows: G = good, little or no etching or overgrowth; M = moderate, some etching or overgrowth which has destroyed or obscures delicate structures and ornamentation; P = poor, strong solution or overgrowth which has destroyed many species or made the original species difficult to be recognized. The abundance of specimens is noted as: VA = very abundant (flood); A = abundant; C = common; F = few; R = rare; VR = very rare (one or two specimens per slide.

Site 290 (Holes 290 and 290A)

The productive samples examined from these holes and the nannofossils they contain are listed in Table 3. Rare occurrences of moderately preserved *Discoaster brouweri* and *D. asymmetricus* in Core 1 samples suggest that this interval can be correlated with the late Pliocene *Cyclococcolithina macintyrei* Subzone. The absence of other diagnostic nannofossil species may indicate reworking into a younger, nonfossiliferous interval. The early Pliocene and the entire Miocene intervals are not represented in samples from this site. Samples 290-3-1, 50-51 cm through 290-6, CC are of late Oligocene age, and samples from Core 7 are of early Oligocene age. Core 8 is a hard, coarse, volcanic conglomerate from which one of the pebbles and some of the matrix were examined for nannofossils. A few specimens of late middle Eocene to early Oligocene age were recovered. All of Core 9 consists of a very "soupy" suspended mud and in all probability represents a thorough mixing of sediments from above. Several late Eocene species were recorded that were not observed in overlying samples. Consequently, reliable age determinations cannot be made for samples from Cores 8 and 9.

Samples from the late Oligocene Cores 1 and 2 of Hole 290A can be correlated with Samples 290-3-1, 50-51 cm to 290-5-1, 135-136 cm. The early Oligocene and late Eocene ? were penetrated only in Hole 290.

Site 291 (Holes 291 and 291A)

Table 4 lists the productive samples examined from these holes and the nannofossils they contain. Sample 291-1, CC contains rare specimens of *Discoaster brouweri* and *D. asymmetricus* which can be best correlated with the *Cyclococcolithina macintyrei* Subzone. Preservation is very poor; consequently, these specimens could represent reworking of late Pliocene fossils into younger nonfossiliferous sediments. Samples 291-2-2, 86-87 cm through 291-3-1, 110-111 cm contain the index species *Sphenolithus distentus* and are of late Oligocene age, while Sample 291-3-1, 124-124.5 cm and below contain a typical late Eocene assemblage. Clearly a hiatus is present in Core 3, Section 1 with the entire early Oligocene being absent. Sample 291-5-1, 115-116 cm immediately overlies basalt and contains only two specimens of *Cyclococcolithina formosa*. While not a true age-diagnostic species, it does indicate that this sample is no older than early Eocene. The absence of other diagnostic species suggests that these more resistant specimens have been reworked into younger Eocene sediments.

Cores 1 to 3 of Hole 291A can be correlated with the late Eocene cores of Hole 291. (Core 3 consists of red mud recovered from the drill bit upon completion of the hole.) The similarity in the assemblages recovered from Samples 291-3, CC and 291A-1, CC is striking; even to the presence of a late Oligocene component which must represent contamination from up-hole.

TABLE 3
Nannofossil Occurrences at Site 290

AGE		NANNOFOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	*Bramletteius serraculoides*	*Coccolithus eopelagicus*	*C. pelagicus*	*Coronocyclus sp.*	*Cyclicargolithus abisectus*	*C. floridanus*	*Cyclococcolithina formosa*	*Dictyococcites bisectus*	*D. scrippsae*	*Discoaster aster*	*D. asymmetricus*	*D. barbadiensis*	*D. brouweri*	*D. deflandrei*	*D. nodifer*	*D. tani*	*Helicopontosphaera intermedia*	*H. reticulata*	*Reticulofenestra hillae*	*R. umbilica*	*Sphenolithus ciperoensis*	*S. distentus*	*S. moriformis*	*S. pseudoradians*	*S. radians*	*Triquetrorhabdulus carinatus*
SITE 290																														
PLIO.	LATE	*C. macintyrei*	HOLE 290 1-1, 1-2	M													R													
			1 cc	M											R		R													
OLIGOCENE	LATE	*Sphenolithus ciperoensis*	3-1, 50-51	M			F		F	A								R		F					R	F				
			3-3, 25-26	G	R	R	C	R	C	A		R						F	R	F					C	C	F	R		R
			3 cc	G			F	R		C				R				F	R	R										
			4-1, 128-129	M			F		C	A		F						R		F					R	C		R		R
			4-2, 70-71	M		F	R	R	C	A		F						R	R	F						F	F	R		R
			4 cc	G						C				R				R	R			R			R	C		R		
			5-1, 135-136	M			F		C	C		R						R		R					R	F	R	R		
		S. distentus	5-3, 115-116	G			R		F	C		F						R		R						F	F	R		R
			5 cc	G			F							R				F		R							R			
			6-3, 103-104	G			F		F	C								R	R	F						F	F	R		R
			6 cc	G										R				R		F							F			
	EARLY	*R. hillae*	7-1, 10-12	M			R			C		C						R	R	R		R	R	R						
			7-4, 134-135	G	R	R	R			C	?	C		R				R	R	R			F	R		R	R			R
			7 cc	G										R				R	R					R						
			8-5, 140-141	M		R				R			R					R									R			
EOC.	L.	*D. barbadiensis*	9 cc	M			R			F	R					R		R					R	R			R		R	
OLIG.	LATE	*S. ciperoensis*	HOLE 290A 1-2, 90-91	M		R		R	C	A		F	R	R				R	R		R				F	R	R			
			1 cc	G			F			C				R				F		R										
			2 cc	M						A				C				F		C					R		R			

Site 292

The productive samples examined from this biostratigraphic control hole and the many well-preserved nannofossils they contain are listed in Table 5. The continuously cored intervals provide an unusually fine representation of the Holocene through the late Eocene nannofossil zones and subzones. Several subzones in the early half of the late Miocene cannot be identified. This agrees with foraminiferal data which also indicate a zone is missing, but apparently there is no break in deposition. The absence of the early Miocene *Helicopontosphaera ampliaperta* Zone coincides with missing foraminiferal zones and probably represents a hiatus. The other missing subzones shown in Table 5 may reflect too large a sampling interval for them to be recognized, or it may reflect the failure to recognize zone-defining species.

Of particular note is the continuously cored Oligocene interval which contains well-preserved nannofossil assemblages representative of all the major zones within this interval. The relationship of these assemblages with both underlying and overlying sediments can be seen because the cored intervals record both the upper and lower contacts.

Site 293

The present water depth (5599m) in addition to the very poor state of preservation of the few forms that were recovered from cores at this site suggest that deposition occurred well below the carbonate compen-

TABLE 4
Nannofossil Occurrences at Site 291

SITE 291 AGE		NANNOFOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	*Bramletteius serraculoides*	*Coccolithus eopelagicus*	*C. pelagicus*	*Coronocyclus sp.*	*Cyclicargolithus abisectus*	*C. floridanus*	*Cyclococcolithina formosa*	*Dictyococcites bisectus*	*Discoaster aster*	*D. asymmetricus*	*D. barbadiensis*	*D. binodosus*	*D. brouweri*	*D. deflandrei*	*D. nodifer*	*D. saipanensis*	*D. tani*	*Helicopontosphaera compacta*	*Reticulofenestra umbilica*	*Sphenolithus distentus*	*S. moriformis*	*S. predistentus*	*S. pseudoradians*	*S. tribulosus*
			HOLE 291																									
PLIO.	LATE	*C. macintyrei*	1 cc	P										R			R											
OLIGOCENE	LATE	*S. distentus*	2-2, 86-87	M		R	R	F		A		C						R			F			F	R	F	R	R
			2 cc	M		R	R	R		A								R			F			F	R	C	R	R
			3-1, 105-106	M	R	F	F			A		C									F			R	F	F	R	
			3-1, 110-111	P	F	F	F			A		A									F			F	C	C	R	
EOCENE	LATE	*Discoaster barbadiensis*	3-1, 117-118	M			R					R																
			3-1, 124-125	M				R							A					A			C					
			3-1, 140-141	M	R					R		R			R					R							R	
			3 cc	M	R	R	R	R		A	R	F			R			R		R	R		F	R	F	R	R	R
			4-1, 60-61	M			R			C	F	F			A				R	C			C					
			4-1, 65-66	M			F				C	C			A	A			F	A			A					
			4-2, 50-51	P			R				C	R			A				R	C			F					
			4-3, 50-51	M		R	R				C	F			A				R	C			F					
			4-3, 75-76	P			C				A		R		A					A	R		C					
			4 cc	P		R	R	R			R	R	R		R						R				R	R		
			5-1, 115-116	M							R																	
			HOLE 291A																									
EOCENE	LATE	*D. barb.*	1 cc	M	R	R	R	R	?	C	R	F			F			R		R	R		R	F	F	R	R	R
			2 cc	M			R									R						R	R					
			3 cc	M	R		R		R	R	R				R					R			R				R	

sation depth. Rapid burial can probably best explain the few fairly well-preserved specimens which were recovered from the silty fraction of a turbidite sequence. In general, there are very few age-diagnostic indigenous species in these cores, and the major portion of the specimens in the recovered assemblages are reworked into the late Pliocene samples (Table 6). A sample of the basaltic breccia matrix, 293-20-1, 15-16 cm, was found to contain the early Pliocene ? species *Discoaster brouweri* and *Reticulofenestra pseudoumbilica*. The recovery of *Discoaster pentaradiatus* from sediment chips found lining the core catcher after attempting to retrieve Core 23 further confirms the early Pliocene ? age determination for this lower rock unit.

An attempt was made to see how the character of the nannofossil assemblages might change through an interval following the deposition of a coarse turbidite. A series of very fine-grained sand to clay-sized graded beds overlying a coarse sand interval in Core 7, Section 2 was sampled and examined for nannofossils. Unfortunately, all four samples were found to be barren.

Site 294

Nannofossils occur sparsely, and their recovery was very poor from samples at this site and no specific zones or subzones could be recognized. Most of the recovered specimens are reworked Eocene forms, although the assemblage recovered from Sample 294-1-2, 75-76 cm is not incompatible with the Quaternary age determined for this core with the use of radiolarians. The samples and their fossil constituents are listed below.

294-1-2, 75-76 cm: *Cyclococcolithina leptopora*. Reworked *Discoaster deflandrei, Sphenolithus* sp.

294-2, CC: *Cyclococcolithina leptopora*.

294-3, CC: *Cyclococcolithina leptopora*. Reworked *Discoaster deflandrei, Helicopontosphaera kamptneri*.

TABLE 5
Nannofossil Occurrences at Site 292

SITE 292

AGE		NANNOFOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	*Angulolithina arca*	*Aspidorhabdus stylifer*	*Braarudosphaera discula*	*Bramletteius serraculoides*	*Ceratolithus cristatus*	*C. primus*	*C. rugosus*	*C. tricorniculatus*	*Coccolithus eopelagicus*	*C. miopelagicus*	*C. pelagicus*	*Coronocyclus serratus*	*Cyclicargolithus abisectus*	*C. floridanus*	*Cyclococcolithina formosa*	*C. leptopora*	*Dictyococcites bisectus*	*Discoaster aster*	*D. asymmetricus*	*D. aulakos*	*D. barbadiensis*	*D. bellus*	*D. berggreni*	*D. blackstockae*	*D. braarudii*	*D. brouweri*	*D. challengeri*	*D. decorus*
HOLO./PLEIST.		*E. huxleyi*	1-1, 40-41	G		R			C											C												
			1-2, 60-61	G		R			C											F												
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	1-3, 40-41	G					R											F												
			1-4, 40-41	G		R			R											F												
			1 cc	G		R			A											C												
			2-1, 100-101	G		F			R											F												
			2-2, 40-41	G		F			R											F												
			2-2, 40-41	G					R											F												
			2 cc	G		R			R											C												
	E.	*G. caribbean.*	3-1, 100-101	G		R			F											F												
PLIOCENE	LATE	*C. macintyrei*	3-2, 40-41	G					R											R										C		
			3-3, 40-41	G					R		R				R	R				F										A		
		Discoaster tamalis	3-4, 40-41	G							R									C			R							A		F
			3 cc	G							R									F			R							A	R	
			4-1, 40-41	G							R				R					C										C		R
			4-2, 40-41	G							R									R			C							A		F
			4-3, 40-41	G							R				R					C			C							A		R
			4-4, 40-41	G							R									C			A							A	R	R
	EARLY	*D. asymmet.*	4-4, 40-41	G							R									R			A							A	R	R
			4 cc	G							R									R			R							VA	A	
			5-1, 40-41	G							R				R					A			A							A		R
		S. neoabies	5-2, 40-41	G							C									F			A							C		
		Ceratolithus rugosus	5-3, 40-41	G	R					F	R									C										C		
			5-4, 40-41	G	R					F	C									F										A		
			5-5, 40-41	M	R					R	F	R																		A		
			5-6, 40-41	M	R						R									F										C		
			5 cc	G							R	R								F										C	R	
		C. acutus	6-1, 90-91	M						R										C										C		
			6-2, 40-41	G						F					F					F			C							C	A	
MIOCENE	LATE	*T. rugosus*	6-3, 40-41	G	R					R					C					C			C							R	A	
		Ceratolithus primus	6-4, 40-41	G						C		F								F			F					R		F	C	
			6-5, 40-41	G						F		R			F					R			R							F	C	
			6-6, 40-41	G						F					F					R								R		C	R	
			6 cc	G						F										R											F	
			7-1, 40-41	G						R					F					F							C			F		
			7-2, 40-41	M						R					F					F								R		F		
			7-4, 40-41	M						R					F					R							R			R		
			7-6, 40-41	G						R										C							R			C	R	
			7 cc	G						R										F										A	R	
			8-2, 40-41	G						R										F							F			C		
			8-4, 40-41	G						R										F							F			C		
			8-6, 40-41	M																R							C	R		C		
			8 cc	G						R										R										C		
	MIDDLE	*Discoaster hamatus*	9-1, 90-91	G											R					F								R		A	F	
			9-3, 40-41	G											R					R						F				C		
			9-5, 40-41	G											F					R						C				C		
			9-6, 40-41	G																F						C		R		C	R	
			9 cc	G																F										F	R	
		C. coalitus	10-1, 110-111	G											F					F												

CORE, SECTION, INTERVAL (cm)	*D. deflandrei*	*D. druggii*	*D. exilis*	*D. hamatus*	*D. kugleri*	*D. nodifer*	*D. pentaradiatus*	*D. perplexus*	*D. propentaradiatus*	*D. quadramus*	*D. quinqueramus*	*D. saipanensis*	*D. signus*	*D. surculus*	*D. tamalis*	*D. tani*	*D. toralus*	*D. triradiatus*	*D. variabilis*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa aperta*	*G. caribbeanica*	*G. doronicoides*	*G. oceanica*	*Helicopontosphaera compacta*	*H. intermedia*
1-1, 40-41																				F	C	F	R		F	A		
1-2, 60-61																				C	A			F	C	A		
1-3, 40-41																				F		F		A	C	VA		
1-4, 40-41																				F						VA		
1 cc																										C		
2-1, 100-101																				F						VA		
2-2, 40-41																				F		C		R				
2-2, 40-41																				C		A	F	R	R	A		
2 cc																										A		
3-1, 100-101																							R	VA	A			
3-2, 40-41																		F		A		A			R			
3-3, 40-41																						A						
3-4, 40-41							A							F	C			R				F						
3 cc							F							C	F													
4-1, 40-41							A							A	R													
4-2, 40-41							A							C	F				R									
4-3, 40-41							A							C	A				R									
4-4, 40-41							A							C	R													
4-4, 40-41							C							A	R				C									
4 cc							A							A					C									
5-1, 40-41							A							A					R									
5-2, 40-41							A							VA														
5-3, 40-41							A							A					R									
5-4, 40-41							A							A			R											
5-5, 40-41							C							A					R									
5-6, 40-41							C							A					F									
5 cc							C							A					R									
6-1, 90-91							C							A					A									
6-2, 40-41							C							R					A									
6-3, 40-41														R					A									
6-4, 40-41							F				R			F					A									
6-5, 40-41							C				C			F					A									
6-6, 40-41							A				C			C					A									
6 cc														F					A									
7-1, 40-41							F				C			F					A									
7-2, 40-41							C				A			F					A									
7-4, 40-41							C				A			C					C									
7-6, 40-41											A			C					C									
7 cc											A			C					C									
8-2, 40-41							F				A			A					A									
8-4, 40-41							F				A								C									
8-6, 40-41							R				A								C									
8 cc							C				C								A									
9-1, 90-91				R			C			R	C								A									
9-3, 40-41				F			A		F	R	R								C									
9-5, 40-41				R					C										C									
9-6, 40-41				C					A										C									
9 cc				C															A									
10-1, 110-111									C										A									

CORE, SECTION, INTERVAL (cm)	*H. kamptneri*	*H. reticulata*	*H. sellii*	*Reticulofenestra laevis*	*R. pseudoumbilica*	*R. reticulata*	*R. umbilica*	*Rhabdosphaera clavigera*	*Syracosphaera pulchra*	*Scyphosphaera apsteini*	*S. pulcherrima*	*S. recurvata*	*Sphenolithus abies*	*S. belemnos*	*S. ciperoensis*	*S. dissimilis*	*S. distentus*	*S. heteromorphus*	*S. moriformis*	*S. neoabies*	*S. predistentus*	*S. pseudoradians*	*Thoracosphaera saxea*	*Triquetrorhabdulus carinatus*	*T. rugosus*	*Umbilicosphaera cricota*
1-1, 40-41	C							R	R														F			C
1-2, 60-61	C							R	R														F			C
1-3, 40-41	F																						R			R
1-4, 40-41	F							R															R			
1 cc	C																									
2-1, 100-101	F							F															R			
2-2, 40-41	C							F															F			
2-2, 40-41	A								R	R	R												C			C
2 cc	A									R																
3-1, 100-101	C																						R			
3-2, 40-41	C																						R			
3-3, 40-41	F																						R			
3-4, 40-41	F																						F			
3 cc											R	R														
4-1, 40-41	C				R																		R			
4-2, 40-41	R																						R			
4-3, 40-41			F																							
4-4, 40-41																										
4-4, 40-41	R				F								C													
4 cc					F								F													
5-1, 40-41	R				R								F										R			
5-2, 40-41					R															R			R			
5-3, 40-41					F																					
5-4, 40-41					R																		F			
5-5, 40-41					F								R										F			
5-6, 40-41					R								F										R			
5 cc					F								R							R						
6-1, 90-91					C																		R			
6-2, 40-41					F								F										F			
6-3, 40-41					C								C												F	
6-4, 40-41					F																		R		F	
6-5, 40-41					R																		R		R	
6-6, 40-41					A								R										F			
6 cc					C																					
7-1, 40-41													R												R	
7-2, 40-41					R								C													
7-4, 40-41					R								C												R	
7-6, 40-41					F								C												R	
7 cc					F																				R	
8-2, 40-41					F								F												R	
8-4, 40-41					R								C													
8-6, 40-41													A													
8 cc	R																									
9-1, 90-91					R																				R	
9-3, 40-41					R								F													
9-5, 40-41													R													
9-6, 40-41					R																					
9 cc																									R	
10-1, 110-111					C								R												F	

TABLE 5 – *Continued*

SITE 292 (CONTINUED)

AGE	NANNOFOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	*Anguolithina arca*	*Aspidorhabdus stylifer*	*Braarudosphaera discula*	*Bramletteius serraculoides*	*Ceratolithus cristatus*	*C. primus*	*C. rugosus*	*C. tricorniculatus*	*Coccolithus eopelagicus*	*C. miopelagicus*	*C. pelagicus*	*Coronocyclus serratus*	*Cyclicargolithus abisectus*	*C. floridanus*	*Cyclococcolithina formosa*	*C. leptopora*	*Dictyococcites bisectus*	*Discoaster aster*	*D. asymmetricus*	*D. aulakos*	*D. barbadiensis*	*D. bellus*	*D. berggrenii*	*D. blackstockae*	*D. braarudii*	*D. brouweri*	*D. challengeri*	*D. decorus*	*D. deflandrei*	*D. druggii*	*D. exilis*	*D. hamatus*	*D. kugleri*	*D. nodifer*	*D. pentaradiatus*	*D. perplexus*	*D. prepentaradiatus*	*D. quadramus*	*D. quinqueramus*	*D. saipanensis*	*D. signus*	*D. surculus*	*D. tamalis*	*D. tani*	*D. toralus*	*D. triradiatus*	*D. variabilis*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa aperta*	*G. caribbeanica*	*G. doronicoides*	*G. oceanica*	*Helicopontosphaera compacta*	*H. intermedia*	*H. kamptneri*	*H. reticulata*	*H. sellii*	*Reticulofenestra laevis*	*R. pseudoumbilica*	*R. reticulata*	*R. umbilica*	*Rhabdosphaera clavigera*	*Syracosphaera pulchra*	*Scyphosphaera apsteini*	*S. pulcherrima*	*S. recurvata*	*Sphenolithus abies*	*S. belemnos*	*S. ciperoensis*	*S. dissimilis*	*S. distentus*	*S. heteromorphus*	*S. moriformis*	*S. neoabies*	*S. predistentus*	*S. pseudoradians*	*Thoracosphaera saxea*	*Triquetrorhabdulus carinatus*	*T. rugosus*	*Umbilicosphaera cricota*
MIOCENE, MIDDLE	*D. kugleri*	10-2, 40-41	G											C					C				C					R		F				F		R					F									A														F																				R	
		10 cc	G																C		R							R		A				F																A														F								R												R	
	Coccolithus miopelagicus	11-1, 40-41	P										F										C							F				F					R											A																												F							
		11-2, 40-41	P										C						C				A					R						F																C																												F							
		11-3, 40-41	P										R				A		R				C											R																A																												C							
		11-4, 40-41	M										R		R		A		R				C											R										F						A																												C							
		11-5, 40-41	P											R			A						F																											C																												C							
	Sphenolithus heteromorphus	11-6, 40-41	P										F		F		A		R				F									F		R																C										R																	C								
		11 cc	G																				F					R				C		R																F										R				R													A	F						R	
		12-1, 120-121	P												R		A															A							F																																						A	F							
		12-2, 32-33	P										R		R		F		R				F									A		R					R											F																											A	F							
		12-3, 40-41	M										R				A		R													A							C																																						A	R							
		12-4, 40-41	M										R		R		A															A							R																																						R	R							
		12-5, 40-41	M										F		R		A		R				R									A							C																																						A	C							
MIOCENE, EARLY	*Sphenolithus belemnos*	12 cc	G												R		A				R		R									C	R						F																																		C					C							
		13-1, 125-126	M										R		R		A															C	R						R																																		C					C							
		13-3, 40-41	M										R				A															C							F																																		C					C							
		13-4, 40-41	M										R				A															C							F																																		C					C							
		13-5, 40-41	P										F	R			A															C	R																																								F					F							
		13-5, 112-113	M										F	R			A															C	R																																								C					F							
	D. druggii	13-6, 40-41	M										R	F	R		A															C	F						C																																							A					F		
		13 cc	M											F	F		A															A																																														A					F		
		14-1, 114-115	M											C	F		A															A	R						F																																							C					C		
		14-2, 40-41	P										R		R		A															A	R						R											R																									C			C					F		
	Discoaster deflandrei	14-3, 60-61	M												F		A															A							F											R																												C					C		
		14-5, 40-41	P											F	R		A															A	VR						R																																							C					F		
		14 cc	M											A			A															A																																														C					R		
		15-1, 48-49	P											R	F		A															A							F																																				R			C							
		15-3, 40-41	P											F	F		A															A																																														C					R		
		15-6, 40-41	P												C		A															A							R																																							C					F		
		15 cc	M												R		A															A																										R																				F							
		16-2, 40-41	M										R	R	F		A				R											A							R																																				R			F					C		
		16-4, 40-41	P										F	R	F		A															A																																											F			F					C		
		16-6, 59-60	P										F		R		A				R											A																																														F					C		
		16 cc	G											R			A															A																																														F							
OLIGOCENE, LATE	*C. abisectus*	17-1, 126-127	P									R	C		R	F	A				R											A							R																																				F			C					C		
		17-3, 56-57	P										F			C	A															A							R																																							C					C		
		17-5, 40-41	P										C		R	F	A															A							R																																				R			C					C		
		17 cc	G											R																		A																										R																				C					A		
		18-1, 40-41	P										R			A	C				R											A																																														C					F		
	Sphenolithus ciperoensis	18-3, 40-41	M													A	A			R												A																											R															R				C					C		
		18-5, 40-41	M													C	C															A																																										A				C					C		
		18 cc	G											R			C															A																										R																R				C					C		
		19-1, 40-41	P													A	A															C							R																																			C				C					F		
		19-3, 40-41	P													A	A															F																																										F				F					F		
		19-5, 40-41	P											R		A	A				C											F																																										F									F		
		19 cc	G											R	R																	F							R																			R																R				F					F		
		20-2, 40-41	P											R		A	A																																																										F				C					F		
		20 cc	G											R	R		A															F							R																			R																R				C					F		
		21-1, 100-101	P													A	A															F																																										C				C					R		

TABLE 5 – ***Continued***

SITE 292 (CONTINUED)

Age		Nannofossil Zone or Subzone	Core, Section, Interval (cm)	Preservation	*Angulolithina arca*	*Aspidorhabdus stylifer*	*Braarudosphaera discula*	*Bramletteius serraculoides*	*Ceratolithus cristatus*	*C. primus*	*C. rugosus*	*C. tricorniculatus*	*Coccolithus eopelagicus*	*C. miopelagicus*	*C. pelagicus*	*Coronocyclus serratus*	*Cyclicargolithus abisectus*	*C. floridanus*	*Cyclococcolithina formosa*	*C. leptopora*	*Dictyococcites bisectus*	*Discoaster aster*	*D. asymmetricus*	*D. aulakos*	*D. barbadiensis*	*D. bellus*	*D. berggrenii*	*D. blackstockae*	*D. braarudii*	*D. brouweri*	*D. challengeri*	*D. decorus*	*D. deflandrei*	*D. druggii*	*D. exilis*	*D. hamatus*	*D. kugleri*	*D. nodifer*	*D. pentaradiatus*	*D. perplexus*	*D. prepentaradiatus*	*D. quadramus*	*D. quinqueramus*	*D. saipanensis*	*D. signus*	*D. surculus*	*D. tamalis*	*D. tani*	*D. toralus*	*D. triradiatus*	*D. variabilis*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa aperta*	*G. caribbeanica*	*G. doronicoides*	*G. oceanica*	*Helicopontosphaera compacta*	*H. intermedia*	*H. kamptneri*	*H. reticulata*	*H. sellii*	*Reticulofenestra laevis*	*R. pseudoumbilica*	*R. reticulata*	*R. umbilica*	*Rhabdosphaera clavigera*	*Syracosphaera pulchra*	*Scyphosphaera apsteinii*	*S. pulcherrima*	*S. recurvata*	*Sphenolithus abies*	*S. belemnos*	*S. ciperoensis*	*S. dissimilis*	*S. distentus*	*S. heteromorphus*	*S. moriformis*	*S. neoabies*	*S. predistentus*	*S. pseudoradians*	*Thoracosphaera saxea*	*Triquetrorhabdulus carinatus*	*T. rugosus*	*Umbilicosphaera cricota*
OLIGOCENE	LATE	*Sphenolithus ciperoensis*	21-5, 40-41	P											R		C	C															F																																										C									R		
			21 cc	G											R			C															F																										R															C				C							
			22-2, 40-41	M													C	A															F																																									C				C					R		
			22 cc	G											R																		F																																									A											
			23-1, 40-41	M										R			A	A															F																																									A									R		
			23-3, 40-41	P													C	A															F																																									A		R		C							
			23 cc	G											R			A															C																														R											C		R		F							
			24-2, 45-46	P										R		R	C	A															F																																									C				F					R		
			24-3, 40-41	P										R			C	A															R																																									F											
			24 cc	G											R							R											R							R																			R					R														R		R							
			25-1, 40-41	M													C	A															R																																									A		R							R		
		Sphenolithus distentus	25 cc	G														A															R																										R					R														VA				R					
			26-1, 60-61	P													R	A															R														R																														F					R				
			26-2, 40-41	P									F					A															R																																												F					R				
			26 cc	M									R					C				R											R																										R																		R		R		C			F		
			27-1, 40-41	P									R					C																													R																														F				R	R				
			27 cc	M									R					C				C											C																										R					R														F		R		R					
			28 cc	M									C					A				R											R														R																	A														A		C		R			R		
			29-1, 90-91	M									R					A																																																													C				R	R		F		
			29 cc	M									F									R											A														R																	A														F		A		C			R		
			30-1, 103-104	M									F					C				R																																																									C									
			30 cc	M									A					A															A																										R					C														R		A		C					
			31-2, 40-41	M			R						R					A															R														R																														F				R					
			31 cc	G			R						F									R											F														R														R					R														F									
			32-1, 95-96	P									F					A			F	R											F																															R														F		F		C	F				
	EARLY	*S. predistentus*	32 cc	G				F					F																				A																										C					A																C		A					
			33-2, 55-56	P									F								R																																																																			
			33 cc	G			F	F					R									R											F																										C					A																R		F					
			34-2, 40-41	M			F	C					C					A			F																																											F																F							
		R. hillae?	34 cc	G			A	A					F																				C																										C								R																R				
		C. formosa	35-1, 83-84	M				C					F						C		F	R																R																													R													F			R				
			35-3, 61-62	M				C					R						R		F																																								R																										
			35 cc	P				C											C			R											C														R														R			R					A														R		R					
			36-1, 66-67	P				C											A		C																																														C																					
EOCENE	LATE	*Discoaster barbadiensis*	36-2, 78-79	P				F										F	A																			R						R				R																				F																				
			36-3, 31-32	P				F										F	A			R																R						R				R																				F														F							
			36 cc	M				R											C						A								R					R						A																						R	F																				
			37-1, 131-132	M				R					R					C	F		A				C								R											C				R																				F														R							
			37-3, 69-70	M				R										C			A				A																			C				C																				F														R							
			37 cc	M				F											R						A								R					R						C																						F	F																				
			38-2, 102-103	P				F										C			C				A																			C				F																				F														R							
			38 cc	G				R											A						A								A											A														R								A																R				
			39-2, 72-73	M				R										F			C				A													R						C				R																				R														R							
			39-3, 71-72	P				C										F			C				C																			C				F														C								F														F							
			39 cc	G				R					C												A								A					F						A														C						C																R							

TABLE 6
Nannofossil Occurrences at Site 293

AGE	NANNOFOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	*Ceratolithus cristatus*	*Coccolithus pelagicus*	*Cyclococcolithina formosa*	*C. leptopora*	*Discoaster barbadiensis*	*D. brouweri*	*D. challengeri*	*D. deflandrei*	*D. hamatus*	*D. pentaradiatus*	*D. saipanensis*	*D. surculus*	*D. tani*	*D. variabilis*	*D. spp.*	*Gephyrocapsa caribbeanica*	*G. oceanica*	*G. sp.*	*Helicopontosphaera kamptneri*	*Reticulofenestra pseudoumbilica*	*R. umbilica*	*Sphenolithus pseudoradians*	*S. radians*	*S. spp.*
HOLO./		1 cc	P				R	R			?			?				F			F			R	R		R
PLEIST.		3-5, 80-81	P				R											R	R	?			?				R
		4-2, 81-82	P								R													?			
		4-2, 137-138	P		R		R																				
		7 cc	P							?																	
LATE		8-2, 101-102	P	R	R		R		R		R				R		R					R					F
PLIOCENE		9 cc	M	F			F					R				R	R						R				R
		10 cc	P																			R					
		12 cc	P																								R
		13 cc	P											R													
		17 cc	P				R																				
		18-1, 60-61	P								R													R			
EARLY		20-1, 15-16	G						R														R				
PLIOCENE		22 cc	P		R	R					R													F		?	
?		23 cc	G										R														

294-4-4, 120-121 cm: Reworked *Discoaster barbadiensis*, *D. nodifer*.

294-4, CC: Reworked *Discoaster deflandrei*, *D. tani*.

Site 295

No indigenous nannofossils were recovered from samples of this hole. Only the 295-bit sample was found to contain the reworked Eocene species *Discoaster saipanensis* and *Reticulofenestra umbilica*.

Site 296

The productive samples examined from this biostratigraphic control hole and the nannofossils they contain are listed in Table 7. The continuously cored Holocene to late Oligocene interval of this hole provides a fine representation of nearly all the Neogene nannofossil zones and subzones. Two subzones in the early Pliocene-late Miocene and a subzone in each of the late Miocene and the middle Miocene intervals were not recognized. Their absence could reflect too great a sampling interval or a hiatus. Although the interval below 472 meters was only intermittently cored, a complete sequence of late Oligocene zones was observed in Cores 34 through 63. The boundary between the *Sphenolithus ciperoensis* Zone and the *Sphenolithus distentus* Zone cannot be clearly defined. If the specimen questionably identified as *S. ciperoensis* from Core 56 is truly that species, then the zone boundary lies between Cores 56 and 57. However, if *S. ciperoensis* has its first occurrence in Core 52, then the zone boundary lies between Cores 52 and 53. Consequently, until this problem is resolved, the interval represented by Cores 53 through 56 is considered to be a transitional interval between the two zones. Cores 64 and 65 contain only a few specimens of the nannofossil species *Helicopontosphaera compacta*, *Dictyococcites bisectus*, and possibly *Cyclococcolithina formosa*. These species have reported occurrences ranging from the middle early Eocene to the early Oligocene and while they may not be very age definitive, they do provide some indication of the possible minimum and maximum ages for these samples. If the identification of *C. formosa* in Core 65 is correct, then the sample can be no younger than early Oligocene. However, the poor state of preservation of the specimens in these lower few cores may indicate that these are reworked individuals.

TABLE 7
Nannofossil Occurrences at Site 296

SITE 296 AGE		NANNOFOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	*Anguloithina arca*	*Aspidorhabdus stylifer*	*Catinaster coalitus*	*Ceratolithus cristatus*	*C. primus*	*C. rugosus*	*C. tricorniculatus*	*Coccolithus eopelagicus*	*C. miopelagicus*	*C. pelagicus*	*Coronocyclus serratus*	*Cyclicargolithus abisectus*	*C. floridanus*	*Cyclococcolithina formosa*	*C. leptopora*	*Dictyococcites bisectus*	*D. scrippsae*	*Discoaster asymmetricus*	*D. aulakos*	*D. bellus*	*D. berggreni*	*D. blackstockae*	*D. bollii*	*D. braarudii*	*D. brouweri*	*D. brouweri rutellus*	*D. calcaris*	*D. challengeri*	*D. decorus*	*D. deflandrei*	*D. druggii*	*D. exilis*	*D. hamatus*	*D. intercalaris*	*D. kugleri*	*D. loeblichii*	*D. neohamatus*	*D. neorectus*	*D. nodifer*	*D. pentaradiatus*	*D. prepentaradiatus*	*D. pseudovariabilis*	*D. quinqueramus*	*D. signus*	*D. surculus*	*D. tamalis*	*D. tani*	*D. toralus*	*D. variabilis*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa caribbeanica*	*G. doronicoides*	*G. oceanica*	*Helicopontosphaera ampliaperta*	*H. compacta*	*H. euphratis*	*H. intermedia*	*H. kamptneri*	*H. sellii*	*Pontosphaera multipora*	*Reticulofenestra pseudoumbilica*	*Rhabdosphaera clavigera*	*Scyphosphaera pulcherrima*	*S. recurvata*	*Sphenolithus abies*	*S. belemnos*	*S. ciperoensis*	*S. distentus*	*S. heteromorphus*	*S. moriformis*	*S. neoabies*	*S. predistentus*	*Syracosphaera pulchra*	*Thoracosphaera saxea*	*Triquetrorhabdulus carinatus*	*T. milowii*	*T. rugosus*	*Umbellosphaera tenuis*	*Umbilicosphaera cricota*
HOLOCENE/PLEISTOCENE		*Emiliania huxleyi*	1-1, 31-32	G				R											C																																A	C			A					C				R																R	F
			1-4, 90-91	M															F																																C	F			A					C																					F
			1 cc	G															R																																VA				A					C																					
			2-2, 34-35	G															C																																A	F			A					F																					F
			2-6, 68-69	G															R																																VA		R	F	C					R																					F
			2 cc	G										R																																										VA					C																					
			3-1, 19-20	G				R											C																																F		R		A					F	R			R											R						F
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	3-3, 100-101	G		R													R																															F		F	R	F	A					F																					R
			3-4, 96-97	G															F																															C				F	C																						R					
			3 cc	G															C																															C		F			C					F																					
			4-2, 51-52	M															C																															F		F		C	F					F																					R
			4-3, 127-128	M															C																																	C		C	C					R																					
			4 cc	G															C																															F		C			F					R																					
			5-1, 75-76	M															C																															F		C	F	C	R					F																R					F
			5-2, 7-8	G															F																															A		A	F	F	F					F																R					
	EARLY	*Gephyrocapsa caribbeanica*	5-4, 41-42	M															F																															C		C		A						F																R					
			5 cc	G															F																															F			C	C						F		R																		
			6-1, 62-63	M															F																															F		F	A	C						F					R											R					
			6-5, 30-31	M															F																															F		F	A	C	R					R		R																			
			6 cc	G				F											A																															VA				VA						C		R														R					
			7-2, 70-71	M															R																															F			C	A						R																					
		E. annula	7-4, 140-141	M															F																															C		C	R	A						R						R															
			7 cc	G		R		R											F																															VA				VA						R		R			R											R					
PLIOCENE	LATE	*C. macintyrei*	8-1, 134-135	G										R					F										F		R																			F		F	R	A	VR					R																R					F
			8-2, 100-101	G										F					F										F		R																			C		F	R	C						R		R		R											R						F
			8-3, 136-137	M				R						R					F										R																								F				A						R															R						
		Discoaster pentaradiatus	8-4, 30-31	G										R					F																									R										C		F		A						R															R						
			8-4, 52-53	M										R					R																									R										A		C		A						R		R																			
			8-4, 115-116	M															C										R															R										C		C		A						R																					
			8 cc	G				R						A					C										C															C					F					C		C		A						R																					
			9-1, 72-73	M															F										F															F										C		C		C						R																					
			9-2, 120-121	M										F					F										R															R										R		F		A						R		R																			
			9-3, 89-90	M										F					F										F															F												R		C						R																					
			9-4, 21-22	M										R					F			R							F		R													F										F		R		A						R	R				R										R	R					
			9-5, 72-73	M															R										R															R												F		C																											
			9-6, 91-92	M															F										F																									R				C						R		R														R					
			9 cc	G										F					A										C															C					C									A						F																					
			10-2, 24-25	M										R					F																									R												F		A						R																					
			10-4, 21-22	M										R															F															R												F		C																											
		Discoaster tamalis	10-5, 115-116	M		R								C					R			R							F				R											F					R	R		R		R		R		C						R	R	R													R						
			10-6, 60-61	G										R					F										R				R																	R		R		F		F		C						R																R					
			10 cc	G										C					A			C							A															F					C	C															C					R																
			11-2, 75-76	G															F			R							C		R		F											F					F	R		R	R	F		F		A	VR					R		R		R												R					
			11-4, 80-81	G															C			F							F															F						R				R				A						R																					
			11 cc	G						F									A			F							A															A					C	C														F																					
	EARLY	*Discoaster asymmetricus*	12-1, 103-104	M															F										C		R		R											C					R				R	F		R	VR	C	VR					R	R	R			R		R									R					
			12-4, 95-96	M						R									C			R							R				R											R					R			R	R			R		F						F			C													R					
			12-5, 85-86	M						R									F			R							R				R											R																				R			C																			
			12 cc	G						F				A					A			A							A			R	R																			R	F											C			A			R															
			13-3, 95-96	M															F			R							R															R																				R			F																			

TABLE 7 – *Continued*

SITE 296 (CONTINUED)

Age	Nannofossil Zone or Subzone	Core, Section, Interval (cm)	Preservation	*Angulolithina arca*	*Aspidorhabdus stylifer*	*Catinaster coalitus*	*Ceratolithus cristatus*	*C. primus*	*C. rugosus*	*C. tricorniculatus*	*Coccolithus eopelagicus*	*C. miopelagicus*	*C. pelagicus*	*Coronocyclus serratus*	*Cyclicargolithus abisectus*	*C. floridanus*	*Cyclococcolithina formosa*	*C. leptopora*	*Dictyococcites bisectus*	*D. scrippsae*	*Discoaster asymmetricus*	*D. aulakos*	*D. bellus*	*D. berggrenii*	*D. blackstockae*	*D. bollii*	*D. braarudii*	*D. brouweri*	*D. brouweri rutellus*	*D. calcaris*
PLIOCENE, EARLY	*Discoaster asymmetricus*	13 cc	G															A			F							A		
		14-4, 102-103	M															F			R							R		
		14 cc	G															A			C							A		
		15-2, 75-76	M										F					C			R				R			C		
		15-4, 50-51	M															F			R							F		
	S. neoabies	15 cc	M						R	VR								A										A		
		16-1, 130-131	G										F					F							R					
	Ceratolithus rugosus	16-2, 60-61	G							R								C										F		
		16-3, 70-71	G	R				R					C					F			R									
		16 cc	G					R	R				A					A										A		
		17-3, 55-56	G	R									C															R		
		17 cc	G	R				R	R				C					A										C		
MIOCENE, LATE	*Ceratolithus primus*	18-1, 85-86	G										C					F										C		
		18 cc	G	R				R		R								A										C		
		19-1, 68-69	G										F					C						F				F		
		19-3, 75-76	G					R					C	R				C						C				C		
		19-4, 80-81	G					R					R					C										F		
	Discoaster berggrenii	19-5, 80-81	M															F						C				C		
		19-6, 80-81	G																					C				F		
		19 cc	G															A						A				C		
		20 cc	M	R														A						A			F			
		21-3, 60-61	G										R					F						A			F	C		
		21 cc	M															A						C			A	F	F	
		22-3, 50-51	G										R					F						A				C	F	
		22-5, 70-71	G										R					R						C			F	C		
		22-6, 70-71	G															F						C			C	C	F	
	D. neorectus	22 cc	G											R				F									A	C	C	
		23-2, 109-110	G										R					R										A	F	
MIOCENE, MIDDLE	*D. hamatus*	23-3, 90-91	G															F								R	F	A		
		23 cc	G															F								R	A	A		
		24 cc	G			R												C					C			F	A	C		
	Catinaster coalitus	25-1, 70-71	M			R							F					C								F	R	C		
		25-2, 70-71	G			R						C						F											F	F
		25-3, 70-71	G			R						A						F								R	F			
		25-4, 70-71	M									A						F									F	R		
	Discoaster kugleri	25 cc	G											R				C								R				
		26-2, 70-71	M									C						F								R				
		26-5, 70-71	P									F						R												
		26 cc	G															C				R					F			
		27-2, 70-71	M									A		R												R				
		27-3, 70-71	M									C						R								R				
		27 cc	G											F				A				R				C	C			
	S. heteromorph.	28-1, 105-106	G									C		F				F												
		28-2, 70-71	G									A		R				R				F								
		28-4, 70-71	M									F						C												
		28 cc	G									A						A												
MIOCENE, EARLY	*Helicopontosphaera ampliaperta*	29-1, 70-71	G									F	F			F		F												
		29-2, 70-71	G									C	F			F		F												
		29 cc	G													F		A												
		30-1, 100-101	G										R			C		R												
		30 cc	M													R		C				R								
		31-1, 70-71	M									F	R			C														
		31-3, 69-70	M									F				C														

Core, Section, Interval (cm)	*D. challengeri*	*D. decorus*	*D. deflandrei*	*D. druggii*	*D. exilis*	*D. hamatus*	*D. intercalaris*	*D. kugleri*	*D. loeblichii*	*D. neohamatus*	*D. neorectus*	*D. nodifer*	*D. pentaradiatus*	*D. prepentaradiatus*	*D. pseudovariabilis*	*D. quinqueramus*	*D. signus*	*D. surculus*	*D. tamalis*	*D. tani*	*D. toralus*	*D. variabilis*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa caribbeanica*	*G. doronicoides*
13 cc	F	R											C					R				A					
14-4, 102-103		R											R					R				R					
14 cc		R											A					C				F					
15-2, 75-76		C											R					R			R	F					
15-4, 50-51		F											F					R				R					
15 cc													C					R				A					
16-1, 130-131		F											R									R					
16-2, 60-61																		R				F					
16-3, 70-71													R					R				R					
16 cc	F												C									A					
17-3, 55-56													R									R					
17 cc	R												F									C					
18-1, 85-86													R			F						C					
18 cc	R															R		R				A					
19-1, 68-69	F															C						C					
19-3, 75-76	R															C		R				C					
19-4, 80-81																C		R				F					
19-5, 80-81																C		R									
19-6, 80-81													R			C						R					
19 cc	F															C		R				A					
20 cc																C		F			R	C					
21-3, 60-61																C						F					
21 cc													R			C		F				F					
22-3, 50-51																						F					
22-5, 70-71																C		R				R					
22-6, 70-71																C						F					
22 cc									R		R					F					R	C					
23-2, 109-110													A			C						C					
23-3, 90-91						A							R	R								C					
23 cc						C	R		R				C			F						A					
24 cc						A				R												A					
25-1, 70-71																						C					
25-2, 70-71					R								R		F							C					
25-3, 70-71	R				F										F							A					
25-4, 70-71					F										R							C					
25 cc					F			R	R												R	A					
26-2, 70-71																						C					
26-5, 70-71																						F					
26 cc					F			F														A					
27-2, 70-71								R														C					
27-3, 70-71					F			C														F					
27 cc	R		R		F			C														C					
28-1, 105-106																						F					
28-2, 70-71			R																			C					
28-4, 70-71			F		R																	C					
28 cc	F		A														F					A					
29-1, 70-71			F																								
29-2, 70-71			C																			R					
29 cc	R		C																			A					
30-1, 100-101			F																								
30 cc			A																								
31-1, 70-71			F																								
31-3, 69-70			C																								

Core, Section, Interval (cm)	*G. oceanica*	*Helicopontosphaera ampliaperta*	*H. compacta*	*H. euphratis*	*H. intermedia*	*H. kamptneri*	*H. sellii*	*Pontosphaera multipora*	*Reticulofenestra pseudoumbilica*	*Rhabdosphaera clavigera*	*Scyphosphaera pulcherrima*	*S. recurvata*	*Sphenolithus abies*	*S. belemnos*	*S. ciperoensis*	*S. distentus*	*S. heteromorphus*	*S. moriformis*	*S. neoabies*	*S. predistentus*	*Syracosphaera pulchra*	*Thoracosphaera saxea*	*Triquetrorhabdulus carinatus*	*T. milowii*	*T. rugosus*	*Umbellosphaera tenuis*	*Umbilicosphaera cricota*
13 cc						F		R	A																		R
14-4, 102-103						R																					
14 cc						C			A																		
15-2, 75-76						R	R		C				R														
15-4, 50-51						R			C				R														
15 cc						A			A		R		R														R
16-1, 130-131						R	R		C				F						C								
16-2, 60-61						R			F										R								
16-3, 70-71						R	R		F				F						C								
16 cc						C			A				R														C
17-3, 55-56						R			F																		
17 cc						C			A			R															
18-1, 85-86						R			F			R															
18 cc						C			A				R														
19-1, 68-69									C																	
19-3, 75-76									A																	
19-4, 80-81									F																	
19-5, 80-81									C																	
19-6, 80-81									A																	
19 cc						C																			R		
20 cc						F			A																		
21-3, 60-61									F																	
21 cc									A																	
22-3, 50-51																										
22-5, 70-71						R			F																		
22-6, 70-71						R																					
22 cc													F													
23-2, 109-110						R																					
23-3, 90-91									A																	
23 cc									F																	
24 cc						F			C																		
25-1, 70-71																										
25-2, 70-71									A																	
25-3, 70-71																										
25-4, 70-71																										
25 cc						F			A																		
26-2, 70-71																										
26-5, 70-71																										
26 cc						F			A				F														
27-2, 70-71																										
27-3, 70-71																										
27 cc						C			C																		
28-1, 105-106																	C										
28-2, 70-71					R												F	R									
28-4, 70-71																	F										
28 cc						C			C								F	C									
29-1, 70-71		R		R													F	F									
29-2, 70-71		R		R													C	F									
29 cc						C			C								A										
30-1, 100-101		R		R													C	C									
30 cc		R															VA	C									
31-1, 70-71		R															C	F									
31-3, 69-70				R													C	A									

TABLE 7 – Continued

SITE 296 (CONTINUED)

AGE		NANNOFOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	Anguloilithina arca	Aspidorhabdus stylifer	Catinaster coalitus	Ceratolithus cristatus	C. primus	C. rugosus	C. tricorniculatus	Coccolithus oopelagicus	C. miopelagicus	C. pelagicus	Coronocyclus serratus	Cyclicargolithus abisectus	C. floridanus	Cyclococcolithina formosa	C. leptopora	Dictyococcites bisectus	D. scrippsae	Discoaster asymmetricus	D. aulakos	D. bellus	D. berggrenii	D. blackstockae	D. bollii	D. braarudii	D. brouweri	D. brouweri rutellus	D. calcaris	D. challengeri	D. decorus	D. deflandrei	D. druggii	D. exilis	D. hamatus	D. intercalaris	D. kugleri	D. loeblichii	D. neohamatus	D. neorectus	D. nodifer	D. pentaradiatus	D. prepentaradiatus	D. pseudovariabilis	D. quinqueramus	D. signus	D. surculus	D. tamalis	D. tani	D. toralus	D. variabilis	Emiliania annula	E. huxleyi	E. ovata	Gephyrocapsa caribbeanica	G. doronicoides	G. oceanica	Helicopontosphaera ampliaperta	H. compacta	H. euphratis	H. intermedia	H. kamptneri	H. sellii	Pontosphaera multipora	Reticulofenestra pseudoumbilica	Rhabdosphaera clavigera	Scyphosphaera pulcherrima	S. recurvata	Sphenolithus abies	S. belemnos	S. ciperoensis	S. distentus	S. heteromorphus	S. moriformis	S. neoabies	S. predistentus	Syracosphaera pulchra	Thoracosphaera saxea	Triquetrorhabdulus carinatus	T. milowii	T. rugosus	Umbellosphaera tenuis	Umbilicosphaera cricota
MIOCENE	EARLY	Sphenolithus belemnos	31-4, 68-69	M									A	R	R		A		R				R											C	C																		R																					R				F									
			31-5, 71-72	M									F		F		A																	A	F																		R																					F				C									
			31 cc	M									F						F															VA																										C																				R						R			
			32-2, 70-71	M									C		R		C																	A	F																																											C				F									
			32-3, 70-71	M									C		F		C																	A	R																																											R				C									
		Discoaster druggii	32-4, 71-72	M									R		R		F																	C	F																																																F									
			32-5, 70-71	M									C				F																	A	F																																																									
			32 cc	M									C																					VA																																																		F					R				
			33-1, 105-106	M									F				F																	A	C																																																	F									
		D. deflandrei	33-2, 68-69	M									C				C																	A																																																	C									
			33-4, 54-55	M									A	R		VR	C																	A																																																	C									
			33 cc	M									C						F															VA																																																		F						R			
OLIGOCENE	LATE	Dictyococcites abisectus	34-1, 98-99	M												F	C																	C																																																	F									
			34-4, 66-67	M										R		C	C																	F																																																	F									
			34-5, 41-42	M												C	C																	R																																																	F									
			34 cc	M									F				F		F															VA																																																	F						R			
			35-4, 72-73	M										R		C	C																																																																	R									
			35 cc	M									A			C																		C																																																								R			
			36-4, 58-59	M									F	R		F	C																	R																																																	F									
			36 cc	M									F			C																		R																																																							R			
			37-4, 56-57	M									F			A	C																	R																																																	C									
			37 cc	M									R			C	F		R															R																																																												
		Sphenolithus ciperoensis	38-1, 96-97	M										F		A	F			F														R																																										R			F									
			38 cc	M												A																		A																													R												R									R	R			
			39-3, 62-63	M								R				A				C														R																																											F			C					R				
			39 cc	M									R			C																		R																																																	C									
			40 cc	M									R			C				F														R																																											R			F									
			41 cc	M											R	C				F														R																													R												C			F					R				
			42 cc	M								R				C				C														R																													R												F			F					R				
			43-1, 103-104	M												C				C														R																																											F			F					R				
			44 cc	M								F				C				F														F																	R												R												F			F					R				
			45 cc	M									F			F				C														F																													R												C			R									
			46 cc	M									R			C	F			C														F																	R												R												C	R		F					F				
			47 cc	M									R			C	F			C														F																	R												R												C			F					F				
			48-1, 140-141	M												F	F				R																																																																								
			49 cc	M												F	R			F														R																																																													
			52-1, 62-63	M												A				C	R													R																																											R			C					R				
			52 cc	M									R			C	F			C														R																													R												R			F									
		S. ciperoensis or S. distentus	53 cc	P									R				R			F														R																											R		R															R									
			54 cc	M									R			R				R	R													R																											R																											
			55 cc	M									R				R			R														R																																															R									
			56-5, 65-68	P												R					R																																																																									
			56-5, 70-71	P												R				R																																									R																												
			56 cc	P									R			C	C			F	A													R																													R												?			R									
		Sphenolithus distentus	57 cc	P									R			C	C			F														R																													R															R									
			58 cc	P									F			C	F			C														R																											R		R													R		F		R			R				
			59 cc	P												F	R																																												R																		R									
			63 cc	P								R				C	C			F														R									R								R										R													F		F									
			64 cc	P																																																																																												
			65 cc	P														?		R																																																																													

Site 297

The nannofossil recovery from this hole is not consistent with the normal sequence of Pleistocene subzones (Table 8). Samples 297-1, CC through 297-4-4, 70-71 cm contain well-preserved specimens typical of the late Pleistocene *Gephyrocapsa oceanica* Zone. Samples 297-6-1, 70-71 cm through 297-11-3, 70-71 cm contain specimens representative of the early Pleistocene *Gephyrocapsa caribbeanica* Subzone. However, the species diversity in this latter assemblage is reduced, and the quality of preservation is poorer than that observed in the *G. oceanica* Zone assemblages. Between these two assemblages a group of samples (297-4-6, 60-61 cm through 297-5, CC) contains an assemblage that can best be recognized as belonging to the Holocene-Pleistocene *Emiliania huxleyi* Zone. Whether this zonal displacement is due to faulting, slumping, or reworking of the upper unit is not known at this time.

The late Pliocene interval is represented by Samples 297-11, CC and 297-17, CC. The former sample clearly belongs in the *Cyclococcolithina macintyrei* Subzone, while the latter sample does not contain sufficient nannofossils to identify it with a specific late Pliocene subzone.

Sample 297-18, CC can best be assigned to the *Reticulofenestra pseudoumbilica* Zone, but again subzonal designation is not possible. Cores 19 through 23 are barren of nannofossils and cannot be dated.

Samples 297-24-1, 116-117 cm through 297-24, CC contain an assemblage than can probably be best assigned to the middle Miocene *Discoaster exilis* Zone. Samples from Cores 25 and 26 contain very few poorly preserved nannofossils, but their position in the stratigraphic sequence probably also places them in the *D. exilis* Zone.

The final core sample, 297-27, CC, while containing a few reworked specimens of *Discoaster saipanensis*, has a fairly diverse, relatively well-preserved assemblage of nannofossils which can be placed in the early middle Miocene *Sphenolithus heteromorphus* Zone.

Site 298 (Holes 298 and 298A)

The productive samples examined from these holes and the nannofossils they contain are listed in Table 9. A normal sequence of Holocene and Pleistocene nannofossil zones and subzones are represented in these samples. A few specimens of the following Pliocene, Miocene, and early Oligocene or late Eocene species are found scattered throughout the younger assemblages: *Dictyococcites bisectus*, *Discoaster brouweri*, *D. exilis*, *D. kugleri*, *D. nodifer*, and *D. surculus*. The single sample, 298A-1, CC, from Hole 298A can be correlated with samples of the *Emiliania huxleyi* Zone in Hole 298.

Site 299

The productive samples examined from this site and the nannofossils they contain are listed in Table 10. Samples from Cores 1 through 8 contain relatively normal nannofossil assemblages that can be correlated with the Holocene-Pleistocene *Emiliania huxleyi* Zone. The generally poor state of preservation as well as the paucity and low diversity of fossil forms in the remainder of the productive samples from this hole reflect the influence of cold-water currents encroaching upon this portion of the Sea of Japan from the north. The late Pleistocene *Gephyrocapsa oceanica* Zone can be recognized in Samples 299-9, CC through 299-15-2, 55-56 cm. The early Pleistocene *Gephyrocapsa caribbeanica* Subzone can be recognized in Samples 299-15-4, 60-61 cm through 299-30, CC. Although Samples 299-23, CC, 299-26, CC, and 299-30, CC contain only rare specimens of nannofossils, the latter two samples do contain the subzonal index species *G. caribbeanica.* No age-diagnostic nannofossils were recovered from samples below this point.

Site 300

Only rare heavily overgrown specimens of *Coccolithus pelagicus* were recovered from Sample 300-1, CC. This undoubtedly reflects the influence of cold-water currents on the nannofossil assemblages. However, more nearly normal Holocene-Pleistocene specimens referrable to the *Emiliania huxleyi* Zone were recovered from Sample 300-2, CC. The fossil assemblages recovered from these two samples are listed in Table 11.

Site 301

Only sparsely occurring nannofossils were observed in a few samples from this site (Table 11). Holocene-Pleistocene through early Pleistocene zones or subzones can be recognized in the samples through Sample 301-4, CC. Only one additional sample, 301-6, CC, was found to contain nannofossils. This sample must be of early Pliocene age or older unless the specimens of *Reticulofenestra pseudoumbilica* are reworked.

Site 302

The cold-water conditions characteristic of this part of the Sea of Japan are reflected in the sparse nannofossil recovery from Hole 302 (Table 11). Nannofossil assemblages recovered from samples from Cores 1, 2, and 3 can be referred to the late Pleistocene *Gephyrocapsa oceanica* Zone. Sample 302-4-2, 70-71 cm contains only the species *Gephyrocapsa doronicoides* and, consequently, may belong to the *G. doronicoides* Zone. Sample 302-5, CC contains rare, heavily overgrown specimens of *Reticulofenestra pseudoumbilica* and thus may belong to that early Pliocene Zone.

The remaining productive samples, 302-10, CC through 302-17-2, 70-71 cm, contain only sparse nannofossils including a few reworked Oligocene specimens of *Cyclicargolithus abisectus* and *Sphenolithus ciperoensis*. Associated diatoms suggest a possible late Miocene age for this interval.

REFERENCES

Berggren, W.A., 1972. A Cenozoic time-scale—some implications for regional geology and paleobiogeography: Lethaia, v. 5, p. 195-215.

Berggren, W.A. and Van Couvering, J., 1973. Late Neogene chronostratigraphy, biostratigraphy, biochronology, and paleoclimatology: Woods Hole Oceanographic Institution Tech. Rept., No. 73-40.

Black, M., 1964. Cretaceous and Tertiary coccoliths from Atlantic seamounts: Palaeontology., v. 7, p. 306-316.

TABLE 8
Nannofossil Occurrences at Site 297

SITE 297 AGE		NANNOFOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	*Ceratolithus cristatus*	*Coccolithus pelagicus*	*Cyclococcolithina leptopora*	*Discoaster bollii*	*D. braarudii*	*D. brouweri*	*D. deflandrei*	*D. saipanensis*	*D. tani*	*D. variabilis*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa aperta*	*G. caribbeanica*	*G. doronicoides*	*G. oceanica*	*Helicopontosphaera kamptneri*	*Pontosphaera multipora*	*Reticulofenestra pseudoumbilica*	*Rhabdosphaera clavigera*	*Sphenolithus abies*	*S. heteromorphus*	*S. moriformis*	*Syracosphaera sp.*	*Umbilicosphaera cricota*	*U. sibogae*
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	1 cc	G	R		R				R				R						R										
			2 cc	G			R								F		R		R		F	R									
			3 cc	G	R		F										C		F		C										
			4-1, 76-77	G			R										R				R	R									
			4-2, 70-71	G			C										C		C		C										
			4-4, 70-71	G			A										A		F		A	F									
	HOLOCENE/PLEISTOCENE	*Emiliania huxleyi?*	4-6, 60-61	G			C									R	C		A	A	C	R							R	R	
			4 cc	M																F		R									
			5-2, 70-71	M											R	R			F	C	C										
			5-4, 70-71	G			R								R		R	R	F	A	F								R	F	
			5-6, 70-71	G			R								F		R		A	A	F									F	R
			5 cc	G	R	R	R								R	?	R		C	VA		R									
	EARLY	*Gephyrocapsa caribbeanica*	6-1, 70-71	G																R											
			6-3, 70-71	G											R				C	A											
			6-5, 70-71	M											R				R	R											
			7-3, 70-71	G			C								C		C		C	A		F			R						
			7 cc	P			R												F			R									
			8-3, 90-91	M											R				R	R											
			8-6, 135-136	P	R		C			R	R								F												
			9-3, 70-71	G			R								F				F	C											
			9 cc	G															R	F											
			10-1, 0-1	G		C	A								C		A			C		F									
			10-3, 70-71	M															R	R											
			10-5, 70-71	M											R				R	R											
			10-6, 70-71	M															R	R											
			10 cc	G											R					R											
			11-2, 120-121	G											R				R	R											
			11-3, 70-71	M											R					R											
		E. annula	11-4, 70-71	G			A								C		A		R	F		R									
PLIO.	LATE	*C. macintyrei*	11 cc	G	R	R	C			F					F		F			C											
			17 cc	P									R									R									
	E.	*R. pseudoumb.*	18 cc	P			R			C				F								R		R		F					
MIOCENE	MIDDLE	*D. exilis?*	24-1, 116-117	M		R	F	R			R											R		R							
			24-2, 63-64	M		R	R							R								R									
			24 cc	M			C	R	R	F	R		R	R								R		R		F					
			25-2, 41-42	P										R																	
			26 cc	P			R																								
		S. heteromorphus	27 cc	G			F				R	R		R								R	R	F			F	R			

TABLE 9
Nannofossil Occurrences at Site 298

Age	Nannofossil Zone or Subzone	Core, Section, Interval (cm)	Preservation	*Braarudosphaera bigelowi*	*Ceratolithus cristatus*	*Coccolithus pelagicus*	*Cyclococcolithina leptopora*	*Dictyococcites bisectus*	*Discoaster brouweri*	*D. exilis*	*D. kugleri*	*D. nodifer*	*D. surculus*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa caribbeanica*	*G. doronicoides*	*G. oceanica*	*Helicopontosphaera hyalina*	*H. kamptneri*	*Reticulofenestra pseudoumbilica*	*Umbilicosphaera cricota*
		HOLE 298																					
HOLOCENE/ PLEISTOCENE	*Emiliania huxleyi*	1 cc	M	R	R	R	R		R				R						F			R	
		2-4, 125-126	G				F								C			R	C	R			C
		2 cc	M			R									F				F		R		
		3-1, 120-121	G												C				F				
		3 cc	M		R	R	C		R						C				F		R		
		4-1, 40-41	M												A			F	F				
PLEISTOCENE, LATE	*Gephyrocapsa oceanica*	4 cc	M													R	F	F					
		5-1, 85-86	M													R	F	F	R				
		5-2, 53-54	M				F									R	F	F					
		6-1, 60-61	M											R		R	C				R		
		7-1, 40-41	G											R		R	C	C	R				
PLEISTOCENE, EARLY	*Gephyrocapsa caribbeanica*	7 cc	G		R		F			R	R			R		F	C	C			R		
		8 cc	G				F									R	F	F			R		
		9-1, 70-73	G				C							C			C	A			R		
		9 cc	M					R										R					
		10 cc	G			F	C										A	A			R		
		11 cc	G			R	C										F	C			R		
		12 cc	G			R	F									F	F	C			R		
		13 cc	G				F									F	C	C					
		14 cc	G			R										C	C	C			R		
		15 cc	G				R									R	F	C			R		
		16-4, 53-54	M														F	F					
		16 cc	G		R	R	F					R		F			C				R		
		HOLE 298A																					
HOLO./ PLEIST.	*E. huxleyi*	1 cc	G				R								C	R	R		C		R		

Black, M. and Barnes, B., 1961. Coccoliths and discoasters from the floor of the South Atlantic Ocean: J. Roy. Micro. Soc., v. 80, p. 137-147.

Boudreaux, J.E. and Hay, W.W., 1969. Calcareous nannoplankton and biostratigraphy of the late Pliocene-Pleistocene-Recent sediments in the Submarex cores: Rev. Espan. Micropaleontol., v. 1, p. 249-292.

Bramlette, M.N. and Riedel, W.R., 1954. Stratigraphic value of discoasters and some other microfossils related to Recent coccolithophores: J. Paleontol., v. 28, p. 385-403.

Bramlette, M.N. and Sullivan, F.R., 1961. Coccolithophorids and related nannoplankton of the early Tertiary in California: Micropaleontology., v. 7, p. 129-188.

Bramlette, M.N. and Wilcoxon, J.A., 1967a. Middle Tertiary calcareous nannoplankton of the Cipero Section, Trinidad, W.I.: Tulane Stud. Geol. Paleontol., v. 5, p. 93-131.

———, 1967b. *Discoaster druggi* nom. nov. pro *Discoaster extensus* Bramlette and Wilcoxon, 1967, non Hay, 1967: Tulane Stud. Geol. Paleontol., v. 5, p. 220.

TABLE 10
Nannofossil Occurrences at Site 299

SITE 299															
AGE		NANNO-FOSSIL ZONE OR SUBZONE	CORE, SECTION, INTERVAL (cm)	PRESERVATION	*Braarudosphaera bigelowi*	*Coccolithus pelagicus*	*Cyclococcolithina leptopora*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa caribbeanica*	*G. doronicoides*	*G. oceanica*	*Helicopontosphaera kamptneri*	*Umbilicosphaera cricota*
HOLOCENE/ PLEISTOCENE		*Emiliania huxleyi*	1 cc	P		R			R				R		
			2-2, 50-51	P		A				R			R		
			2 cc	M	R	R			C				C		
			3 cc	M		R			F				F	R	
			4 cc	M		R	R		R			R	F	R	
			5 cc	M	R	F	R		R		C	F	F	R	R
			6-4, 45-46	G		C	R		C			F	A		
			6 cc	M	R	F	R		C			C	A		
			8-2, 12-13	M		R			R			R	F		
			8 cc	M		R			F			F	C		
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	9 cc	P		R	R						R		
			10-2, 55-56	M	R	F	R	R		R	R	R	F		
			10-4, 20-21	M		F					F	R	R		
			10 cc	P		F					R	R	F		
			11 cc	P		R	R						R		
			13-2, 20-21	M		R						R	F		
			13 cc	M		R							R		
			14-2, 2-3	P		F							R		
			14 cc	M		R									
			15-2, 55-56	M		R					R		R		
	EARLY	*Gephyrocapsa caribbeanica*	15-4, 60-61	P	R	R						R		R	
			15 cc	P	R	R		R						R	
			16-4, 80-81	P		R					R				
			16 cc	P	R	R						R			
			17-2, 75-76	P		F	R	R			F			R	
			17 cc	P		R					F	F		R	
			18-2, 71-72	P							R	R			
			22-4, 60-61	P		R				R					
			22 cc	P	R	R	R					R		R	
			23 cc	P		R	R								
			26 cc	P		R	R				R				
			30 cc	P		R					R				
?		?	38-6, 119-120	P		R									

Brönnimann, P. and Stradner, H., 1960. Die Foraminiferen- und Discoasteriden-zonen von Kuba and ibre interkontinentale Korrelation: Erdoel-Z., v. 76, p. 364-369.

Bukry, D., 1970. Coccolith age determinations, Leg 4, Deep Sea Drilling Project. *In* Bader, R.G., et al., Initial Reports of the Deep Sea Drilling Project, Volume 4: Washington (U.S. Government Printing Office), p. 375-381.

———, 1971a. Cenozoic calcareous nannofossils from the Pacific Ocean: San Diego Soc. Nat. Hist. Trans., v. 16, p. 303-328.

———, 1971b. Discoaster evolutionary trends: Micropaleontology, v. 17, p. 43-52.

———, 1973a. Coccolith stratigraphy, eastern equatorial Pacific, Leg 16 Deep Sea Drilling Project. *In* van Andel, T.H., Heath, G.R., et al., Initial Reports of the Deep Sea Drilling Project, Volume 16: Washington (U.S. Government Printing Office), p. 653-711.

———, 1973b. Low-latitude Coccolith biostratigraphic zonation. *In* Edgar, N.T., Saunders, J.B., et al., Initial Reports of the Deep Sea Drilling Project, Volume 15: Washington (U.S. Government Printing Office), p. 685-703.

———, 1973c. Phytoplankton stratigraphy, Deep Sea Drilling Project Leg 20, western Pacific Ocean. *In* Heezen, B.C., MacGregor, I.D., et al., Initial Reports of the Deep Sea Drilling Project, Volume 20: Washington (U.S. Government Printing Office), p. 307-317.

Bukry, D. and Bramlette, M.N., 1968. Stratigraphic significance of two genera of Tertiary calcareous nannofossils: Tulane Stud. Geol. Paleontol., v. 6, p. 149-155.

———, 1969. Some new and stratigraphically useful calcareous nannofossils of the Cenozoic: Tulane Stud. Geol. Paleontol., v. 7, p. 131-142.

Bukry, D. and Percival, S.F., 1971. New Tertiary calcareous nannofossils: Tulane Stud. Geol. Paleontol., v. 8, p. 123-146.

Cohen, C.L.D., 1964. Coccolithophorids from two Caribbean deep-sea cores: Micropaleontology, v. 10, p. 231-250.

Cohen, C.L.D. and Reinhardt, P., 1968. Coccolithophorids from the Pleistocene Caribbean deep-sea core CP-28: N. Jb. Geol. Palaont., Abhandl., v. 131, p. 289-304.

Deflandre, G., 1942. Coccolithophoridées fossiles d'oranie genres *Scyphosphaera* Lohmann et *Thorosphaera* Ostfeld: Soc. Hist. Nat. Toulouse Bull., v. 77, p. 125-137.

———, 1947. *Braarudosphaera* nov. gen., type d'une famille nouvelle de Coccolithophoridés actuels à éléments composites: C.R. Acad. Sci., Paris, v. 225, p. 439-441.

———, 1953. Hétérogenéité intrinsèque et pluralité des éléments dans les coccolithes actuels et fossils: C. R. Acad. Sci., Paris, v. 237, p. 1785-1787.

Deflandre, G. and Fert, C., 1954. Observations sur les Coccolithophoridés actuels et fossiles en microscope ordinaire et electronique: Ann. Paleontol., v. 40, p. 117-176.

Ellis, C.H., Lohman, W.H., and Wray, J.L., 1972. Upper Cenozoic calcareous nannofossils from the Gulf of Mexico (Deep Sea Drilling Project, Leg 1, Site 3): Colorado School Mines Quart., v. 67, 103 p.

Gaarder, K.R., 1970. Three new taxa of Coccolithineae: Nytt. Mag. Bot., v. 17, p. 113-126.

Gartner, S., Jr., 1967. Calcareous nannofossils from Neogene of Trinidad, Jamaica, and Gulf of Mexico: Kansas Univ. Paleontol. Contr., Paper 29, p. 1-7.

———, 1969a. Two new calcareous nannofossils from the Gulf Coast Eocene: Micropaleontology, v. 15, p. 31-34.

———, 1969b. Correlation of Neogene planktonic foraminifer and calcareous nannofossil zones: Gulf Coast Assoc. Geol. Soc. Trans., v. 19, p. 585-599.

Gartner, S., Jr., and Smith, L.A., 1967. Coccoliths and related calcareous nannofossils from the Yazoo Formation (Jackson, Late Eocene) of Louisiana: Kansas Univ. Paleontol. Contr., Paper 20, p. 1-7.

Gran, H.H. and Braarud, T., 1935. A qualitative study of the phytoplankton in the Bay of Fundy and the Gulf of Maine: J. Biol. Board Canada, v. 1, p. 279-467.

Grassé, P.P., 1952. Traité de Zoologie: Anatomie, systématique, biologie:, v. 1, fasc. 1: Phylogénie. Protozoaires: genéralités. Flagellés. Paris (Masson).

Haq, B.U., 1966. Electron microscope studies on some Upper Eocene calcareous nannoplankton from Syria: Stockholm Contr. Geol., v. 15, p. 23-37.

Haq, B.U., 1973. Evolutionary trends in the Cenozoic coccolithophore genus *Helicopontosphaera*: Micropaleontology, v. 19, p. 32-52.

Hay, W.W., 1970. Calcareous nannofossils from cores recovered on Leg 4. *In* Bader, R.G., Gerard, R.D., et al., Initial Reports of the Deep Sea Drilling Project, Volume 4: Washington (U.S. Government Printing Office), p. 455-501.

Hay, W.W., Mohler, H., Roth, P.H., Schmidt, R.R., and Boudreaux, J.E., 1967. Calcareous nannoplankton zonation of the Cenozoic of the Gulf Coast and Caribbean-Antillean area, and transoceanic correlation: Gulf Coast Assoc. Geol. Soc. Trans., v. 17, p. 428-480.

TABLE 11
Nannofossil Occurrences at Sites 300, 301, and 302

Age		Nannofossil Zone or Subzone	Site, Core, Section, Interval (cm)	Preservation	*Braarudosphaera bigelowi*	*Ceratolithus cristatus*	*Coccolithus pelagicus*	*Cyclicargolithus abisectus*	*Cyclococcolithina leptopora*	*Discoaster deflandrei*	*Emiliania annula*	*E. huxleyi*	*E. ovata*	*Gephyrocapsa caribbeanica*	*G. doronicoides*	*G. oceanica*	*Helicopontosphaera kamptneri*	*Reticulofenestra pseudoumbilica*	*Sphenolithus ciperoensis*	*Umbilicosphaera cricota*
			SITE 300																	
HOLO./PLEIST.		*Emiliania huxleyi*	1 cc	P			R													
HOLO./PLEIST.		*Emiliania huxleyi*	2 cc	G			R					R	R	R	C	C	R			R
			SITE 301																	
HOLO./PLEIST.		*Emiliania huxleyi*	2-3, 45-46	P											R	R				R
HOLO./PLEIST.		*Emiliania huxleyi*	2-5, 120-121	M	R		R					A	R		C	A				R
PLEI.	L.	*G. oceanica*	2 cc	M			R									F				
PLEI.	E.	*G. caribb.*	4 cc	G			R						R	C			R			
?		?	6 cc	M			R										R	R		
			SITE 302																	
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	1 cc	M			R						R			R				
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	2 cc	M			R				R									
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	3-2, 36-37	P			R		R											
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	3-4, 50-51	M			A		F				F	A	C	F				
PLEISTOCENE	LATE	*Gephyrocapsa oceanica*	3 cc	P		R												R		
PLEISTOCENE	E.	*G. doron.?*	4-2, 70-71	P											R					
PLIO.		*R. pseudo.?*	5 cc	P														R		
MIOCENE?	LATE?	?	10 cc	P				R	R										R	
MIOCENE?	LATE?	?	11 cc	M					R											
MIOCENE?	LATE?	?	14 cc	P				R												
MIOCENE?	LATE?	?	16 cc	P						R										
MIOCENE?	LATE?	?	17-2, 70-71	P				R												

Hay, W.W., Mohler, H.P., and Wade, M.E., 1966. Calcareous nannofossils from Nal'chik (Northwest Caucasus): Ecolog. Geol. Helv., v. 59, p. 379-399.

Kamptner, E., 1937. Neue und bermerkenswerte Coccolithineen aus dem Mittelmeer: Arch. Protistenk., v. 89, p. 279-316.

———, 1943. Zur revision der coccolithineen-spezies *Pontosphaera huxleyi:* Anz. Akad. Wiss. Wien, Math-Naturw., Kl. 80, p. 43-49.

———, 1948. Coccolithen aus dem Torton des Inneralpinen Wiener Beckens: Sitz.-Ber. Osterr. Akad. Wiss., Math.-Naturw. Kl., Abt. I, v. 157, p. 1-16.

———, 1954. Untersuchungen über den Feinbau der coccolithen: Arch. Protistenk., v. 100, p. 1-90.

———, 1963. Coccolithineen-Skelettreste aus Tiefseeablagerungen des Pazifischen Ozeans: Ann. Naturh. Mus. Wien, v. 66, p. 139-204.

Kamptner, E., 1967. Kalkfalgellaten-Skelettreste aus Tiefseeschlamm des Sudatlantik: Ann. Naturh. Mus. Wien, v. 71, p. 117-198.

Levin, H.L., 1965. Coccolithophoridae and related microfossils from the Yazoo Formation (Eocene) of Mississippi: J. Paleontol., v. 39, p. 265-272.

Loeblich, A.R., Jr., and Tappan, H., 1966. Annotated index and bibliography of the calcareous nannoplankton: Phycologia, v. 5, p. 81-216.

———, 1968. Annotated index and bibliography of the calcareous nannoplankton II: J. Paleontol., v. 42, p. 584-598.

———, 1969. Annotated index and bibliography of the calcareous nannoplankton III: J. Paleontol., v. 43, p. 568-588.

———, 1970a. Annotated index and bibliography of the calcareous nannoplankton IV: J. Paleontol., v. 44, p. 558-574.

———, 1970b. Annotated index and bibliography of the calcareous nannoplankton V: Phycologia, v. 9, p. 157-174.

———, 1971. Annotated index and bibliography of the calcareous nannoplankton VI: Phycologia, v. 10, p. 315-339.

———, 1973. Annotated index and bibliography of the calcareous nannoplankton VII: J. Paleontol., v. 47, p. 715-759.

Lohmann, H., 1902. Die Coccolithophoridae, eine monographie der coccolithen bildenden Flagellaten, zugleich ein Beitrag zur Kenntnis des Mittelmeerauftriebs: Arch. Protistenk., v. 1, p. 89-165.

Markali, J. and Paasche, E., 1955. On two species of *Umbellosphaera*, a new marine coccolithophorid genus: Nytt. Mag. Bot., v. 4, p. 95-100.

Martini, E., 1958. Discoasteriden und verwandte formen in NW-deutschen Eozän (Coccolithophorida): Senckenb. Lethaea, v. 39, p. 353-388.

———, 1965. Mid-Tertiary calcareous nannoplankton from Pacific deep-sea cores: Symp. Colston Res. Soc. Proc. 17th, p. 393-411.

———, 1969. Nannoplankton aus dem Miozän von Gabon (Westafrika): N. J. Geol. Palaont., Abhandl., v. 132. p. 285-300.

———, 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation: *In* Farinacci, A. (Ed.), Plank. Conf., Roma, 1970 Proc., Rome (Tecnoscienza), v. 2, p. 738-785.

Martini, E. and Bramlette, M.N., 1963. Calcareous nannoplankton from the experimental Mohole drilling: J. Paleontol., v. 37, p. 845-856.

Martini, E. and Ritzkowski, S., 1968. Was is das "Unter-Oligocän"?: Nachr. Akad. Wiss. Göttingen, II Math.-Phys. Kl., Jahrg. 1968, p. 231-249.

Martini, E. and Worsley, T., 1970. Standard Neogene calcareous nannoplankton zonation: Nature, v. 115, p. 289-290.

Müller, C., 1970. Nannoplankton aus dem Mittel-Oligozän von Norddeutschland und Belgien: N. Jb. Geol. Palaont., Abhandl., v. 135, p. 82-101.

Murray, G. and Blackman, V.H., 1898. On the nature of the coccospheres and rhabdospheres: Phil. Trans. Roy. Soc. Lond., ser. B, v. 190, p. 427-441.

Roth, P.H., 1970. Oligocene calcareous nannoplankton biostratigraphy: Ecolog. Geol. Helv., v. 63, p. 799-881.

———, 1973. Calcareous nannofossils—Leg 17, Deep Sea Drilling Project. *In* Winterer, E.L., Ewing, J.L., et al., Initial Reports of the Deep Sea Drilling Project, Volume 17: Washington (U.S. Government Printing Office), p. 695-795.

Roth, P.H., Franz, H.E., and Wise, S.W., Jr., 1971. Morphological study of selected members of the genus *Sphenolithus* Deflandre (Incertae sedis, Tertiary). *In* Farinacci, A. (Ed.) Plank. Conf. 2nd, Rome, Proc. 1970, Roma (Tecnoscienza), v. 2, p. 1099-1119.

Roth, P.H. and Thierstein, H.R., 1972. Calcareous nannoplankton, Leg 14 of the Deep Sea Drilling Project. *In* Hayes, D.E., Pimm, A.C., et al., Initial Reports of the Deep Sea Drilling Project, Volume 14: Washington (U.S. Government Printing Office), p. 421-485.

Schiller, J., 1930. Coccolithineae: *In* Rabenhorst, L., Kryptogamen-Flora von Deutschland, Osterreich und der Schweiz: Leipzig, Akad. Verlagsgesellschaft, v. 10, no. 2, p. 89-267.

Stradner, H., 1961. Vorkommen von nannofossilien im Mesozoikum und Alttertiär: Erdoel-Z., v. 77, p. 77-88.

Tan Sin Hok, 1927. Over de samenstelling en het onstaan van krijt en mergelgesteenten van de Molukken: Jb. Mijnw. Nederl.-Indië, v. 55, p. 111-122.

Wallich, G.G., 1877. Observations on the coccosphere: Ann. Mag. Nat. Hist., v. 19, 4th ser., p. 342-350.

Weber-Van Bosse, A., 1901. Etudes sur les algues de l'Archipel Malaisien. III. Note préliminaire sur les résultats algologiques de l'expédition du *Siboga*: Ann. Jard. Bot. Buitenzorg, v. 17, p. 126-141.

Wilcoxon, J.A., 1970. *Cyclococcolithina* Wilcoxon nom. nov. (Nom. Subst. pro *Cyclococcolithus* Kamptner, 1954): Tulane Stud. Geol. Paleontol., v. 8, p. 82-83.