15. CALCAREOUS NANNOFOSSILS – LEG 15, DEEP SEA DRILLING PROJECT[1]

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INTRODUCTION

This account of the calcareous nannoplankton encountered in cores recovered on Leg 15 of the Deep Sea Drilling Project is intended to serve as an aid in the selection of samples for more detailed studies. Indications of the abundance and state of preservation of calcareous nannofossils are given in the sections of this volume dealing with the description of the cores. This chapter contains (1) a list of the species recognized; (2) a summary of the highest and lowest occurrence surfaces and zones used to determine stratigraphic position of samples, with data on the position of each surface in each of the holes cored; (3) a series of tables presenting data on the abundances of the species recognized in each of the samples examined; and (4) a special section on the Pleistocene calcareous nannofossils found in Holes 147, 148, 149, and 154A.

SPECIES RECOGNIZED

The following list includes all of the species which have been recognized and tabulated in Tables 1 through 30. The full species name and author is given with an indication of the genus in which the species was originally placed. Species discussed in more detail in the special section on the Pleistocene are indicated with an asterisk. The original descriptions of the other species can be found by consulting the annotated indices and bibliographies of the calcareous nannoplankton published by Loeblich and Tappan (1966, 1968, 1969, 1970a, 1970b).

Actinozygus splendens (Deflandre) (ex Rhabdolithus)
Ahmuellerella octoradiata (Gorka) (ex Discolithus)
Arkhangelskiella costata Gartner
Arkhangelskiella cymbiformis Vekshina
Arkhangelskiella ethmopora Bukry
Arkhangelskiella parca Stradner
Arkhangelskiella specillata Vekshina
**Braarudosphaera bigelowi* (Gran & Braarud) (ex Pontosphaera)
Campylosphaera dela (Bramlette & Sullivan) (ex Coccolithites)
Catinaster calyculus Martini & Bramlette
Catinaster coalitus Martini & Bramlette
**Ceratolithus cristatus* Kamptner
Ceratolithus rugosus Bukry & Bramlette
Ceratolithus tricorniculatus Gartner
Chiasmolithus bidens (Bramlette & Sullivan) (ex Coccolithus)
Chiasmolithus californicus (Sullivan) (ex Coccolithus)
Chiasmolithus consuetus (Bramlette & Sullivan) (ex Coccolithus)
Chiasmolithus danicus (Brotzen) (ex Cribrosphaerella)
Chiasmolithus gigas (Bramlette & Sullivan) (ex Coccolithus)
Chiasmolithus grandis (Bramlette & Riedel) (ex Coccolithus)
Chiasmolithus oamaruensis (Deflandre) (ex Tremalithus)
Chiasmolithus solitus (Bramlette & Sullivan) (ex Coccolithus)
Chiasmolithus sp. (isolated rims)
Chiastozygus plicatus Gartner
Chiastozygus sp.
Coccolithus apomnemoneumus Hay & Mohler
Coccolithus carteri (Wallich) (ex Coccosphaera)
Coccolithus cavus Hay & Mohler
Coccolithus crassus Bramlette & Sullivan
Coccolithus pataecus Gartner
**Coccolithus pelagicus* (Wallich) (ex Coccosphaera)
Coccolithus pseudocarteri Hay, Mohler, & Wade
Coronocyclus nitescens (Kamptner) (ex Umbilicosphaera)
Coronocyclus serratus Hay, Mohler, & Wade
Cretarhabdus conicus Bramlette & Martini
Cretarhabdus crenulatus Bramlette & Martini
Cribrosphaera ehrenbergi ***Arkhangelskii***
Cribrosphaera linea (Gartner) (ex Cribrosphaerella)
Cruciplacolithus tenuis (Stradner) (ex Heliorthus)
Cyclicargolithus floridanus (Roth & Hay) (ex Coccolithus)
**Cyclococcolithina leptopora* (Murray & Blackman) (ex Coccosphaera)
Cyclococcolithina macintyrei (Bukry & Bramlette) (ex Cyclococcolithus)
Cyclolithella annula (Cohen) (ex Coccolithites)
Cylindralithus sp.
Discoaster adamanteus Bramlette & Wilcoxon
Discoaster aster Bramlette & Riedel
Discoaster asymmetricus Gartner
Discoaster aulakos Gartner
Discoaster barbadiensis Tan Sin Hok
Discoaster binodosus Martini
Discoaster bollii Martini & Bramlette
Discoaster brouweri brouweri Tan Sin Hok (= Discoaster brouweri)
**Discoaster brouweri rutellus* Gartner
Discoaster brouweri subsp. *tamalis* Kamptner (= Discoaster tamalis Kamptner)
Discoaster brouweri subsp. *tridenus* Kamptner (= Discoaster tridenus Kamptner)

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Discoaster brouweri subsp. *triradiatus* Tan Sin Hok (= Discoaster triradiatus Tan Sin Hok)
Discoaster challengeri Bramlette & Riedel
Discoaster deflandrei Bramlette & Riedel
Discoaster diastypus Bramlette & Sullivan
Discoaster dilatus Hay
Discoaster divaricatus Hay
Discoaster druggi Bramlette & Wilcoxon
Discoaster exilis Martini & Bramlette
Discoaster extensus Hay
Discoaster gemmeus Stradner
Discoaster gemmifer Stradner
Discoaster hamatus Martini & Bramlette
Discoaster kugleri Martini & Bramlette
Discoaster lenticularis Bramlette & Sullivan
Discoaster lidzi Hay
Discoaster lodoensis Bramlette & Riedel
Discoaster mediosus Bramlette & Sullivan
Discoaster multiradiatus Bramlette & Riedel
Discoaster neohamatus Bukry & Bramlette
Discoaster nephados Hay
Discoaster nobilis Martini
**Discoaster pentaradiatus* Tan Sin Hok
Discoaster perclarus Hay
Discoaster perplexus Bramlette & Riedel
Discoaster phyllodus Hay
Discoaster quinqueramus Gartner
Discoaster saipanensis Bramlette & Riedel
Discoaster saundersi Hay
Discoaster sp.
Discoaster sublodoensis Bramlette & Sullivan
Discoaster subsurculus Gartner
**Discoaster surculus* Martini & Bramlette
Discoaster tani nodifer Bramlette & Riedel
Discoaster tani ornatus Bramlette & Wilcoxon
Discoaster tani tani Bramlette & Riedel
Discoaster trinidadensis Hay
Discoaster variabilis Martini & Bramlette
Discoaster woodringi Bramlette & Riedel
Discoasteroides kuepperi (Stradner) (ex Discoaster)
Discolithina japonica Takayami
**Discolithina cf. macropora* (Deflandre)
**Discolithina spp.*
**"Discolithus" phaseolus* Black & Barnes
**Discosphaera tubifera* (Murray & Blackman) (ex Rhabdosphaera)
Eiffellithus turriseiffeli (Deflandre) (ex Zygolithus)
**Ellipsodiscoaster lidzi* Boudreaux & Hay
**Emiliania huxleyi* (Lohmann) (ex Pontosphaera)
Ericsonia subpertusa Hay & Mohler
Fasciculithus involutus Bramlette & Sullivan
Fasciculithus janii Perch-Nielsen
Fasciculithus tympaniformis Hay & Mohler
**Gephyrocapsa californiensis* Kamptner
**Gephyrocapsa kamptneri* Deflandre
**Gephyrocapsa oceanica* Kamptner
**Gephyrocapsa parallela* Beaudry & Hay, n. sp.
**Gephyrocapsa sinuosa* Beaudry & Hay, n. sp.
**Gephyrocapsa sp.* (isolated rims)
Glaukolithus diplogrammus (Deflandre) (ex Zygolithus)
Helicopontosphaera ampliaperta (Bramlette & Wilcoxon) (ex Helicosphaera)
Helicopontosphaera intermedia (Martini) (ex Helicosphaera)
**Helicopontosphaera kamptneri* Hay & Mohler
Helicopontosphaera parallela (Bramlette & Wilcoxon) (ex Helicosphaera)
Helicopontosphaera recta (Haq) (ex Helicosphaera; H. seminulum ssp. recta)
**Helicopontosphaera sellii* Bukry & Bramlette
**Helicopontosphaera wallichi* (Lohmann) (ex Coccolithophora)
Heliolithus kleinpelli Sullivan
Heliolithus cf. riedeli Bramlette & Riedel
Heliorthus concinnus (Martini) (ex Zygolithus)
Kamptnerius magnificus Deflandre
Kamptnerius punctatus Stradner
Lithastrinus grilli Stradner
Lithraphidites carniolensis Deflandre
Lithraphidites quadratus Bramlette & Martini
"Loxolithus" Noel
Lucianorhabdus cayeuxi Deflandre
Markalius astroporus (Stradner) (ex Cyclococcolithus)
Marthasterites furcatus (Deflandre) (ex Discoaster)
Marthasterites tribrachiatus (Bramlette & Riedel) (ex Discoaster)
Microrhabdulus decoratus Deflandre
Microrhabdulus stradneri Bramlette & Martini
Micula staurophora (Gardet) (ex Discoaster)
Neococcolithes protenus (Bramlette & Sullivan) (ex Zygolithus)
Oolithotus antillarum (Cohen) (ex Discolithus)
Parhabdolithus embergeri (Noel) (ex Discolithus)
Pontosphaera discopora Schiller
**Pontosphaera scutellum* Kamptner
**Pontosphaera spp.*
Prediscosphaera cretacea (Arkhangelskii) (ex Coccolithophora)
Prinsius bisulcus Hay & Mohler
**Pseudoemiliania lacunosa* Kamptner ex Gartner
Reticulofenestra bisecta (Hay, Mohler, & Wade) (ex Syracosphaera)
Reticulofenestra cf. pseudoumbilica Gartner (very small specimens)
Reticulofenestra pseudoumbilica Gartner
Reticulofenestra umbilica (Levin) (ex Coccolithus)
**Rhabdosphaera clavigera* Murray & Blackman
**Rhabdosphaera stylifera* Lohmann
**Scapholithus fossilis* Deflandre
**Scyphosphaera apsteini* Lohmann
Sphenolithus abies Deflandre
Sphenolithus anarrhopus Bukry & Bramlette
Sphenolithus belemnos Bramlette & Wilcoxon
Sphenolithus ciperoensis Bramlette & Wilcoxon
Sphenolithus heteromorphus Deflandre
Sphenolithus furcatolithoides Locker
Sphenolithus moriformis Bronnimann & Stradner
Sphenolithus neoabies Bukry & Bramlette
Sphenolithus pacificus Martini
Sphenolithus predistentus Bramlette & Wilcoxon
Sphenolithus radians Deflandre
**Syracosphaera clava* Beaudry & Hay, n. sp.
**Syracosphaera decussata* Beaudry & Hay, n. sp.
**Syracosphaera histrica* Kamptner

*Syracosphaera jonesi (Cohen) (ex Cricolithus)
Syracosphaera labrosa Bukry & Bramlette
**Syracosphaera pulchra* Lohmann
**Syracosphaera sp.*
Tetralithus aculeus (Stradner) (ex Zygrhablithus)
Tetralithus cf. murus Martini
Tetralithus gothicus Deflandre
Tetralithus gothicus trifidus Stradner
Thoracospahera pelagica Kamptner
**Thoracosphaera saxea* Stradner
Tranolithus sp.
Triquetrorhabdulus carinatus Martini
Triquetrorhabdulus inversus Bukry & Bramlette
Triquetrorhabdulus rugosus Bramlette & Wilcoxon
Umbilicosphaera cricota (Gartner) (ex Cyclococcolithus)
**Umbilicosphaera mirabilis* Lohmann
Watznaueria barnesae (Black) (ex Tremalithus)
Zygodiscus adamas Bramlette & Sullivan
Zygodiscus pseudoanthophorus Bramlette & Martini
Zygodiscus sigmoides Bramlette & Sullivan
Zygodiscus simplex (Bramlette & Sullivan) (ex Zygrhablithus)
Zygodiscus sp.
*"Little u"
*"*Truncate-elongate coccolith*"

OCCURRENCE SURFACES AND ZONES

During investigation of the cores, special attention was given to determining the position of the highest and lowest occurrences of species of known stratigraphic value. Zones are defined as the interval between successive surfaces of biostratigraphic importance. The philosophy of the methods used here is elucidated in a recent paper by Hay (1972).

Figure 1 presents the surfaces recognized in this study, and lists the zones defined by these surfaces. The zonal terminology is used on the core descriptions elsewhere in this volume and in Tables 1 through 30. Figure 2 summarizes the information contained in Tables 1 through 30 and shows the positions of the surfaces and zones in terms of the samples which bracket them. This figure is intended as a guide to locating intervals of particular interest.

ABUNDANCES OF SPECIES IN CORES RECOVERED ON LEG 15

The following brief discussions of the calcareous nannofossil biostratigraphy of cores recovered on Leg 15 supplement the detailed information on the distribution of species indicated in Tables 1 through 30. Species abundances are recorded in the tables as the logarithm of abundance in a smear slide viewed at 1000X. The number "+2" indicates that hundreds of specimens of a species are present in a single field of view (a condition which is rare in strata older than Pleistocene); "+1" indicates tens of specimens in a single field of view; and "0" indicates a single specimen in a field of view. "–1" indicates a single specimen of the species is encountered in ten fields of view; "–2" indicates a single specimen in hundred of fields of view; and "–3" (rarely used here) indicates a single specimen in thousands of fields of view.

Site 146

Calcareous nannoplankton occur in the uppermost part of Section 1 and in the core catcher sample of Core 1 (Table 1). Both assemblages are similar, and contain *Discoaster brouweri, D. pentaradiatus, D. quinqueramus,* and other species characteristic of the late Miocene *Discoaster quinqueramus* Zone. All other samples from Core 1 proved to be barren of these fossils, suggesting that the top of Section 1 and the core catcher sample may represent contamination from slumping of layers higher in the hole.

Core 2 (Table 1) contains a rich and varied assemblage, enriched in asteroliths, with abundant specimens of *Triquetrorhabdulus carinatus.* Typical specimens of *Discoaster druggi* occur in samples from Sections 2, 3, and 4, so that these strata may be assigned to the *Discoaster druggi* Zone of the Early Miocene. Sections 5 and 6 contain *Discoaster* cf. *druggi* as a relatively rare asterolith component, suggesting that the base of the barrel belongs to the *Triquetrorhabdulus carinatus* Zone (Early Miocene or Late Oligocene). No sphenoliths other than *Sphenolithus moriformis* and *S. pacificus* occur in these samples.

TABLE 1
Calcareous Nannofossils in Cores 1 and 2, Hole 146

Age	a		Early Eocene							
Zone	b		*Discoaster druggi*				*Triquetrorhabdulus carinatus*			
Sample Level	1-1(25-26)	1(CC)	2-2(130-131)	2-3(142-146)	2-4(60-70)	2-4(105-115)	2-5(36-37)	2-5(122-123)	2-6(52-53)	2-6(117-118)
Total Abundance	–2	+2	+1	+1	+2	+1	+2	+2	+2	+2
Ceratolithus tricorniculatus		–2								
Coccolithus eopelagicus			–1		–1					–1
C. pelagicus			+1	+1	+1	+1	+1	+1	+1	+1
C. pseudocarteri			–1							·
Cyclicargolithus floridanus			+1	0	+1	+1		+1	0	+1
Cyclococcolithina leptopora		–1								
Discoaster adamanteus				–1	0	–1	0	0	0	
D. argutus				–2		–2				
D. asymmetricus		+1								
D. brouweri rutellus	–2	0								
D. deflandrei			0	–1	0	0	–1			
D. druggi			0	–1	0	0	?	?	?	?
D. extensus		0								
D. pentaradiatus	–2	+1								
D. quinqueramus	–2	+1								
D. surculus		–1								
D. trinidadensis					–1					
D. cf. *woodringi*					0		0	0	0	
Helicopontosphaera parallela			0							
Reticulofenestra bisecta			+1	0	+1	+1	0	0	0	+1
R. pseudoumbilica		0								
Sphenolithus moriformis			0		0	0	0	–1	0	+1
S. pacificus			0		0		+1	+1	0	+1
Triquetrorhabdulus carinatus			0	0	0	0	+1	0	0	0

[a]Late Miocene

[b]*Discoaster quinqueramus*

Figure 1. *Surfaces and zones based on calcareous nannofossils used in this study. (HOS = highest occurrence surface; LOS = lowest occurrence surface).*

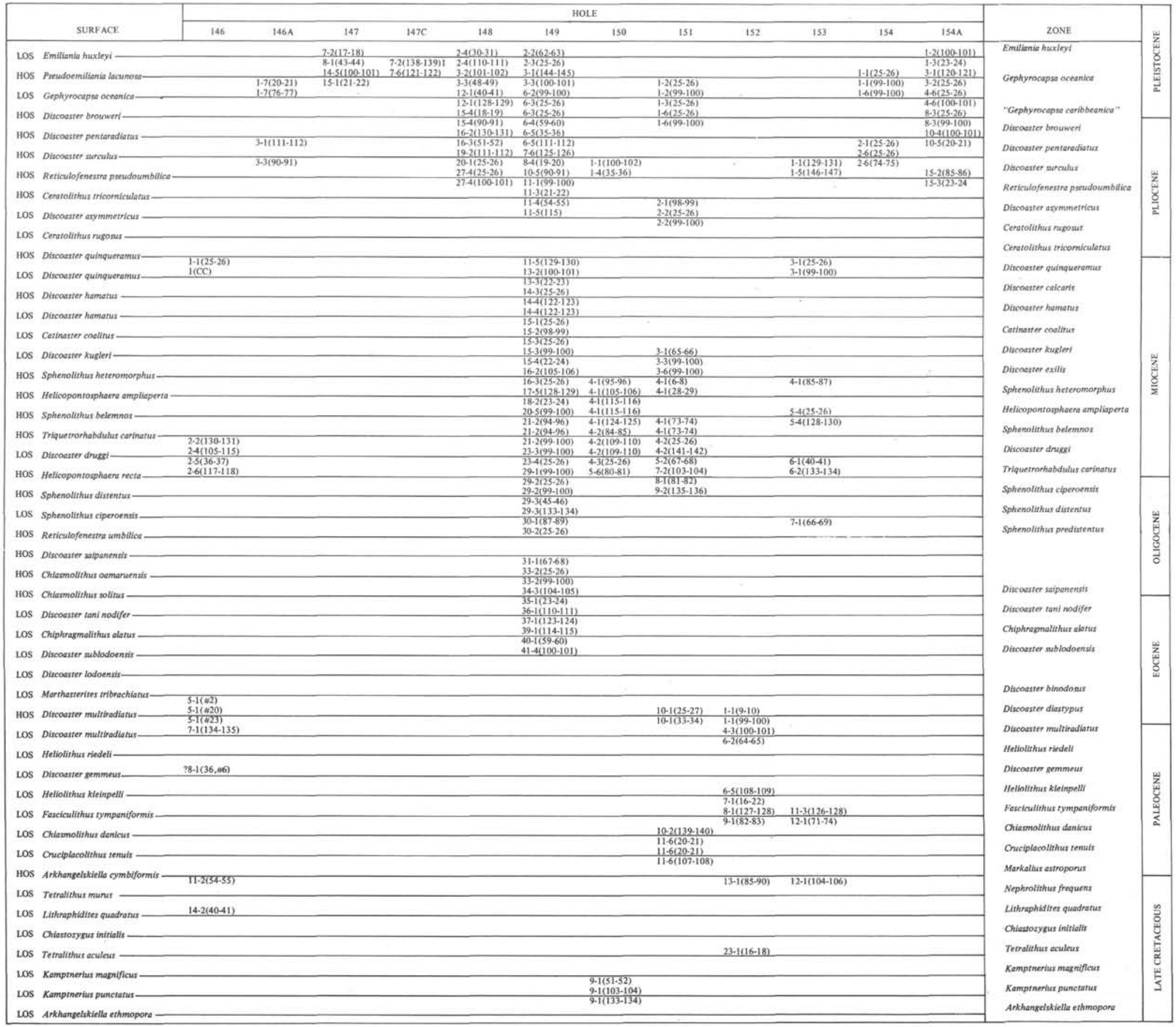

Figure 2. *Relation of cores recovered on Leg 15 to surfaces and zones based on calcareous nannofossils.*

TABLE 2
Calcareous Nannofossils in Cores 5 through 8, Hole 146

Age	Eocene						Paleocene										
Zone	*Discoaster diastypus*						*Discoaster multiradiatus*									a	
Sample / Level	5-1(#2)	5-1(#6)	5-1(#14)	5-1(#15)	5-1(#16)	5-1(#20)	5-1(#23)	5-1(#25)	5-1(#26)	5-2(#30)	5-2(#35)	5-2(#39)	6-1(117-122)	7-1(53-54)	7-1(134-135)	8-1(10[#1])	8-1(36[#6])
Total Abundance	−1	−1	+1	+1	0	0	+1	0	+1	+1	0	+1	−1	+1	+2	0	−1
Campylosphaera dela			−1	−1					−1								
Chiasmolithus bidens																	−1
C. californicus					−2					−1		−1	−1		−1		
C. consuetus												−1		−1			
C. grandis				−1													
Coccolithus apomnemoneumus			0	+1	0	0	+1	0	+1	+1	+1	+1		+1	+1		
C. cavus	−1	−1	+1	−1	0	0	+1	0	+1	+1	+1	+1	−1	−1	+1		
Discoaster cf. *aster*			0	0	−1	0	−1		0	−1					−1		
D. diastypus			0	+1	−1	−1		−1	0	−1	−1	−1					
D. gemmeus																0	−1
D. lenticularis			0												−2		
D. multiradiatus			0				0		0	−1	−1	0	−1	0	+1		
D. nobilus			−1			−2											
Ericsonia subpertusa		−1	0	+1		0	+1	0	+1	+1	+1	+1	−1	+1	+1		
Fasciculithus tympaniformis														−1	−2	0	−1
Neococcolithes protenus										−1	−1	−1					
Sphenolithus anarrhopus		−2	0	+1					0	?							

[a]*Discoaster gemmeus* or *Heliolithus riedeli*

No calcareous nannoplankton were found in Cores 3 and 4. Distribution of species in samples from Cores 5 through 8 is presented in Table 2. Core 5 contains sparse to good assemblages, with the calcareous nannofossils becoming more abundant and better preserved toward the base of Section 1 and in Section 2. The highest occurrence of *Discoaster multiradiatus* lies between the rocks numbered 20 and 23 [Samples 146-5-1(#20) and 146-5-6(#23)] in Section 1. Higher samples contain *Discoaster diastypus* and a generally sparse assemblage of coccoliths. They may be referred to the *Discoaster diastypus* Zone (Early Eocene) suggested in the Leg 3 report (Bukry and Bramlette, 1970) and consisting of the interval between the highest occurrence of *Discoaster multiradiatus* and the highest occurrence of *Discoaster diastypus*. Lower samples from Section 1, and samples from Section 2 belong to the upper part of the *Discoaster multiradiatus* Zone (Late Paleocene or Early Eocene). Core 6 yielded only sparse assemblages of the *Discoaster multiradiatus* Zone. The lower part of the *Discoaster multiradiatus* Zone (Late Paleocene) is well represented in Core 7; the samples contain a very high proportion of asteroliths of the nominate species as compared to coccoliths. *Fasciculithus tympaniformis* is also present in Core 7 samples. Only the uppermost part of Core 8, the upper 40 cm of Section 1, contains any calcareous nannoplankton fossils. The assemblages are extremely poor, consisting of *Discoaster gemmeus, Fasciculithus tympaniformis,* and a few corroded coccoliths. They belong to either the *Discoaster gemmeus* Zone or to the *Heliolithus riedeli* Zone (Middle Paleocene).

Cores 9 and 10 contain siliceous clays devoid of calcareous nannoplankton fossils.

The distribution of species in Cores 11 through 41R is presented in Table 3. Core 11 contains calcareous nannoplankton fossils below 140 cm in Section 1. Higher samples contain either no calcium carbonate, or, between 114 and 138 cm, contain planktonic foraminifera and a mass of minute carbonate particles not recognizable as calcareous nannoplankton. Below 140 cm, Cretaceous calcareous nannoplankton appear, becoming more abundant and diverse with depth. Only *Micula* and *Tetralithus* sp. are present at 140 cm; *Watznaueria barnesae* appears at 142 cm, and a more diverse assemblage is present in Section 2. None of the Late Maestrichtian marker species are present. Cores 12 and 13 contain the same sort of assemblage as the lower part of Core 11, with species diversity reaching a maximum of about ten in Section 4 of Core 13. Here, specimens resembling the early specimens of *Lithraphidites quadratus* from the Ripley Formation in Alabama are present, and a tentative assignment to the *Lithraphidites quadratus* Zone of Cepek and Hay (1969) seems possible.

From Core 14 to the base of the hole, the calcareous nannofossil assemblages are monotonous, with the same long-ranging species present in most samples. The preservation is generally poor; the centers of many coccoliths lack structure, and other specimens appear to have calcitic overgrowths. Below Core 26, the species diversity drops, and only *Micula, Watznaueria barnesae,* and *Cretarhabdus crenulatus* are recognizable. Throughout this section, the groundmass of the rock appears to be fragments derived from calcareous nannofossils. Short-ranged species useful in subdivision of the Upper Cretaceous are absent throughout the section, and only

TABLE 3
Calcareous Nannofossils in Cores 11 through 41R, Hole 146

Age	Late Cretaceous																																		
Zone	*Lithraphidites quadratus*																																		
Sample / Level	11-1(140)	11-1(142)	11-1(143)	11-2(6-7)	11-2(54-55)	11-2(105-107)	13-1(95-97)	13-1(131-135)	13-2(39-42)	13-2(115-122)	13-3(32-35)	13-3(134-135)	13-4(39-43)	13-4(123-125)	13-5(30-34)	13-5(146-147)	14-1(118-123)	14-1(147-148)	14-2(40-41)	14-2(40-41)	14-2(113-115)	14-3(65-66)	14-3(136-137)	14-4(53-54)	15-2(19-20)	15-2(138-140)	15-3(39-40)	15-3(146-147)	15-4(40-42)	15-4(138-140)	15-5(55-56)	15-5(145-146)	15-6(38-40)	15-6(131-133)	16-1(81-83)
Total Abundance	−1	−1	+1	0	0	0	0	+1	0	0	+1	+1	+1	+1	0	+1	+1	0	0	0	0	0	0	0	+1	+1	0	+1	0	0	0	0	+1	+1	0
Actinozygus splendens					−2																											−1			
Arkhangelskiella costata						−2			−1								−1			−1					−2	−2							0	−1	−1
A. cymbiformis					−2	−2				−2	−1		−1			−1				−2													−1		
A. parca																																			
Chiastozygus sp.								−1																											
Cretarhabdus conicus								−2		−2			−1											−2								−2	−1		−1
C. crenulatus						−2	0	0	0	−1	0	0	0	0	−1	0	0	−1	−1	0	0	0	0	−1	−1	−1	−1	0	−2		−1	−1	0	0	0
Cribrosphaera ehrenbergi						−2		−1																			−1	−2			−2		−1		−1
C. linea								−1	0		−1	−1	−1			−1						0	0	0		−1	−1	0				0	0	0	
Cylindralithus sp.					−2			−1	−1		−1					−1	−1			−1			−2					−1						−1	
Eiffellithus turriseiffeli								−1		−1			−2	0								−1		−1											
Glaukolithus diplogrammus																																−1	0	−1	
Lithraphidites quadratus						?		−1									−2		−2																
L. carniolensis																																			
Microrhabdulus decoratus																	−2									−2									
M. stradneri										−2		−2	−2				−2				−2		−1	−1								−1		−1	−1
Micula staurophora	−1	−1	+1	0	0	0	0	0	0	0	0	0	0	+1	−1	−1	0	−1	−1	0	−1	0	0	−1	0	0	0	0	−1	−1	−1	0	0	0	0
Prediscosphaera cretacea					−2	−1		−1	−1	−1	0	0	0				−1		−1	−1	−1			−1							−1		0	−1	−1
Tetralithus aculeus																																			
T. gothicus													−2				−2																		
T. gothicus trifidus																																			
Watznaueria barnesae		−1	0	−1	0	0	0	+1	+1	0	+1	+1	+1	+1	0	+1	+1	0	0	0	0	0	0	0	+2	+1	0	+1	0	0	0	0	+1	0	0
Zygodiscus pseudoanthophorus								−2		−2		−2								−2		−2	−2		−2	−2	−2	−2			−2		−1		
Z. sp.																																			

TABLE 3 – *Continued*

Age	Late Cretaceous																																		
Zone	*Lithraphidites quadratus*																																		
Sample Level	16-2(9-10)	16-2(107-108)	16-3(30-32)	16-3(143-144)	16-4(40-41)	16-4(147-148)	16-5(60-62)	16-5(146-147)	16-6(112-114)	16-6(147-148)	17-1(81-82)	17-2(21-23)	17-3(122-123)	17-4(18-20)	17-5(52-53)	17-6(110-111)	18-1(53-55)	18-1(113-115)	18-2(59-60)	18-2(118-119)	18-3(95-100)	18-4(101-103)	18-5(78-80)	18-6(67-68)	19-1(101-105)	19-2(31-32)	19-2(141-142)	19-3(80-82)	19-4(63-64)	19-4(86-87)	20-1(51-52)	20-2(57-59)	20-3(56-57)	22-1(143-144)	22-2(112-113)
Total Abundance	0	+1	+1	0	+1	0	0	0	0	0	0	0	0	+1	0	+1	+1	0	0	0	+1	0	+1	0	+1	+1	0	0	0	0	+1	0	0	0	+1
Actinizygus splendens	–2													–2				–2																	
Arkhangelskiella costata			0	–1	0	0	–1	–1	–1	–1	–1	–2	–1	0	–1	0	–1	–1	–1	–2	–1	–1	–1	–1	0	0	–1	–1	–1		–1	–1	–1	–2	0
A. cymbiformis		–2										–2		–1			–2			–2															
A. parca																																			
Chiastozygus sp.			0																																
Cretarhabdus conicus	–1		–1	–1	0						–2	–2		0		0	–2				0		–1	–2		0		–1	–1	–1		–1			0
C. crenulatus	0	0	0	0	0	0	0	0	0		0	0	0	+1	0	+1	0	0	0	–1	0	0	0	0	0	+1		0	0	0	0	0	0	0	+1
Cribrosphaera ehrenbergi		–1	0	–1								–2	–1	0		–1	–1				0		–1		–1						–1				0
C. linea	0	0	0	–1	0	0	0		0	–1		–1	–1	0	0		–1	–1	–1	–1	0	0	0		0		–1	0	–1	–1	0	–1	–1	–1	+1
Cylindralithus sp.								–1				–2				–2			–1	–1		–1					–1		–1				–1		
Eiffellithus turriseiffeli														–2			–2				–1														
Glaukolithus diplogrammus																	–1	–1			–1	–1	–1	–1									–1		0
Lithraphidites quadratus																																			
L. carniolensis														–1	–1	0		–1			–1	–1					–1					–1	–1		
Microrhabdulus decoratus	–1	–1	–1		–1	–1								–1								–1		–1	0	0	–1		0	–1	–1		–1		0
M. stradneri	–1	–1	–1												–2								–1	–1								–1	–		
Micula staurophora	–1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	0	0	0	0	0	0	–1	0	0	–1	0	0	0	–1	+1
Prediscosphaera cretacea	0	0	0		0	0	0		–1	–1	–1	–1	–1	0	–1	0		–1	–1	–2	0		0			0		0	–1	–1	0	–1			0
Tetralithus aculeus						?						–2						–1														–2		–1	
T. gothicus														0	–2	–1	–1	–1				–1	–1	0	–1	0	–2	–1			0		–1	0	0
T. gothicus trifidus																–1			–1	–2		–1	–1	0		–1	–2			–1	0		–1	0	–1
Watznaueria barnesae	0	+1	+1	0	+1	0	0	0	0	0	0	0	0	+1	0	+1	+1	0	0	0	+1	0	+1	0	+1	+1	0	0	0	0	+1	0	0	0	+1
Zygodiscus pseudoanthophorus						–1			–1															–1	–1		–2	–1							
Z. sp.			0		0												–1					–2													0

TABLE 3 – *Continued*

Age	Late Cretaceous																																		
Zone	*Tetralithus aculeus*																																		
Sample Level	22-2(120-121)	23-1(138-139)	23-2(23-24)	23-3(77-79)	24-1(17-18)	25-2(23-24)	26-1(90-91)	26-1(145-146)	26-2(27-28)	26-2(138-140)	27-1(147-148)	27-2(9-12)	27-2(112-114)	28-2(87-88)	28-3(31-32)	28-3(73-74)	29-1(5-7)	30-1(54-55)	30-1(96-97)	30-2(23-27)	30-3(144-145)	30-4(81-82)	31-1(129-130)	31-2(95-97)	31-3(124-126)	31-4(65-70)	32-1(65-67)	32-2(111-112)	33-1(63-65)	33-1(143-144)	34-1(97-98)	35-1(101-102)	35-2(27-28)	38R-1(89-90)	41R-1(89-90)
Total Abundance	0	+1	+1	0	+1	0	+1	0	+1	0	0	+1	0	–1	–1	–1	0	+1	0	+1	0	0	0	0	–1	–1	0	–1	–1	–1	–1	–1	–1	0	–1
Actinozygus splendens																																			
Arkhangelskiella costata	–1	–1	0		–1							–1																							
A. cymbiformis	–2																																		
A. parca						–2			–2																										
Chiastozygus sp.																																			
Cretarhabdus conicus												–1																							
C. crenulatus	0	+1	+1	0	0	0	0	0	+1	–1	0	+1	0	–1		–1		0	–1	0	0	0	0	0		–1				–1					–1
Cribrosphaera ehrenbergi																																			
C. linea	–1		+1	0		–1			0			0																							
Cylindralithus sp.			–1				–1																												
Eiffellithus turriseiffeli							?													–1															
Glaukolithus diplogrammus					–1																														
Lithraphidites quadratus																																			
L. carniolensis			0																																
Microrhabdulus decoratus																																			
M. stradneri																																			
Micula staurophora	–1	0	0	0		0	0	0	0	0	0	0	0				0		–1	0			–1	0	–1					–1					
Prediscosphaera cretacea		0	0	0																0															
Tetralithus aculeus						–2																													
T. gothicus	–1	–1		0	–1	–1	–1		–1	–1																									
T. gothicus trifidus	–1	–1			–1				–1																										
Watznaueria barnesae	0	+1	+1	0	+1	0	0	0	+1	0	0	+1	0	–1	–1	–1	0	+1	0	0	0	0	0	0	–1	–1	0	–1	–1	–1	?	–1	–1	0	–1
Zygodiscus pseudoanthophorus																																			
Z. sp.							–1																												

Tetralithus aculeus, present in Cores 17 and 20, and *Tetralithus gothicus trifidus*, present in Cores 17 through 26, enable a more precise stratigraphic determination, suggesting Campanian age (*Tetralithus aculeus* Zone of Cepek and Hay, 1969). Lower cores are referrable to the Late Cretaceous, but narrower age assignment is not possible using the calcareous nannoplankton.

The cores taken in surficial sediment during the reentry procedure are referred to Hole 146A. Only Cores 1 and 3 retrieved sediment suitable for study. Distribution of calcareous nannofossils in these cores is presented in Table 4.

The Cenozoic assemblages are generally enriched in asteroliths, suggesting deposition in the lower part of the region of calcium carbonate compensation. Disappearance of calcareous nannoplankton in the Middle Paleocene accords with Worsley's (1971) hypothesis of migration of compensation depth associated with the Cretaceous-Tertiary boundary event. The increase in species diversity in the Late Cretaceous below the Cretaceous-Tertiary boundary also is in agreement with the Worsley model. The reason for the monotony of the Late Cretaceous assemblages is not clear; it may be that only a relatively few species inhabited this area or alternatively that the assemblage is the result of selective solution and/or recrystallization. *Tetralithus gothicus trifidus* is the only relatively short-ranging species in the later part of the Late Cretaceous which is resistant to solution. It appears to be particularly valuable as a biostratigraphic indicator in the deep-sea chalks.

TABLE 4
Calcareous Nannofossils in Cores 1 and 3, Hole 146A

Age	a		b	c
Zone	d		e	?
Sample / Level	1-7(20-21)	1-7(76-77)	3-1(111-112)	3-3(90-91)
Total Abundance	+1	+1	+2	–1
Ceratolithus cristatus			–1	
Coccolithus pelagicus		–2	0	–1
Cyclococcolithina leptopora	–1	–1	0	–1
Discoaster brouweri rutellus			0	–2
D. brouweri tamalis			–1	
D. brouweri tridenus			–1	
D. brouweri triradiatus			–1	
D. extensus				–1
D. pentaradiatus			0	–2
D. surculus				–2
D. variabilis				–1
"Discolithus" phaseolus	0	0	+1	
Gephyroscapsa californiensis	0	–1		
G. kamptneri	+1	+1	+2	
G. oceanica	–1			
Helicopontosphaera kamptneri	0	0	0	
H. sellii			–1	
H. wallichi			0	
Pseudoemiliania lacunosa (circular)	–1	0	+1	
P. lacunosa (elliptical)	0	0	+1	
Rhabdosphaera stylifera	0	+1		
Sphenolithus abies		–2		

[a]Pleistocene [d]*Gephyrocapsa oceanica*
[b]Pliocene [e]*Discoaster pentaradiatus*
[c]Miocene

Site 147

The entire section cored at this site is Late Pleistocene to Recent. The lowest occurrence of *Emiliania huxleyi* appears to be between Cores 7 and 8, so that the upper part of the hole belongs to the *E. huxleyi* Zone and the remainder to the later part of the *Gephyrocapsa oceanica* Zone. The top of *Pseudoemiliania lacunosa* is reached in the deepest core. The distribution of the calcareous nannofossils in the cores from Hole 147 is presented in Table 5, and a more thorough discussion of this interesting suite of cores is presented in the section of this chapter dealing with the Pleistocene.

A subsequent hole, 147C, was drilled in the immediate vicinity. Only Core 7 from this hole was sampled for calcareous nannoplankton, and results of examination of the material is presented in Table 6.

Site 148

The distribution of calcareous nannofossils in Cores 1 through 29 is presented in Table 7. Coccoliths are abundant and well preserved in the younger cores, but tend to be corroded in cores from greater depths.

The lowest occurrence of *Emiliania huxleyi* is in Section 4 of Core 2; Core 1 and the upper part of Core 2 belong to the *E. huxleyi* Zone.

The highest occurrence of *Pseudoemiliania lacunosa* is in Core 3, with the circular variety ranging higher than the elliptical variety, which does not occur above Core 4.

The lowest occurrence of *Gephyrocapsa oceanica* is in Section 1 of Core 12, so that the entire sequence from the middle of Section 4 of Core 2 to the middle of Section 1 of Core 12 belongs to the *G. oceanica* Zone. The interval of overlap of *G. oceanica* and *Pseudoemiliania lacunosa* is unusually long in this hole, indicating a high sedimentation rate.

The highest occurrence of *Discoaster brouweri* is in Section 4 of Core 15, and the interval from the middle of Section 1 of Core 12 to the middle of Section 4 of Core 15 is assigned to the "*Gephyrocapsa caribbeanica*" Zone. As noted in the special section on the Pleistocene, the name *Gephyrocapsa caribbeanica* is considered a probable junior synonym of *Gephyrocapsa kamptneri*, but the term "*G. caribbeanica*" Zone is retained for practical purposes.

The highest occurrence of *Discoaster pentaradiatus* is between samples from Sections 2 and 3 of Core 16. The immediately overlying interval to the middle of Section 4 of Core 15 is the *Discoaster brouweri* Zone of Martini and Worsley (1971).

The lower limit of the *Discoaster pentaradiatus* Zone is uncertain because the highest occurrence of *Discoaster surculus* is difficult to fix since the preservation of asteroliths below Core 16 is generally poor. Specimens with affinities to *D. surculus*, but with narrow arms are present in Core 19, but the highest typical specimens of this distinctive species were noted in Core 20. Somewhat arbitrarily, the interval from the base of Section 2 of Core

TABLE 5
Calcareous Nannofossils in Cores 1 through 18, Hole 147

Age	Recent ?																													
Zone	*Emiliania huxleyi*																													
Sample Level	1-2(90-91)	2-2(1-2)	2-2(40-41)	2-2(80-81)	2-2(120-121)	2-3 (10-11)	2-3(52-53)	2-3(90-91)	2-3(129-130)	2-3(139-140)	2-3(141-142)	2-4(4-5)	2-4(31-32)	2-4(50-51)	2-4(69-70)	2-4(108-109)	2-4(142-143)	3-1(95-96)	3-1(132-133)	3-2(99-100)	3-3(30-31)	3-3(70-71)	3-3(100-101)	3-3(148-149)	4-1(51-52)	4-1(89-90)	4-2(10-11)	4-2(50-51)	4-3(10-11)	4-3(50-51)
Total Abundance	+1	+1	+1	+1	0	+1	+1	+2	+1	+2	+1	+1	0	+2	+2	+1	0	+1	+1	+1	+1	0	+1	+1	0	0	+1	+1	+1	0
Braarudosphaera bigelowi																														
Ceratolithus cristatus																														
Coccolithus pelagicus																		–1								–2	–1			–2
Cyclococcolithina leptopora	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	0			–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
Discolithina cf. *macropora*																														
D. spp.																														
"Discolithus" phaseolus		–1	0		–1	–1		0	0	+1	0	–1		–1		0	0	–1			0		–1		–1	–1	0			0
Discosphaera tubifera																														
Ellipsodiscoaster lidzi																														
Emiliania huxleyi	0	+1	+1	+1	0	+1	+1	+2	+1	+2	+1	+1	0	+2	+2	+1	0	+1	+1	+1	+1	0	0	+1	0	0	+1	+1	+1	–1
Gephyrocapsa californiensis																														
G. kamptneri																														
G. oceanica	+1	+1	+1	+1	0	+1	+1	+2	+1	+2	+1	+1	0	+2	+1	+1	0	+1	+1	+1	+1	0	+1	+1	0	0	+1	+1	+1	–2
G. parallela		–1		–1	–1	–1	–1		–1	–1			–1					–1	–1	–1	–1	–1	–1		–1		–1		–1	
G. sinuosa												–2						–2							–2				–1	
G. sp.	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1		–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	0	0	–1
Helicopontosphaera kamptneri	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
H. sellii																	–1	–2												
H. wallichi	–1		–1											–1																
Pontosphaera scutellum																														
P. spp.																					–1									
Pseudoemiliania lacunosa (circular)																														
P. lacunosa (elliptical)																														
Rhabdosphaera clavigera																														
R. stylifera			–1		–1									–1		0								–1						
Scapholithus fossilis																	–2				–1									
Scyphosphaera apsteini																														
Syracosphaera clava	–1																–2									–2		–1		–1
S. decussata			–1			–1											–1	–2											–1	–1
S. historica																														
S. jonesi	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1
S. pulchra	–2																–2	–2							–2	–2				–2
S. sp.																	–1													–1
Thoracosphaera saxea	–1					–2																				–2				–2
Umbilicosphaera mirabilis	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–2	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1
"Little u"	–2																	–2				–1				–2		–1	–1	–1

16 through Core 19 is referred to the *Discoaster pentaradiatus* Zone, and Cores 20 through 26 and the first three sections of Core 27 are referred to the *Discoaster surculus* Zone.

The base of the *Discoaster surculus* Zone can be fixed within Core 27. The highest occurrence of *Sphenolithus abies* lies between the top of Core 27 and the base of Core 26, in an unrecovered interval. If the terminology of Boudreaux and Hay (1969) were used, Core 27 would be referred to the *Sphenolithus abies* Zone. However, following the scheme of Martini and Worsley (1971), the highest occurrence of *Reticulofenestra pseudoumbilica* is used to define the base of the *Discoaster surculus* Zone, and this event occurs in the uppermost part of Section 4 of Core 27. The lowest occurrence of *Pseudoemiliania lacunosa* was not reached above the volcanics encountered at the base of the hole, so that the sediments of the lower three sections of Core 27 belong to the uppermost part of the *R. pseudoumbilica* Zone.

The volcanic sediments contained in Cores 28 through 31 include a few fine-grained layers with mixed calcareous nannofossils of Late Cretaceous (particularly Campanian-Maestrichtian) and older Tertiary age.

Site 149

Core 1 consists only of a catcher sample with a rich, well-preserved assemblage belonging to the *Emiliania huxleyi* Zone.

Distribution of calcareous nannofossils for Cores 2 through 8 is shown in Table 8. Core 2 contains a number of important horizons. The lowest occurrence of *Emiliania huxleyi* is between samples from Sections 2 and 3. In the first two sections, the abundance of *E. huxleyi* steadily diminishes, and the species is replaced by *Gephyrocapsa oceanica* as dominant species by the middle of Section 1. *Gephyrocapsa californiensis* has its highest occurrence near the base of Section 1. Other species of *Gephyrocapsa* have their highest occurrences in subsequent sections. From this,

TABLE 5–*Continued*

Age	Recent ?									Pleistocene																		
Zone	*Emiliania huxleyi*																											
Sample Level	4-3(95-96)	4-3(135-136)	4-4(1-2)	4-4(40-41)	4-4(122-123)	4-5(17-18)	4-5(59-60)	4-5(99-100)	4-6(10-11)	4-6(50-51)	4-6(90-91)	5-2(3-4)	5-2(40-41)	5-2(84-85)	5-2(120-121)	6-1(130-131)	6-2(20-21)		6-3(22-23)	6-3(124-125)	6-5(50-51)	6-5(117-118)	6-5(139-140)	6-6(50-51)	6-6(89-90)	6-6(129-130)	7-1(127-128)	7-2(17-18)
Total Abundance	0	+1	+1	+1	+1	+1	+1	+1	0	+1	+1	+2	+2	+2	+1	+1	+1	0	+1	+1	+1	+1	+1	0	0	+1	+1	+1
Braarudosphaera bigelowi																												
Ceratolithus cristatus																												
Coccolithus pelagicus		–1	–1		–1		–1	–1		–1	–1		–1		–1				–1					–1		–1		
Cyclococcolithina leptopora	–1	–1	–1	–1	–1	–1		–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–2	–1	–1	0	0	0	0	0	–2
Discolithina cf. *macropora*																												
D. spp.						–1																	0	–1	–1			
"Discolithus" phaseolus										–1	0	0	–1	0	0	–1	–1		0	–2	0	0	–1	0	–1	0	–1	0
Discosphaera tubifera													–2						–1									
Ellipsodiscoaster lidzi																–2												
Emiliania huxleyi	0	+1	+1	+1	+1	+1	–1	0	0	+1	+1	+2	+2	+2	+1	+1	+1		+1	+1	+1	0	–1	0	0	–1	–1	0
Gephyrocapsa californiensis																				+1							0	
G. kamptneri											+1	0	0		+1						–1	0	+1	0	0	+1	0	0
G. oceanica	0	0	+1	+1	+1	+1	+1	+1	0	0	+1	+1	+1	+1	0	+1	+1		0	0	+1	+1	+1	+1	0	0	+1	+1
G. parallela	–1	–1	–1	–1	–1	–1		–1		–1	–1	–1	–1	–1	–1	–1	–1	–2	–1	–2	–1		–1			–1		–1
G. sinuosa											–2								–2	–2								–2
G. sp.	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	0	–1	0	–1	–2
Helicopontosphaera kamptneri	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1
H. sellii											–2																	
H. wallichi																												
Pontosphaera scutellum																												
P. spp.										–1						–1				–1								
Pseudoemiliania lacunosa (circular)																												
P. lacunosa (elliptical)																												
Rhabdosphaera clavigera																												
R. stylifera	0									–1	0	–1	–1		–1	–1	–1		0						–1		0	
Scapholithus fossilis						–1					–2			–1	–1	–1	–1		–1	–2					–1			
Scyphosphaera apsteini																												
Syracosphaera clava	–1	–1	–2	–1				–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1				–1			–1	–2
S. decussata			–1		–1					–1	–2						–1	–2	–1	–1	–1	–1	–1	–1	–1		–1	–1
S. historica																												
S. jonesi	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	0	0	0	–1	–1	–1	0	0		–1	–1	–1	0	–1	–1	–1	
S. pulchra			–2		–2						–2							–2	–1					–1	–1	0	–1	–1
S. sp.																			–1			–1			–1	–1		
Thoracosphaera saxea			–2								–2							–2										
Umbilicosphaera mirabilis	–1		–1		–1	–1	–1	–1		–1	–1	–1		–1		–1	–1		–1	–1		–1	–1	0	–1	–1	–1	–1
"Little u"	–1	–1	–1		–1	–1	–1	–1									–1	–1	–2	–2	–1		–1	–1	–1			–1

it would appear that the sequence of events in this core duplicates that found in cores from Sites 147 and 148, and that a fine stratigraphic breakdown may be possible in this part of the Pleistocene. That the sequence is the same here is somewhat remarkable because of the considerable disturbance of the cored material. Sections 1 and 2 of this core can be referred to the *Emiliania huxleyi* Zone; the lower part of the core belongs to the *Gephyrocapsa oceanica* Zone. Core 3 contains typical, well-preserved assemblages of the *Gephyrocapsa oceanica* Zone. Circular specimens of *Pseudoemiliania lacunosa* appear in the lower part of Section 2. In the terminology of Gartner (1969), the *Gephyrocapsa* Zone would include the upper part of Section 2 of this core and the lower part of the preceding core, up to the level of first occurrence of *E. huxleyi.* Subjacent cores would belong to the *Pseudoemiliania* Zone. Core 4 contains more typical *Gephyrocapsa oceanica* Zone assemblages, with *Pseudoemiliania* becoming more abundant and present as both circular and elliptical forms. A number of more exotic species of Quaternary nannoplankton are present here, including *Discoaster perplexus* and *Oolithotus antillarum.* Core 5 is similar to Core 4. Core 6 presents a complex picture. No less than four calcareous nannoplankton zones are represented in this core, and the distributional sequence is that expected. Section 2 contains assemblages typical of the *Gephyrocapsa oceanica* Zone. Section 3, however, contains *Gephyrocapsa caribbeanica* Zone assemblages, with the expected relative abundances of different species. Section 4 and the upper part of Section 5 contain *Discoaster brouweri,* which increases in abundance downward; these sediments belong to the *D. brouweri* Zone. The lower part of section 5 and section 6 contain *Discoaster pentaradiatus* in addition to *D. brouweri,* and are referrable to the *D. pentaradiatus* Zone. It is very surprising that the *"G. caribbeanica"* Zone and the *D. brouweri* Zone are represented by such a short section, and this is probably a function of drilling disturbances. The first five sections of Core 7, supposedly recovered below Core 6, contain mixed

TABLE 5–*Continued*

Age	Pleistocene																													
Zone	*Gephyrocapsa oceanica*																													
Sample Level	8-1(43-44)	8-1(126-127)	8-2(28-29)	8-2(97-98)	8-3(38-39)	8-3(114-115)	8-4(41-42)	8-4(131-132)	8-5(136-137)	8-6(37-38)	8-6(125-126)	9-2(10-11)	9-2(60-61)	9-2(122-123)	9-3(27-28)	9-3(97-98)	9-4(48-49)	9-4(138-139)	9-5(32-33)	9-5(84-85)	9-5(129-130)	9-6(32-33)	9-6(81-82)	9-6(144-145)	10-1(13-14)	10-1(146-147)	10-2(33-34)	10-2(123-124)	10-3(16-17)	10-3(131-132)
Total Abundance	+1	+2	0	+1	+1	+1	+1	+1	+1	+1	+2	+1	+2	+1	+1	+1	+2	+2	+2	0	0	+1	+1	+2	+1	+2	+1	+2	+1	+1
Braarudosphaera bigelowi																														
Ceratolithus cristatus																														
Coccolithus pelagicua			-1															-1									-1			
Cyclococcolithina leptopora	0	0	-1	-1			-1	-1	-1	-1	0	-1	-1	-1		-1		-1	-1			-1	-1	-1		-1	-1	-1	-2	-1
Discolithina cf. *macropora*																														
D. spp.									-2				-1					-1			-1			-2				-1		
"Discolithus" phaseolus	-1	0	0	0		-1	-1	-1	-1	0	-1	0	0	0	0		0		0	-1		-1	-1	0		0	0	0	0	
Discosphaera tubifera																														
Ellipsodiscoaster lidzi					-1							-2																		
Emiliania huxleyi																														
Gephyrocapsa californiensis					0	+1	0			0	0			0		0	+1	+1											0	
G. kamptneri	+1	+2		+1	+1	+1	+1		+1	+1	+1	+1	+2	+1	+1	+1	+2	+2	+2	0	0	+1	+1	+2	0	+2	+1	+2	+1	0
G. oceanica	0	+1		0	0	+1	+1	+1	+1	+1	+2	0	+1	+1	+1	0	+2	+1	+1	0	0	+1	+1	+1	+1	+1	0	0	+1	+1
G. parallela			-1	-1		-1	-1			-1		-1			-1				-1	-1										
G. sinuosa	-1	+1	0	0	+1	0	0	0	0	-1		-1	+1	+1	-1	0	0	0	+1	-1			-1	0		0	+1	0	0	+1
G. sp.	-1	-1	-1	-1		0	0	-1	0	-1	0	-1	0	0	-1	-1	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	0	-1
Helicopontosphaera kamptneri												-1	-1	-1	-1	-1		-1	-1	-1		-1	-1	-1	-1	-1	-1	-1	-1	-1
H. sellii																			-2											
H. wallichi																														
Pontosphaera scutellum																														
P. spp.																														
Pseudoemiliania lacunosa (circular)																														
P. lacunosa (elliptical)													-2						-1											
Rhabdosphaera clavigera				0	-1				-2			-1	-1	-1	-1								-1	-1		-1		-1		
R. stylifera				-1	0									-1			0							0						
Scapholithus fossilis				0	-1				-2			-1	-1	-1	-1								-1	-1		-1		-1		
Scyphosphaera apsteini																														
Syracosphaera clava				-1			-1	-1	-1	-1	-1		-1	-1	-1	-1			-1		-1	-1	-1	-1		-1	-1	-1	-1	
S. decussata		-1	-1	-1	-1		-1	-1	-1		-1	-1	-1	-1	-1		-1	-1	-1		-1		-1	-1	-1	-1	+1	-1	-1	-2
S. historica																														
S. jonesi	-1		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		0	-1	-1		0	-1		-1		-1		-1
S. pulchra	-1		-1			-1	-1	-1			-1	-2	-1		-2									-1	-1	-2	-1	-1	-1	-1
S. sp.																														
Thoracosphaera saxea																														
Umbilicosphaera mirabilis	-1				-1		-1	-1	-1	-1	0	-1	-1	-1	-1	-1	-1		-1	-1	-1	-1	-1	-1	-1	-1	-1		-1	-1
"Little u"	-1	-1	-1			0	-1	-1	-1	-1	-1	-1		-1		-1	-1	-1	-2		-1	-1			-1	-1			-1	-1

assemblages of the *Discoaster brouweri* and *"Gephyrocapsa caribbeanica"* zones; in all probability they represent material which was re-cored, or which slumped into the hole. Section 6 contains normal calcareous nannoplankton fossils of the *Discoaster pentaradiatus* Zone. In Core 8, the first three sections contain sparse assemblages of the *Discoaster brouweri* Zone, probably slumped into the hole. The lower sections (Sections 4-6) contain a number of species not noted in higher cores, including *Reticulofenestra* cf. *pseudoumbilica, Helicopontosphaera sellii,* and *Discoaster surculus;* these sediments belong to the *Discoaster surculus* Zone.

The distribution of species from Core 9 to Core 14, Section 3, is presented in Table 9. Cores 9 and 10 contain assemblages referrable to the *Discoaster surculus* Zone. *Discoaster brouweri tamalis* becomes rather frequent in this part of the section as at Site 148. Specimens are sparse and preservation poor. Core 11 contains a complex sequence, with three zones present representing an interval which should contain five zones. Sections 1 through 3 contain *Sphenolithus abies* and *Reticulofenestra pseudoumbilica* as well as the lowest occurrence of *Pseudoemiliania lacunosa*, and may be referred to the *R. pseudoumbilica* Zone. Section 4, and Section 5 to a depth of 115 cm, contain *Ceratolithus tricorniculatus* as well and belong to the *Discoaster asymmetricus* Zone. It should be noted that all of this sediment is highly contorted and disturbed. Section 6, in which the sediments are not so highly disturbed, but only slightly intruded (except near the top of the section where some flowage has occurred), contains a rich assemblage belonging to the *Discoaster quinqueramus* Zone. Blebs containing this assemblage occur in the base of Section 5, up to 130 cm. The *Ceratolithus rugosus* and *Ceratolithus tricorniculatus* zones cannot be detected in this core; a paraconformity may exist or a few tens of centimeters of red clay may represent the missing zones. Core 12 contains common, well-preserved calcareous nannofossils, which are typical assemblages of the *Discoaster quinqueramus* Zone. In Core 13, Section 2 contains assemblages of calcareous nannofossils varying considerably

TABLE 5–*Continued*

Sample Level	10-4(32-33)	10-5(27-28)	10-5(62-63)	10-5(131-132)	11-1(31-32)	11-1(99-100)	11-2(31-32)	11-2(101-102)	11-3(30-31)	11-3(103-104)	11-4(33-34)	11-4(100-101)	11-5(31-32)	11-5(100-101)	11-6(30-31)	11-6(100-101)	12-1(31-32)	12-1(100-101)	12-2(35-36)	12-2(103-104)	12-3(89-90)	12-4(41-42)	12-4(80-81)	12-4(118-119)	12-4(146-147)	12-5(2-3)	12-5(18-19)	12-5(48-49)	12-5(71-72)	12-5(83-84)
Age	Pleistocene																													
Zone	*Gephyrocapsa oceanica*																													
Total Abundance	0	+2	+1	+1	0	+2	+1	+1	+1	+1	+2	+1	+2	+1	+1	+1	0	0	+2	+1	+2	+1	+1	0	0	+1	+2	0	0	+1
Braarudosphaera bigelowi																														
Ceratolithus cristatus																														
Coccolithus pelagicus								–1																						
Cyclococcolithina leptopora	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–2	–2	–1	–1	–1	–1	–2	–1
Discolithina cf. *macropora*																														
D. spp.									–1																					
"Discolithus" phaseolus	–1	0	0	0	0	+1	0	0	0	0	0	0	0	–1		0			0		0	0	0			0	0			0
Discosphaera tubifera			–1																											
Ellipsodiscoaster lidzi												–2			–2															
Emiliania huxleyi																														
Gephyrocapsa californiensis		–1	0	0		+2	0	0	+1	+1	0	0	+2		0	0			+2	+1	+1		0			0	+2	0		0
G. kamptneri	–1	+2	+1	+1	0	+2	+1	+1	+1	+1	+2	+1	+1		+1	0			+1	+1	+2	+1	+1	0	0	+1	+2	–1	0	+1
G. oceanica	0	0	+1	+1	0	+2	+1	+1	+1	+1	0	+1		+1	+1				+1	+1	+1	0	+1	0	–1	+1	+1	0	0	+1
G. parallela		–1	–2																											
G. sinuosa	–1	0	0	0	0	+1	–1	0	0	–1	–1	0	–1	0	–1	0	0	0	0	0	0	0	0	0	–1	+1	+1	–1	–1	0
G. sp.	–1	–1	0	–1	–1	0	–1	–1	–1	–1	0	–1	0	–1	–1	0	0	0	0	–1	0	–1	0	–1	–1	0	0	0	–1	0
Helicopontosphaera kamptneri	–1	0	+1	+1	0	+2	+1	+1	+1	+1	0	+1	0		+1	+1			+1	–1	–1	–1	–1	–1	–1	–1	–1			0
H. sellii			–2																						–1	–1	–1			–1
H. wallichi																														
Pontosphaera scutellum																														
P. spp.				–1						–1									–1	–1										
Pseudoemiliania lacunosa (circular)																														
P. lacunosa (elliptical)																														
Rhabdosphaera clavigera	–1	–1		0	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1				–1	–1	–1			–1
R. stylifera	–1	0		0	0											0			0		0									0
Scapholithus fossilis																														
Scyphosphaera apsteini																														
Syracosphaera clava	–1	–1	–1		–1	–1	–1		–1	–1			–1	–1	–1	–1	–1	–2	–1	–1	–2									–1
S. decussata	–2		–1	–1	0	0	0			–1		–2	–1		–1		–2	–1	–1		0	–1	–1		–1	0	0	–1		0
S. historica			–2		–1	–1	0	–1	–1	–1		–1			–1			–1	0											
S. jonesi	–1	+1	–1	–1	–1		–1	–1				–1	–1	–1	–1	–1	–1	–2	–1		–1		–1			–1	–1	0	–1	
S. pulchra	–1			–1	–1			–1	–1	–1		–1					–1						–1	–1					–1	–1
S. sp.																														
Thoracosphaera saxea			–2																											
Umbilicosphaera mirabilis		–1	–2	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1		–1							
"Little u"						–1		–1	–1	–1	–1	–1	–1			–1	–1	–1	–1			–1					–1	–1		–1

in abundance and state of preservation, but referrable to the *Discoaster quinqueramus* Zone. Sections 3 through 6 contain generally common well-preserved present, but typical specimens of *Discoaster neohamatus.* The ranges of *Discoaster quinqueramus* and *Discoaster neohamatus* are usually separated by an interval of strata, which has been termed the *Discoaster calcaris* Zone for a species which is commonly abundant in Late Miocene samples.

The distribution of species from Core 14, Section 4 through Core 18 is shown in Table 10. Samples from the base of Section 4 of Core 14 contain rare but well-preserved calcareous nannofossils, including *Discoaster hamatus* and *Catinaster coalitus*: these strata are here referred questionably to the *Discoaster hamatus* Zone. The upper two sections of Core 15 are generally barren of calcareous nannofossils. The base of Section 2 however, contains a layer with a good, well-preserved assemblage containing very abundant *Catinaster coalitus* and *C. calyculus,* along with *Discoaster extensus, D. bollii, D. exilis, D. kugleri,* and *D. brouweri,* and may be referred to the *Catinaster coalitus* Zone. Section 3 contains a similar assemblage, but lacks the *Catinaster* species; it may be assigned to the *Discoaster kugleri* Zone. Sections 4 and 5 lack *D. kugleri*, but contain abundant *Discoaster exilis*; they belong to the *Discoaster exilis* Zone. The upper two sections of Core 16 are similar to those of the base of the preceding core, and also belong to the *Discoaster exilis* Zone. Sections 3 through 5 contain sparse to common calcareous nannofossils, with *Discoaster exilis* and *Sphenolithus heteromorphus* as conspicuous members; they belong to the *Sphenolithus heteromorphus* Zone. The upper three sections of Core 17 are highly disturbed, but Sections 4 and 5 contain common well-preserved calcareous nannofossils typical of the *Sphenolithus heteromorphus* Zone. In Core 18, both of the sections examined (Sections 2 and 5) contain calcareous nannofossils, generally well preserved, with *Helicopontosphaera ampliaperta, Sphenolithus heteromorphus, Discoaster aulakos, D. divaricatus,* and *D. deflandrei.* All

TABLE 5–*Continued*

Age	Pleistocene																														
Zone	*Gephyrocapsa oceanica*																														
Sample Level	12-5(142-143)	12-6(20-21)	12-6(70-71)	12-6(119-120)	13-1(3-4)	13-2(81-82)	13-3(64-65)	13-4(50-59)	13-5(20-21)	13-5(114-115)	13-6(71-72)	14-1(86-87)	14-2(14-15)	14-2(72-73)	14-2(90-91)	14-3(137-138)	14-4(35-36)	14-4(125-126)	14-5(17-18)	14-5(100-101)	15-1(21-22)	15-1(134-135)	15-2(40-41)	15-2(90-91)	15-2(129-130)	15-3(27-28)	15-3(89-90)	15-4(29-30)	15-4(102-103)	15-5(29-30)	15-5(89-90)
Total Abundance	+1	+1	+1	+2	+1	0	+1	+1	+1	+1	+1	+1	0	+1	+2	0	0	+1	+1	+1	+1	+1	+1	+1	+1	+1		+1	+1	+1	+1
Braarudosphaera bigelowi																															
Ceratolithus cristatus								−1				−1															−1				
Coccolithus pelagicus		−2						0			−1							−1													
Cyclococcolithina leptopora	−1	−1	−1						−1	−1	−1		−1	−1	−1		−1	−1	−2		−1	−1	−1	−1							
Discolithina cf. *macropora*																−2			−2	−2				−2		−2					
D. spp.	−1														−1										−1	−1					
"Discolithus" phaseolus	0	+1	0					−1	−1			0		−1	0			0	0	0			0	0	0	0	−1	−1			−1
Discosphaera tubifera																															
Ellipsodiscoaster lidzi	−1																						−1								
Emiliania huxleyi																															
Gephyrocapsa californiensis	0	0	+1	+1	+1		0	0	0	0	0	0		+1	+1			+1	+1	+1	+1	+1	+1	0	0	0		+1	+1	+1	+1
G. kamptneri	+1	+1	+1	+2	+1		0	0	+1	+1	0	+1	0	+1	+2			+1	+1		+1	+1	0	0	+1	0		+1	+1	0	0
G. oceanica	+1	0	+1	+1	+1		+1	0	+1	+1	+1	0	0	+1	+2			+1	0	0	+1	+1	+1	+1	0	+1		+1	+1	+1	+1
G. parallela																															
G. sinuosa		−1	0	0	0	0	0	0	0	0	−1	0	−1	−1	0	0	0	−1	−1		−1	−1		−1	−1	−1			−2		
G. sp.	0	−1	0	0	0	−1	0	−1	−1	0	−1	0	−1	0	0	−1	−1	0	0	−1	0	0	0	0	0	−1	0	−1	0	0	0
Helicopontosphaera kamptneri	−1	−2	−1	−1	0	−1	−1	−1	−1	0	0	−1	−1	0	−1	−1	−1	−1	−1	0			−1	−1	−1	−1	−1	−1	−1	−1	−1
H. sellii		−2			0	−1			−1	−1	−1				−1		−1		−1						−1						
H. wallichi																															
Pontosphaera scutellum																															
P. spp.						−1									−1		−1														
Pseudoemiliania lacunosa (circular)																					−1	−2							−1	−1	
P. lacunosa (elliptical)		1																						−1	−1						
Rhabdosphaera clavigera	−1	−1	−1	−1	−1		−1	−1	−1	−1		−1			−1	−1		−2	−1				0	−1	0	0	−2	−1	−1	−1	−1
R. stylifera	−1		0	0					−1	−1		−1								−1			0		0	−1		−1	−1	0	−1
Scapholithus fossilis				−1	−1		−1	−1																							
Scyphosphaera apsteini																															
Syracosphaera clava		−2		−1	−1														−2						−1	−1					
S. decussata	0	0		−1	−1	−1	−1	−1	−1	−1	−1	−1	−1	−1		−1	−1	−1	−1	−1	−1	−1	0		−1	−1	−1	−1	−1	−1	−1
S. historica		−1	−1	−1												−1	−1									−1				−1	
S. jonesi		−1	−1	−1	−1	0	−1	−1	0		−1				−1		−1		−1	−1			−1	−1		−1	0	−1	−1	−1	−1
S. pulchra	−1	−1	−1	−2													−1	−1	−2	−1											
S. sp.																															
Thoracosphaera saxea																															
Umbilicosphaera mirabilis	−1	−1			−1	−1		−1	−1			−1		−1	−1	−1	−1	−2		−1	0	−1	−1	−1	−1	−1	−1		−1		−1
"Little u"			−1						−1	−1			−2												−1				−1		

sections belong to the *Helicopontosphaera ampliaperta* Zone. *Coronocyclus nitescens* is a sparse but consistent member of the assemblages.

Table 11 illustrates the distribution of calcareous nannofossils in Cores 20 through 30. Core 20 contains assemblages similar to those of Core 18. In Core 21, *Sphenolithus belemnos* is present in Section 2. The upper part of this section seems referrable to the *Sphenolithus belemnos* Zone. The highest occurrence of *Triquetrorhabdulus carinatus* is near the base of Section 2; strata below 94 cm in that section are referred to the *Discoaster druggi* Zone. Typical specimens of *Discoaster druggi* are present in Sections 4 and 5. All of the higher sections of Core 22 are highly disturbed, only the lower part of Section 6 seems to represent in situ material. The calcareous nannofossils from the base of Section 6 are common and well preserved, and typical of the *Discoaster druggi* Zone. Section 3 of Core 23 contains assemblages of calcareous nannofossils typical of the *Discoaster druggi* Zone. The lowest occurrence of typical *D. druggi* is near the base of Section 3. The lower sections (Sections 4 and 5) are characterized by common, well-preserved calcareous nannofossils, with assemblages typical of the *Triquetrorhabdulus carinatus* Zone. Cores 24 through 28 all contain common calcareous nannofossils, assemblages typical of the *Triquetrorhabdulus carinatus* Zone. Core 29 represents sudden condensation of the stratigraphic section. The uppermost section of the core contains assemblages of the *Triquetrorhabdulus carinatus* Zone. Section 2, however, contains *Helicopontosphaera truncata* and *Sphenolithus ciperoensis* and belongs to the *Sphenolithus ciperoensis* Zone. Section 3 is somewhat peculiar in that *Triquetrorhabdulus carinatus* is not present (its lowest occurrence is in the base of Section 2), but the sphenoliths are not typical *Sphenolithus distentus* as would be expected, but rather seem to be intermediate between that species and *S. predistentus.* Nevertheless, Section 3

TABLE 5–*Continued*

Sample Level	15-5(129-130)	15-6(35-36)	15-6(101-102)	16-2(14-15)	16-2(127-128)	16-3(76-77)	16-4(30-31)	16-4(82-83)	16-4(86-87)	16-4(130-131)	17-1(30-31)	17-1(110-111)	17-2(51-52)	17-3(106-107)	17-4(27-28)	17-5(30-31)	17-5(121-122)	17-6(79-80)	18-1(28-29)	18-1(79-80)	18-1(129-130)	18-2(50-51)	18-2(120-121)	18-3(40-41)	18-3(120-121)	18-4(40-41)	18-4(110-111)	18-5(30-31)	18-5(100-101)	18-6(41-42)	18-6(100-101)
Age	Pleistocene																														
Zone	*Gephyrocapsa oceanica*																														
Total Abundance	+2	+1	0	+1	+1	+1	+1	+1	+1	+2	+1	+1	+1	+1	+2	+1	+1	+1	+1	+1	+1	+1	0	0	+2	0	0	+1	+1	+1	+1
Braarudosphaera bigelowi														−2					−2		−1										
Ceratolithus cristatus				−1				0		−1																					
Coccolithus pelagicus					−1																									−2	
Cyclococcolithina leptopora				−1	0	−1	−1		−1	−1	−1	−1	−1	0	0	0	0	−1	−1	−1	−1	−1		−1		−1	−1	−1	−1	−1	
Discolithina cf. *macropora*					−1	−1	−1														−2					0					
D. spp.				−1	−1		−1	−1													−1					−2	−1			−1	
"Discolithus" phaseolus	0			0		0	0	0	−1	0	−1	0	0		−1	0			0		0				+1	−1	−1	0	−1	−1	0
Discosphaera tubifera																												−2		−2	
Ellipsodiscoaster lidzi																															
Emiliania huxleyi																															
Gephyrocapsa californiensis		+1	0	+1	0	0	0	0	0	+1	0	+1	+1	+1	+1	+1	0	+1		+1			0		+2	0	0	+1	0	0	+1
G. kamptneri	0	0	0	0	+1	0	0	+1	+1	+2	+1	0	0	0	+2	0	+1	0	+1	+1	0	+1	0	0	+2	0	0	+1	0	0	+1
G. oceanica	+2	+1	0	0	+1	+1	+1	+1	0	+2	+1	+1	+1	+1	0	+1	0	+1	+1	+1	+1	+1	0	0	+1	0	0	+1	+1	+1	+1
G. parallela			−2																					0							
G. sinuosa				−1	−1								+1	−1					−1	−1	−2					−2					
G. sp.	0	0	+1	0	0	0	−1	0	0	0	0	0	+1	0	0	0	0	0	0	−1	−1	0	0	0	0	0	0		0	0	0
Helicopontosphaera kamptneri	−1	−1	−1	−1	−1	−1	−1	−1	−1	0	−1	0	0	0	0	−1	−1	0	−1	−1	−1	−1		−1	−1	−1	−1	−1	−1	0	−1
H. sellii			−1		−1		−1																								
H. wallichi																															
Pontosphaera scutellum																															
P. spp.							−1							−1						−1											
Pseudoemiliania lacunosa (circular)			−1	−2																			−2					−2			
P. lacunosa (elliptical)																															
Rhabdosphaera clavigera	−1	−1	−1	−1	−1	−1	−1				−1			−2	−1				−1		−2		−1	−1			−1		−1	−2	
R. stylifera		−1		0			−1	−1										−1							+1	−1	−1				
Scapholithus fossilis																			−1		−2		−1	−1			−1		−1	−2	
Scyphosphaera apsteini																															
Syracosphaera clava			−2					−1		−1		−1					−1	−1						−1	−1	−1		−1			
S. decussata	0	0	−1	0	−1	0	−1	0	−1	−1	−1	−1	−1	−2	−1	−1	−1	−1	−1	−1	−1	0	−1	−1	−1	−2			−1	−1	−1
S. historica	−1	−1	−1	−1		−1																									
S. jonesi	−1	0	−1		−1	−1			0	−1	−1	−1	−1	−1	−2		−1	−1		−1	−2	−1	−1	0	0	0	0	0	0	0	−1
S. pulchra			−2	−1	−1	−1	−1														−1					−1					
S. sp.																															
Thoracosphaera saxea													−1	−2				−2													
Umbilicosphaera mirabilis	−1	−1	−1	0	0		−1		−1	−1		−1		−1	−1			−1	−1	−2										−1	
"Little u"			−1	−2								−1		−1	−1															−2	

may be tentatively referred to the *Sphenolithus distentus* Zone. Samples from Core 30 are dominated by *Sphenolithus predistentus* and are referred to the *Sphenolithus predistentus* Zone.

Distribution of calcareous nannofossils in Cores 31 through 41 is shown in Table 12. Core 31 contains radically different calcareous nannofossils. Only a few, poorly preserved specimens are present; the only recognizable species are *Discoaster barbadiensis, D. saipanensis,* and *Reticulofenestra umbilica.* Assemblages in Core 32 are somewhat more diverse, but not sufficiently so as to permit any precise age determination. Species include *Discoaster barbadiensis, D. saipanensis, Reticulofenestra umbilica* and *Sphenolithus furcatolithoides.* Preservation is somewhat better in Core 33, which contains, in addition to the species found in the superjacent core, *Chiasmolithus grandis* and *Chiasmolithus* cf. *oamaruensis.* The specimens tending toward *C. oamaruensis* may indicate that the age of this series of samples is late *Discoaster saipanensis* Zone. Core 34 lacks *Chiasmolithus* cf. *oamaruensis,* but contains *Triquetrorhabdulus inversus;* its age is *Discoaster saipanensis* Zone. Core 35 contains *Chiasmolithus solitus* and *Sphenolithus radians* along with *Discoaster barbadiensis, D. saipanensis, Reticulofenestra umbilica,* and *Chiasmolithus grandis.* It is assigned to the *Discoaster tani nodifer* Zone because of the presence of *C. solitus.* Calcareous nannofossils are rare and poorly preserved in samples from Core 36, and are questionably referred to the *Discoaster tani nodifer* Zone.

Discoaster saipanensis has its lowest occurrence in the interval between Cores 36 and 37. Core 37 still contains *Reticulofenestra umbilica,* but is referred to the *Chiphrag-*

TABLE 6
Calcareous Nannofossils in Core 7, Hole 147C

Age	Pleistocene									
Zone	*Gephyrocapsa oceanica*									
Sample / Level	7-2(138-139)	7-3(46-47)	7-3(90-91)	7-5(20-21)	7-5(70-71)	7-5(119-120)	7-6(35-36)	7-6(67)	7-6(73-74)	7-6(121-122)
Total Abundance	+1	+1	+1	+1	0	0	0	+1	+1	0
Coccolithus pelagicus						–1				–1
Cyclococcolithina leptopora	0	–1	–1	–1	–1		–1	+1	–1	0
Discolithina spp.										–1
"Discolithus" phaseolus	0	0	–1		–1					–1
Gephyrocapsa oceanica	0	+1	0	+1	0	0	0	0	+1	0
G. californiensis	0	0	0		0	0			0	
G. sinuosa	+1	0	+1	0	–1	–1	–1		0	0
G. sp.	0	0	–1	–1	–1	–1	–1		–1	0
Helicopontosphaera kamptneri	0	0	–1		–1	–1			–1	
Pontosphaera sp.										–2
Syracosphaera clava							–1			
S. decussata				–1			–1		–1	–2
S. jonesi		0		–1	–1	–1	–1			–1
S. pulchra		–1			–1	–1				–1
Umbilicosphaera mirabilis		–1	0	–1	–1		–1		–1	–2

malithus alatus Zone. The name species is not encountered, but the position of the samples below the lowest occurrence of *D. saipanensis* suggests the *C. alatus* Zone age. Core 38 does not contain *Reticulofenestra umbilica;* it is referred to the *Chiphragmalithus alatus* Zone. Core 39 contains generally poor assemblages also referred to the *Chiphragmalithus alatus* Zone.

Cores 40 and 41 contain only a few, poorly preserved calcareous nannofossils, including *Discoaster barbadiensis, D. sublodoensis, Triquetrorhabdulus inversus, Sphenolithus radians,* and *S. furcatolithoides.* The cores probably belong to the *Discoaster sublodoensis* Zone.

Core 42 contains but a very few poorly preserved calcareous nannofossils. However, it seems possible to recognize heavily calcified specimens of *Discoaster lodoensis* among them. In general, the assemblages resemble those of the immediately superjacent cores. These strata may belong to the *Discoaster lodoensis* Zone.

Site 150

Cores 1 through 3 (Table 13) contain highly variable sediment. Some layers yield abundant, diverse, well-preserved coccoliths and discoasters; other layers principally contain discoasters with only a few poorly preserved coccoliths present; and some layers are wholly devoid of calcareous nannoplankton fossils. The assemblages all appear to be derived from the same suite of species, with certain forms removed by selective solution. In the more diverse assemblages, *Pseudoemiliania lacunosa* and *Gephyrocapsa kamptneri* dominate. *Discoaster brouweri, D. pentaradiatus,* and *D. surculus* are present and are referred to the *Discoaster surculus* Zone.

The distribution of calcareous nannofossils in Cores 4 and 5 is given in Table 14. The top of Section 1 of Core 4 is barren, but the lower part of this core contains a series of beds yielding significantly different assemblages of calcareous nannofossils. Between 90 and 110 cm, assemblages with sparse, generally poorly preserved calcareous nannofossils occur: *Discoaster aulakos,* D. cf. *exilis,* D. *brouweri, D. druggi,* and *Sphenolithus heteromorphus.* These uppermost calcareous strata seem to represent the *Sphenolithus heteromorphus* Zone. Between 110 and 120 cm, assemblages are better preserved, but relatively sparse in comparison with richer assemblages lower in the section. The asteroliths are more typically Early Miocene: *Discoaster deflandrei, D. aulakos, D. nephados,* and *D. trinidadensis. Sphenolithus heteromorphus* is present along with *Helicopontosphaera ampliaperta*. Below 120 cm, *Sphenolithus belemnos* is present, so that the base of this section and the top of Section 2 are referred to the *Sphenolithus belemnos* Zone. The highest occurrence of *Triquetrorhabdulus carinatus* is difficult to determine. Its highest occurrence is tentatively placed at about 100 cm in Section 2, so that the base of that section is referred to the *Discoaster druggi* Zone. *Discoaster druggi,* which occurs in Sections 1 and 2, does not occur in Section 3 so that the latter section is referred to the *Triquetrorhabdulus carinatus* Zone. Core 5 contains assemblages typical of the *Triquetrorhabdulus carinatus* Zone, with the name species abundant and *Sphenolithus belemnos* present.

No nannofossils were found in the sample from Core 6. Core 7 again contains an assemblage from the *Triquetrorhabdulus carinatus* Zone. This is very likely a result of slumping into the hole and is not recorded on the tables. No calcareous nannofossils were recovered from Core 8.

Distribution of species in Cores 9 and 10 is shown in Table 15. Core 9 contains a few poorly preserved calcareous nannofossils. The assemblages are dominated by *Watznaueria barnesae* and *Prediscosphaera cretacea,* but *Marthasterites furcatus* is conspicuously present. *Lithastrinus grilli, Arkhangelskiella ethmopora,* and *Kamptnerius punctatus* are also present, and Section 1 to near its base is referred questionably to the *Kamptnerius punctatus* Zone. *K. punctatus* was not found in samples from the base of the section, and the lowest part of the core is referred questionably to the *Arkhangelskiella ethmopora* Zone. Core 10 contains somewhat more abundant, slightly better preserved, calcareous nannofossils; the assemblages in Section 1 resemble those of the base of the superjacent core, but the assemblages from Section 2 contain *Arkhangelskiella specillata, Glaukolithus diplogrammus,* and are notably lacking *Marthasterites furcatus.*

In the two cores taken in Hole 150A, the upper core contains no useful calcareous nannoplankton. The second core yielded two assemblages; one a mixture of Eocene and Pliocene forms, the other apparently indigenous. The latter contains *Discoaster diastypus, D. multiradiatus, Ellipsolithus distichus, Chiasmolithus californicus, C. consuetus,* and other species characteristic of the upper part of the *Discoaster multiradiatus* Zone.

Site 151

The distribution of calcareous nannofossils in Cores 1 and 2 is presented in Table 16. Core 1 contains a section apparently through the earlier part of the Pleistocene and the latest Pliocene. Section 2 contains *Gephyrocapsa oceanica* and *Pseudoemiliania lacunosa*, and is referrable to the lower part of the *Gephyrocapsa oceanica* Zone. The lowest occurrence of *G. oceanica* is between samples from

TABLE 7
Calcareous Nannofossils in Cores 1 through 29, Hole 148

Age	Pleistocene																															
Zone	*Emiliania huxleyi*															*Gephyrocapsa oceanica*																
Sample Level	1-2(52-53)	1-2(84-85)	1-3(40-41)	1-3(100-101)	1-4(9-10)	1-4(85-86)	1-5(20-21)	1-5(118-119)	2-1(59-60)	2-1(127-128)	2-2(40-41)	2-2(112-113)	2-3(35-36)	2-3(131-132)	2-4(30-31)	2-4(110-111)	3-1(140-141)	3-2(41-42)	3-2(101-102)	3-3(48-49)	3-4(33-34)	3-4(101-101)	4-1(129-130)	4-2(30-31)	4-2(100-101)	4-4(20-21)	4-4(48-49)	4-4(90-91)	4-4(148-149)	4-5(50-51)	4-5(120-121)	5-1(50-51)
Total Abundance	0	+1	+2	+1	0	+1	+1	+2	+1	+2	+1	+2	+1	+2	+1	+1	+2	+1	+1	+1	+1	+2	+1	0	+1	+2	0	+1	0	+1	0	+2
Braarudosphaera bigelowi																																-2
Ceratolithus cristatus	-2		-2		-2		-2	-1						-2				-2	-2		-2		-2		-2	-1						
C. rugosus																																
Coccolithus pelagicus				-1			-1															-1										
Cyclococcolithina leptopora	-1	-1	-1	-1	-1	-1	-1	-1		-1	-1	-1		-1		-2	-1	-1	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Discoaster adamanteus																																
D. asymmetricus																																
D. brouweri rutellus																	-2															
D. brouweri tamalis																																
D. brouweri tridenus																																
D. brouweri triradiatus																																
D. cf. *bollii*														-2																		
D. extensus																																
D. cf. *surculus*																																
D. surculus																																
Discolithina japonica																																
D. cf. *macropora*						-2				-2										-2												
D. spp.	-1	-1	-1	-1	-1	-2	-1	-1		-2									-1	-1		-1		-1								
"Discolithus" phaseolus		0	0	0	0	0	0	0		0	0	0	0	0	0	0		0	0	0	-1	0	0	0	-1	0	-2	0				0
Discosphaera tubifera	-1	0			-1	-1	-1	-1		-1	-1			-1					-1				-1		-1			-1				
Ellipsodiscoaster lidzi		-1	-1	-1		-1	0	-1	-2	-1					-1	-1			-1	-1			0		-1			-1				
Emiliania huxleyi	0	+1	+2	+1	0	+1	0	+1	0	0	0	0	-1	-1	0																	
Gephyrocapsa californiensis					-1		0		0	+1	0	+1	0	+1	0	+1	+1	0	0		0	0	0	0	0	+1	0	+1		0	0	+1
G. kamptneri			+1	+1	0	+1	+1	+1	+1	+1	+1	+1	0	+1	+1	0	+1	0	0	0	0	+1	+1		0	+1		+1		+1	0	+1
G. oceanica	-1	0	+1	0	0	0	0	+1	0	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	0	+1	+1	0	0		+1	0	+1
G. parallela																							-1									
G. sinuosa	-1		0	+1	0	0	+1	+1	0	+1	0	+1	0		0			-1	0				0		-1	-1	0	0	-1	-1	-1	0
G. sp.	0	-1	0		-1	0	0	0	0	0	0	0	0	+1	0	0	0	0	0	0	0	0	0	0	0	0		0	-1	0	0	0
Helicopontosphaera kamptneri	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
H. sellii	-1	-1					-1	-1						-1			-1	-1		-1				-2								
H. wallichi								-2																								
Pontosphaera scutellum	-1		-1																													
P. sp.																												-1	-1	-1	-1	
Pseudoemiliania lacunosa (circular)																-2				-1	0	-1		-2				-1		-1		-1
P. lacunosa (elliptical)																								-2				-1		-1		-1
Reticulofenestra cf. *pseudoumbilica*																																
R. pseudoumbilica																																
Rhabdosphaera clavigera												0				-1			-1				-1		-1							
R. stylifera	-1	0	0	0	-1	0	0	0		0	-1	0			0	0			0	0	-1	-1	0	0	-1	0		0				0
Scapholithus fossilis	-1	-1	-1	-1	-1	-1	-1	-1						-1	-1	-2	-2		-1			-1	-1	-1	-1	-1					-1	-1
Scyphosphaera apsteini																																
Sphenolithus abies																																
Syracosphaera clava	-1			-1			-1	-1				-1		-1	-1	-1							-1								-1	
S. decussata	-1		-1	0	-1	-1	0	0	-1	0	-1	0			-1	-1	0	-1	0	0		-1	0	0	-1	-1		0	-1	-1		-1
S. historica							-1	-1		0		-1			-1	-2			-1				-2			-1						
S. jonesi	-1	-1		-1		-1	-1	-1		-1	-1	0	-1	-1	-1	0	-1	-1		-1	-2	-1	-1	0	-1	-1		0	-1		-1	
S. pulchra	-1		-1	0	-1	-1	0	0	-1	0	-1	0			-1	-1	0	-1	0							-2						-1
S. sp.																																
Thoracosphaera saxea															-2			-2				-2				-2			-2	-2		
Umbilicosphaera mirabilis	0	0	0	0	-1	0	-1	-1	-1	-1			-1	-1	-1	0	0	-1	-1	0	-1	0	-1	-1	-1	-1		-1	-1			-1
"Little u"	-2	-2	-1					-1	-1			-2	-2	-1			-2					-2							-2		-1	-2

TABLE 7–*Continued*

Age	Pleistocene																															
Zone	*Gephyrocapsa oceanica*																															
Sample Level	5-1(120-121)	5-2(9-10)	5-2(82-83)	5-3(10-11)	5-3(80-81)	5-3(149-150)	6-1(102-103)	6-2(20-21)	6-2(90-91)	6-3(30-31)	6-3(99-100)	6-3(101-102)	6-4(45-46)	6-5(0-1)	6-5(30-31)	6-5(65-66)	6-5(130-131)	6-6(50-51)	6-6(121-122)	7-1(132-133)	7-2(31-32)	7-2(100-101)	7-3(40-41)	7-4(10-11)	7-4(70-71)	7-4(149-150)	8-1(30-31)	8-1(101-102)	8-2(9-10)	8-2(60-61)	8-2(130-131)	8-3(105-106)
Total Abundance	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	+1	+1	+1	+1	+1	0	+1	+1	+1	+1	0	+1	+1	0	0	+1	+1	+1	+1	+1	0
Braarudosphaera bigelowi			–2							–2			–2											–1							–2	
Ceratolithus cristatus		–2					–1	–1						–1				–1	–1	–1	–1											–1
C. rugosus																																
Coccolithus pelagicus											–2																					
Cyclococcolithina leptopora	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1			–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	0
Discoaster adamanteus																																
D. asymmetricus																																
D. brouweri rutellus																																
D. brouweri tamalis																																
D. brouweri tridenus																																
D. brouweri triradiatus																																
D. cf. *bollii*																																
D. extensus																																
D. cf. *surculus*										–1																					–1	
D. surculus																																
Discolithina japonica																																
D. cf. *macropora*												–2		–2				–2	–2													
D. spp.		–1	–1							–1				–1		–1		–1		–1	–1		–1		–1	–1				–1		–1
"Discolithus" phaseolus		0	0	0	0	0	0	0	0	0	0	0	0	0	–1	0		0	0	0	0		–1	0		0	0	0	–1	–1	0	
Discosphaera tubifera		–2	–1					–1					–1	0				–1						–1					–1		–1	
Ellipsodiscoaster lidzi																														0	0	
Emiliania huxleyi																																
Gephyrocapsa californiensis	0	0	0	0	0	+1	0	+1	0	0	0	0	0	0	0	0			0	0	0	0		0	0	0	0			0	0	0
G. kamptneri	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	+1	+1	+1	0	+1		+1	+1	+1	+1	0	+1	+1	0	0	+1	+1	+1	+1	+1	0
G. oceanica	+1	0	+1	+1	+1	0	0	0		0		0	0	+1	0	+1		0	0	0	0			0	0	0	–1			0	0	0
G. parallela																																
G. sinuosa	–1	0	–1		–1	0	0	0	0	+1	0	0		–1	0	0	0	–1	–1		–1		–1	–1		–1	–1	–1	–1	–1	–1	–1
G. sp.	0	+1	+1	+1	0	0	0	+1	+1	+1		0	0	0		0	0	0	0	+1	+1	0	0	0	0	0	0	0	–1	0	+1	+1
Helicopontosphaera kamptneri	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
H. sellii														–1																		
H. wallichi								–2																								
Pontosphaera scutellum										–1									–2	–1	–1		–1	–1	–1	–1			–1		–1	
P. sp.	–1	–1		–1	–1	0	–1	–1	–1			–1	–1	0			–1	–1	–1	–1	–1		–1	–1		–1			–1	–1	–1	–1
Pseudoemiliania lacunosa (circular)	–1		0	–1	–1	0	0	0	0	0	0	0	0	0	–1	0			–1	–1	–1	0	0	0	–1	0	0	0	0	–1	0	–1
P. lacunosa (elliptical)	–2		–1	–2		0	–1	0	0	0	0	0	–1	0	–1	0		–1	–1	–1	–1	0	0	–1	0	0	0	0	0	+1	+1	+1
Reticulofenestra cf. *pseudoumbilica*											0																					
R. pseudoumbilica																																
Rhabdosphaera clavigera			–1					–1					–1				–1															–1
R. stylifera	0	0	–1		0	0	0	0	–1	0	0	0	0	0		0		0	0	–1	–1		–1	–1	0	0	0		–1	–1	0	
Scapholithus fossilis	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–2		–1	–1	–1	–1	–1	–1				–2			–1	–1	–1	–1	–1
Scyphosphaera apsteini																																
Sphenolithus abies																																
Syracosphaera clava																	–2															
S. decussata	–1	0	0	–1	–1	–1	0	0	–1	–1		–1	0			0		0	–1	0	–1	–1	–1	–1	–1	–1		–1	–1	0	0	–1
S. historica							–1																									
S. jonesi	–1	–1		–1	–1	–1			0	–1		–1	–1	0		–1			–1	–1	–1			–1		–1	–1	–1		0	0	–1
S. pulchra																																
S. sp.																																
Thoracosphaera saxea	–2	–2	–1		–2		–1	–1	–1			–1	–1	–1		–1	–1			–1	–2	–1		–1		–1	–1	–1	–1	–1		–1
Umbilicosphaera mirabilis	0	–1	–1	0	–1	0	0	0	0	–1	–1	0	–1	0	–1		–1			–1	–1	–1	–1	–1	0	–1	–1	–1	–1	0	–1	–1
"Little u"				–2																		–2									–1	–1

TABLE 7–*Continued*

Age	Pleistocene																															
Zone	*Gephyrocapsa oceanica*																															
Sample Level	8-4(30-31)	8-4(100-101)	9-1(123-124)	9-2(40-41)	9-2(110-111)	9-3(50-51)	9-3(120-121)	9-4(47-48)	9-5(10-11)	9-5(29-30)	9-5(64-65)	9-5(129-130)	10-1(48-49)	10-2(5-6)	10-2(60-61)	10-2(111-112)	10-3(34-35)	10-4(20-21)	10-4(100-101)	11-1(30-31)	11-1(104-105)	11-2(20-21)	11-2(90-91)	11-2(146-147)	11-3(30-31)	11-3(100-101)	11-4(20-21)	11-4(90-91)	11-4(146-147)	11-5(10-11)	11-5(80-81)	11-5(149-150)
Total Abundance	+1	+1	+1	+1	+1	+1	+1	0	0	+1	+1	0	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	0	0	+1	+1	+1	0	0
Braarudosphaera bigelowi									–2																		–2					
Ceratolithus cristatus	–2		–1	–1		–1		–2			–1			–1					–1	–1						–1	–1	–1				–1
C. rugosus																																
Coccolithus pelagicus														–1			–1	–1							–1		–1					
Cyclococcolithina leptopora	–1	0	–1	–1	–1	–1	–1		–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1
Discoaster adamanteus																																
D. asymmetricus																																
D. brouweri rutellus																																
D. brouweri tamalis																																
D. brouweri tridenus																																
D. brouweri triradiatus																																
D. cf. *bollii*																																
D. extensus																																
D. cf. *surculus*																																
D. surculus																																
Discolithina japonica																																
D. cf. *macropora*																			–1										–2		–2	
D. spp.	–1	–1		–1		–1	–1				–1	–1	–1		–1		–1	–1	–1	–1	–1			–1	–1		–1	–1	–1	–1	–1	–1
"*Discolithus*" *phaseolus*	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	–1	–1	0	0	0		0		0		0
Discosphaera tubifera	–1			–1																–1												
Ellipsodiscoaster lidzi																		–1														
Emiliania huxleyi																																
Gephyrocapsa californiensis	0	0	0	0	0	0	+1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0				0	0	0		
G. kamptneri	+1	+1	+1	+1	+1	+1	+1	0	0	+1	+1		+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1				+1	+1	+1		
G. oceanica	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0				0		0		
G. parallela																						–1										
G. sinuosa			–1	–1	–1	–1		–1		–1	–1	–1	–1	–1	–1				–1			0	+1	+1		0	0	–1	–1	–1	–1	0
G. sp.	0	0	0	0	–1	0	0	0	+1	0	0	0	+1	+1	+1	0	0	0	0	0	0	+1	+1	0	0	0	0	0	0	0	0	0
Helicopontosphaera kamptneri	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	0	–1	–1	0	–1	–1	–1	–1
H. sellii	–1											–1			–1	–1	–1							–1				–1	–1			
H. wallichi																																
Pontosphaera scutellum	–1	–1		–1						–1	–1								–1			–1	–1	–1	–1	–1	–1	–1	–1		–1	
P. sp.	–1	–1		–1					–1		–1		–1			–1	–1		–1	–1	–1	–1		–1	0	–1	–1		–1		–1	
Pseudoemiliania lacunosa (circular)	0	0	0	0	–1	–1	0	–1			–1			0	0	0	0		–1	–1		–1		0				0	0	–1		
P. lacunosa (elliptical)	0	0	0	–1	–1	–1	0	–1			–1		0	+1	+1	0	0		–1	0	0	0	0	0				0	0			
Reticulofenestra cf. *pseudoumbilica*																																
R. pseudoumbilica																																
Rhabdosphaera clavigera										–1										–1									–1			
R. stylifera	–1	–1	–1	0	0	–1		–1	–1	–1	0			0	–1	0	0		0	–1			–1	0				0		–1		
Scapholithus fossilis	–1	–1	–1									–1							–1			–1				–1			–1	–1	–1	
Scyphosphaera apsteini	–1			–1															–1		–1											
Sphenolithus abies																				–2												
Syracosphaera clava																									–1							
S. decussata	–1	0	–1	–1	–1	–1	–1		–1		–1	–1	0	–1	–1	–1	–1	–1	–1		–1	–1		–1		–1	0	0	0	–1	–1	–1
S. historica																																
S. jonesi			–1	–1							–1			–1					–1	–1	–1	–1		–1				–1	–1	–1	–1	–1
S. pulchra			–1																													
S. sp.																																
Thoracosphaera saxea	–1	–1		–1					–1		–1		–1	–1	–1	–1	–1	–1	–1	–1				–1	–1	–1	–1	–1			–1	–1
Umbilicosphaera mirabilis	–1	–1	–1	–1		–1	–1		–1		–1	–1		–1	0	–1	–1		–1	–1		–1	0	0	0	–1	–1	0	0	–1	–1	
"Little u"											–1																					

TABLE 7–*Continued*

Age	Pleistocene																															
Zone	a			*"Gephyrocapsa caribbeanica"*																												
Sample Level	11-6(45-46)	11-6(104-105)	12-1(40-41)	12-1(128-129)	12-2(43-44)	12-2(120-121)	12-3(39-40)	12-3(115-116)	12-4(41-42)	12-5(2-3)	12-5(61-62)	12-5(128-129)	12-6(40-41)	13-1(19-20)	13-1(90-91)	13-1(148-149)	13-2(61-62)	13-2(132-133)	13-3(50-51)	13-3(121-122)	13-4(40-41)	13-4(109-110)	13-5(20-21)	13-5(90-91)	13-6(10-11)	13-6(80-81)	13-6(149-150)	14-1(116-117)	14-2(41-42)	14-2(96-97)	14-3(45-46)	14-4(9-10)
Total Abundance	0	0	+1	+1	+1	0	+1	0	0	0	0	0	0	0	0	0	0	0	+1	+1	+1	0	0	0	0	+1	0	0	0	0	+1	+1
Braarudosphaera bigelowi																																
Ceratolithus cristatus	–1			–1									–1	–1			–1							–1								
C. rugosus																																
Coccolithus pelagicus	–1		–2		–1	–1		–1		–1		–1	–1	–1	–1		–1			–1		–1		–1	–1	–1		–1	–1	–1	–1	
Cyclococcolithina leptopora	–1	–1	–1	–1	–1	–1	–1	–1	–1			–1	–1		–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	
Discoaster adamanteus																																
D. asymmetricus																																
D. brouweri rutellus																																
D. brouweri tamalis																																
D. brouweri tridenus																																
D. brouweri triradiatus																																
D. cf. *bollii*																																
D. extensus																																
D. cf. *surculus*			–1	–1																												
D. surculus																																
Discolithina japonica																																
D. cf. *macropora*														–1									–2				–1					
D. spp.	–1							–1				–1	–1																–1			
"Discolithus" phaseolus	–1	0	0	0	0	0	0	0	0	0	–1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Discosphaera tubifera																																
Ellipsodiscoaster lidzi																																
Emiliania huxleyi																																
Gephyrocapsa californiensis	0	0	0	0	0						0								0	0	0					0				0		
G. kamptneri	0	0	+1	+1	+1						0								+1	+1	+1					+1				+1	+1	0
G. oceanica	0	0	–1																													
G. parallela		–2																														
G. sinuosa	0	–1	0	0	–1	–1	–1			–1	0	–1	–1		–1	–1	–1	–1	–1		–1	–1	–1	–1		–1	–1		–1		–1	–1
G. sp.	+1	0	0	0	0	0	–1	0	–1	0		0	0	0	0	0	0	0	0	+1	0	0	0	0	0	0	0	0	0	0	0	0
Helicopontosphaera kamptneri	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	0	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
H. sellii					–1	–1		–1		–1		–1	–1						–1			–1	–1	–1		–1		–1	–1	–1	–1	
H. wallichi																																
Pontosphaera scutellum	–2	–1		–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1		–1	–1	–1	–1	–1		–1	–1			–1		–1			–1
P. sp.		–1		–1			–1					–1	–1								–1	–1	–1				–1	–1			–1	
Pseudoemiliania lacunosa (circular)	–1	–1	0	0			0												0	0	–1					0		–1	0	0	0	–1
P. lacunosa (elliptical)	0	0	0	0			0												0	0	0					0		0	0	0	0	–1
Reticulofenestra cf. *pseudoumbilica*																																
R. pseudoumbilica																																
Rhabdosphaera clavigera																																–1
R. stylifera	–1	–1	–1	0			0												–1	–1	–1					0		0	–1		0	0
Scapholithus fossilis			–1	–1		–1	–1					–2									–1			–1				–1				
Scyphosphaera apsteini												–1		–1																		
Sphenolithus abies																																
Syracosphaera clava								–1				–1					–1				–1											
S. decussata	–1	–1	0	0	–1	–1	–1	–1	–1				–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–2	0		–1	–1	–1	–1
S. historica																																
S. jonesi			–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1		–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1
S. pulchra																																
S. sp.																																
Thoracosphaera saxea	–1	–1	–1		–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1		–1		–1
Umbilicosphaera mirabilis	–1	–1	0	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1		–1
"Little u"																		–2					–2									

[a]*Gephyrocapsa oceanica*

TABLE 7–*Continued*

Age	Pleistocene									Pliocene																						
Zone	*"Gephyrocapsa caribbeanica"*									*D. brouweri*							*D. pentaradiatus*															
Sample Level	14-4(80-81)	15-1(15-16)	15-1(61-62)	15-1(121-122)	15-2(40-41)	15-2(109-110)	15-3(30-31)	15-3(100-101)	15-4(18-19)	15-4(90-91)	15-5(9-10)	15-5(120-121)	15-6(18-19)	15-6(122-123)	16-2(60-61)	16-2(130-131)	16-3(51-52)	16-4(4-5)	16-4(63-64)	16-4(131-132)	17-1(3-4)	17-1(60-61)	17-1(130-131)	17-2(50-51)	17-2(123-124)	17-3(60-61)	17-4(2-3)	17-4(46-47)	17-5(38-39)	17-5(110-111)	17-6(101-102)	18-1(30-31)
Total Abundance	0	0	0	+1	+1	+1	0	+1	+1	0	+1	+1	+1	+1	0	+1	+1	+1	0	0	+1	0	+1	0	0	0	0	0	0	0	0	0
Braarudosphaera bigelowi																																
Ceratolithus cristatus					–1							–1		–1			–2					–1		–1	–1	–1			–1	–1		
C. rugosus																	–1															
Coccolithus pelagicus		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1			–1	–1	–1	–2	–1	–1	–1	–1	–1		–1	–1	–1			–1		–1	–1
Cyclococcolithina leptopora	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	0	–1	–1		–1	–1	–1	–1
Discoaster adamanteus												–2																				
D. asymmetricus																																
D. brouweri rutellus										–1	–2	–1		–1		–1	–1	–1	–1			–1		–1	–1	–1	–1		–1		–1	–1
D. brouweri tamalis																																
D. brouweri tridenus																																
D. brouweri triradiatus																																
D. cf. *bollii*																																
D. extensus										–2																						
D. cf. *surculus*				–1	–1				–1							–1		–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	
D. surculus																																
Discolithina japonica																																
D. cf. *macropora*								–2																		–2			–2			
D. spp.			–1	–1			–1	–1	–1	–1	–1	–1	–1			–1	–1	–1	–1	–1		–1			–1	–1		–1		–1		
"Discolithus" phaseolus	0	0	0		0			0	0	–1	0	0	0	0	0	0	0		1	0	0		0	0	0	0	0	0	0	0		
Discosphaera tubifera																																
Ellipsodiscoaster lidzi																																
Emiliania huxleyi																																
Gephyrocapsa californiensis		0				0		0						0		0	0													0		
G. kamptneri		0		+1	0	+1		+1	+1			+1	+1	+1		+1	+1	0			0		0							0		
G. oceanica																																
G. parallela																																
G. sinuosa	–1			–1	–1	–1	–1	–1	–1	–1	0	–1	–1																			
G. sp.	0	0	0	0	0	0	0	0	–1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicopontosphaera kamptneri	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	0
H. sellii	–1						–1	–1			–1		–1	–1	–1		–1	–1		–1	–1		–1	–1	–1	–1	–1		–1	–1	–1	–1
H. wallichi																																
Pontosphaera scutellum	–1		–1	–1	–1			–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1		–1		–1						–1	–1
P. sp.		–1	–1	–1	–1			–1	–1	–1							–1	–1														
Pseudoemiliania lacunosa (circular)		–1		0	0	–1	–1	–1	–1	0		0	0	0		0	0	0		–1	0		–1	0					0			
P. lacunosa (elliptical)	0	0		0	0	–1	–1	–1	0	0		0	0	0		0	0	0		0	+1		0	0					+1			
Reticulofenestra cf. *pseudoumbilica*																																
R. pseudoumbilica																																
Rhabdosphaera clavigera																	0															
R. stylifera	–1	–1		0	0		0	–1	0	–1	–1	0	–1	0	0	0	0												0			
Scapholithus fossilis		–1																														
Scyphosphaera apsteini																	–2								–1	–1			–1	–1		
Sphenolithus abies																																
Syracosphaera clava																																
S. decussata	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
S. historica																																
S. jonesi	–1	–1	–1	–1	0	–1	–1	–1		–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1		–1
S. pulchra																																
S. sp.																																
Thoracosphaera saxea	–1			–1				–1		–1		–1		–1	–1	–1			–1							–1	–1		–1			
Umbilicosphaera mirabilis		–1			–1	–1		0	–1		–1		–1	–1	–1	0	+1	0	0	0	0	–1	–1	–1	0	0	–1	–1	–1	–1	–1	0
"Little u"																								–1								

TABLE 7–*Continued*

Sample Level	18-1(100-101)	18-2(45-46)	18-3(24-25)	18-3(100-101)	19-1(25-26)	19-1(100-101)	19-2(20-21)	19-2(111-112)	20-1(25-26)	20-1(110-111)	20-2(25-26)	20-2(101-102)	20-3(44-45)	20-4(25-26)	20-4(101-102)	20-5(25-26)	20-5(101-102)	20-6(25-26)	20-6(100-101)	21-1(100-101)	21-2(25-26)	21-2(100-101)	21-3(25-26)	21-3(100-101)	22-1(50-51)	22-1(100-101)	22-2(25-26)	22-2(100-101)	22-3(25-26)	22-3(100-101)	23-1(25-26)	23-1(100-101)
Age	Pliocene																															
Zone	*D. pentaradiatus*								*Discoaster surculus*																							
Total Abundance	0	0	0	0	0	+1	0	0	+1	0	0	0	0	0	0	0	0	0	0	0	+1	0	+1	0	+1	+1	+1	0	0	+1	0	0
Braarudosphaera bigelowi																			–2												–2	
Ceratolithus cristatus							–1	–1	–1							–1		–1		–1	–1		–1	–1		–1	–1		–1	–2		–1
C. rugosus											–1		0	–1	–2	–2																
Coccolithus pelagicus	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
Cyclococcolithina leptopora	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–2	–1	–1	–1	–1	–1	–1		–1	–1	–2	–1	–1	–1	–1	–1	–1	–1
Discoaster adamanteus																																
D. asymmetricus													0	–1											–1	–1						
D. brouweri rutellus	–1		–1	–1	–2		–1		–1	0	–1	–1	–1	–1		–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1
D. brouweri tamalis																																
D. brouweri tridenus										–1	–1		–2																			–2
D. brouweri triradiatus									–2			–1			–2																	
D. cf. *bollii*																																
D. extensus																																
D. cf. *surculus*		–1	–1		–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1		–1	–1	–1
D. surculus									–1	–1	–2		–1											–1								
Discolithina japonica																									–2		–2		–2			
D. cf. *macropora*								–2																			–1			–1		–1
D. spp.		–1	–1	–1	–1	–1	–1	–1			–1	–1	–1						–1	–1			–1	–1	–1		–1		–1	–1		–1
"Discolithus" phaseolus											0		0														0					
Discosphaera tubifera																																
Ellipsodiscoaster lidzi																																
Emiliania huxleyi																																
Gephyrocapsa californiensis		0																														
G. kamptneri		0																														
G. oceanica																																
G. parallela																																
G. sinuosa																																
G. sp.	0	0	0	0	0	+1	0	0	0	0	0	0	0	0	0	0	–1	0	0	0	+1	0	+1	0	0	+1	0	0	0	0	0	0
Helicopontosphaera kamptneri	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1
H. sellii	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1		–1	–1			–1			–1			–1	
H. wallichi																																
Pontosphaera scutellum		–1	–1	–1			–1	–1	–1	–1	–1		–1		–1	–1			–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1		
P. sp.	–1			–1		–1	–1			–1											–1			–1					–1			–1
Pseudoemiliania lacunosa (circular)				–1			0	0	0	0	0	0	0	0	0	0								0		–1						
P. lacunosa (elliptical)	0	0		–1			0	0	+1	0	0	0	0	0	0	0								0		0	0			0		
Reticulofenestra cf. *pseudoumbilica*												–1	0	0	0	0	0	0	0	0	0	0	0	–1	+1	0	+1	0	0	–1		0
R. pseudoumbilica																																
Rhabdosphaera clavigera																																
R. stylifera		–1																							–1					–1		
Scapholithus fossilis					–2			–1		–1																		–2				
Scyphosphaera apsteini									–1												–1		–2									
Sphenolithus abies																																
Syracosphaera clava																																
S. decussata	–1	–1		–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
S. historica																																
S. jonesi	–1	–1	–1		–1							–1	–1			–1	–1	–1	–1	–1			–1	–1	–1						–1	–1
S. pulchra			–2			–2	–2											–2			0		–2		–2							
S. sp.																																
Thoracosphaera saxea	–1	–1	–1	–1		–1	–1	–1		–1	–1	–1		–1	–1	–1	–1	–1					–1		–1		–1	–1	–1		–1	–1
Umbilicosphaera mirabilis	–1	–1	–1	0	0	–1	–1	0	–1	–1	0	–1	–1		–1		–1	–1		–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	
"Little u"												–1				–2										–2						

TABLE 7–*Continued*

Sample Level	23-2(26-27)	23-2(100-101)	23-3(25-26)	23-3(100-101)	23-4(31-32)	23-5(24-25)	23-5(100-101)	23-6(25-26)	23-6(110-111)	24-1(110-111)	24-2(25-26)	24-2(100-101)	24-3(27-28)	24-3(100-101)	24-4(25-26)	24-4(100-101)	24-5(24-25)	24-5(110-111)	24-6(25-26)	24-6(100-101)	25-1(113-114)	25-2(25-26)	25-2(100-101)	26-1(115-116)	26-2(61-62)	26-2(139-140)	27-1(25-26)	27-1(100-101)	27-2(25-26)	27-2(100-101)	27-3(25-26)	27-3(101-102)
Age	Pliocene																															
Zone	*Discoaster surculus*																															
Total Abundance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+1	0	0	0	0	0	0	0	0	+1	0	0	0	0	0	0
Braarudosphaera bigelowi																																
Ceratolithus cristatus	–1	–1			–1		–1	–1							–1		–1			–1	–1	–2	–1	–1	–1	–1				–1	–1	–1
C. rugosus										–1																						
Coccolithus pelagicus	–2	–1	–1		0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1					–1	–1	–1	
Cyclococcolithina leptopora		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
Discoaster adamanteus										0		0																				
D. asymmetricus																						0	0						0		0	
D. brouweri rutellus							–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1
D. brouweri tamalis																																
D. brouweri tridenus												–1								–1		–1	–1	–2	–1							
D. brouweri triradiatus										–1																–2			–2			
D. cf. *bollii*																																
D. extensus												–2																				
D. cf. *surculus*	–1		–1		–1	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	–1
D. surculus						–2				–1		–1	–2							–2		–2	–2	–1	–1	–1			–1		–1	
Discolithina japonica																																
D. cf. *macropora*		–1	–1		–1																–2											
D. spp.		–1	–1	–1		–1	–1			–1		–1	–1	–1	–1	–1		–1	–1		–1		–1		–1	–1	–1	–1		–1	–1	–1
"Discolithus" phaseolus				0						0														0	–1	0					0	
Discosphaera tubifera																																
Ellipsodiscoaster lidzi																																
Emiliania huxleyi																																
Gephyrocapsa californiensis																																
G. kamptneri																																
G. oceanica																																
G. parallela																																
G. sinuosa					–1							–1						–1		–1	–1					–1	0	–1	0	0	0	0
G. sp.	0	0	0	0	0	0	0	+1	0	0	0	0	0	0	–1	0	+1	0	0	+1	+1	+1	+1	0	+1	+1	0	0	0	0	0	+1
Helicopontosphaera kamptneri		–1	–1	–1	–1	0	–1	–1	–1	–1	–1	–1	0	–1	–1	–1	0	0	–1	0	–1	–1	0	–1	0	–1	–1	–1	–1	–1	–1	0
H. sellii			–1	–1					–1		–1	–1	–1		–1	–1		–1	–1		–1										–1	
H. wallichi																																
Pontosphaera scutellum		–1	–1	–1	–1	–1	–1																									
P. sp.													–1					–1		–1	–1							–1				–1
Pseudoemiliania lacunosa (circular)				–1		–1				0		0	0							–1		–1	0	–1	–1	–1			–1			
P. lacunosa (elliptical)				–1		0				0		0	0							0		0	0	0	0	0			0		0	
Reticulofenestra cf. *pseudoumbilica*										0		0								0		0	–1	0	0				0		0	
R. pseudoumbilica																																
Rhabdosphaera clavigera																																
R. stylifera																																
Scapholithus fossilis		–2	–2										–2		–1				–1				–2						–1			–1
Scyphosphaera apsteini							–2						–1								–2											
Sphenolithus abies																													0	0	0	
Syracosphaera clava																																
S. decussata	–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1		–1	–1	–1	–1	–1	–1	–1	–1	–1		–1	–1	–1	–1	–1			0
S. historica																																
S. jonesi	–1			–1				–1				–1		–1		–1	–1			–1									–1	–1	–1	
S. pulchra	–2						–2			–2	0			–2	–1			–2														
S. sp.																																
Thoracosphaera saxea	–1	–1				–1		–1		–1	–1		–1	–1	–1		–1			–1	–1		–1	–1	–1	–1	–1	–1		–1	–1	
Umbilicosphaera mirabilis	–1	–1		–1		0	0	0	0	0	0	0	–1	–1	0	–1	–1	–1		–1	–1	–1	–1	–1	–1	–1		–1	–1		–1	–1
"Little u"					–2			–2																								

TABLE 7– *Continued*

Age	Pliocene								
Zone	a	*R. pseudoumbilica*							
Sample Level	27-4(25-26)	27-4(100-101)	27-5(25-26)	27-5(100-101)	27-6(25-26)	27-6(100-101)	28-1(58-59)	28-1(110)	29-1(119-120)
Total Abundance	0	0	0	0	–1	0	–1	–1	–1
Braarudosphaera bigelowi									
Ceratolithus cristatus	–1		–1			–1			
C. rugosus									
Coccolithus pelagicus	–1		–1	–1	–1	–1	–1		–1
Cyclococcolithina leptopora	–1	–1	–1	–1	–1	–1	–1		
Discoaster adamanteus									
D. asymmetricus	0	0	0			0			
D. brouweri rutellus		–1	–1	–1	–1				
D. brouweri tamalis									
D. brouweri tridenus	–2		–1		–1				
D. brouweri triradiatus						–1			
D. cf. *bollii*									
D. extensus					–2				
D. cf. *surculus*	–1	–1	–1	–1	–1	–1			
D. surculus	–2	–2	–2		–1				
Discolithina japonica									
D. cf. *macropora*					–2				
D. spp.	–1			–1	–1	–1			
"Discolithus" phaseolus									
Discosphaera tubifera									
Ellipsodiscoaster lidzi									
Emiliania huxleyi									
Gephyrocapsa californiensis									
G. kamptneri									
G. oceanica									
G. parallela									
G. sinuosa	0	–1	0						
G. sp.	+1	0	0	0	+1	+1			
Helicopontosphaera kamptneri	–1	–1	–1	–1	0	–1			
H. sellii					–1	–1			–1
H. wallichi									
Pontosphaera scutellum									
P. sp.	–1								
Pseudoemiliania lacunosa (circular)					–1				
P. lacunosa (elliptical)	0	0	0		0	0			
Reticulofenestra cf. *pseudoumbilica*		0			0	0			
R. pseudoumbilica		–1	–1	–1	–1	–1			
Rhabdosphaera clavigera									
R. stylifera									
Scapholithus fossilis									
Scyphosphaera apsteini					0	0			
Sphenolithus abies	0	0	0		0	0	0		
Syracosphaera clava									
S. decussata				–1		–1			
S. historica									
S. jonesi									
S. pulchra									
S. sp.									
Thoracosphaera saxea				–1	–1	–1			
Umbilicosphaera mirabilis	–1	–1	0	–1	0	–1			
"Little u"						–2			–2

[a]*Discoaster surculus*

the base of Section 2 and the top of Section 3. Sections 3, 4, 5, and the upper part of Section 6 belong to the *Gephyrocapsa caribbeanica* Zone. (Note: In the terminology of Gartner [1969], the entire upper part of this core would be assigned to the *Pseudoemiliania* Zone). The highest occurrence of *Discoaster brouweri* is in Section 6 so that the base of this section and the core catcher belong to the *Discoaster brouweri* Zone. Core 2 lies in the region of overlap of the ranges of *Ceratolithus tricorniculatus* and *C. rugosus.* Subdivision of the core is possible on the basis of *Discoaster asymmetricus,* which has its lowest occurrence in Section 2. Section 1 and the top of Section 2 belong to the *Discoaster asymmetricus* Zone; the lower part of Section 2 and Section 3 belong to the *Ceratolithus rugosus* Zone.

Distribution of species in Cores 3 through 9 is shown in Table 17. Section 1 of Core 3, contains a rich, moderately well preserved calcareous nannofossil assemblage of the *Discoaster kugleri* Zone. The name species does not occur in the lower sections, however, which, with subjacent sections of this core, is referred to the *Discoaster exilis* Zone. It is likely that the portion of the first section representing the *D. kugleri* Zone has fallen from higher in the hole. Core 4 also contains a complex sequence in the first section. The first 50 cm or so contain *Discoaster exilis* and *Sphenolithus heteromorphus,* and belong to the *Sphenolithus heteromorphus* Zone. The lowest occurrence of *Discoaster exilis* and the highest occurrence of *Sphenolithus belemnos* lie within Section 1 so that the lower part of the section belongs to the *Sphenolithus belemnos* Zone. The highest occurrence of *Triquetrorhabdulus carinatus* is between samples from Sections 1 and 2, and Section 2 and is referred to the *Discoaster druggi* Zone. Core 5 contains a similar assemblage, but the discoasters indicate a somewhat older age; all samples are referred tentatively to the *Triquetrorhabdulus carinatus* Zone. Core 6 contains an assemblage belonging to the *Triquetrorhabdulus carinatus* Zone as does Core 7. The highest occurrence of *Sphenolithus ciperoensis* appears to lie between Cores 7 and 8 so that Cores 8 and 9 are both referrable to the *Sphenolithus ciperoensis* Zone. *Triquetrorhabdulus carinatus* is common throughout these cores.

Distribution of species in samples from Cores 10 and 11 is shown in Table 18. Mud on the liner near the top of Section 1 of Core 10 contains a fine assemblage with many asteroliths not often encountered in deep-sea deposits in this area: *Marthasterites tribrachiatus, Discoaster mediosus, D. lodoensis,* and *D. diastypus.* This material seems to represent a mixture of the *Discoaster binodosus* and *Marthasterites tribrachiatus* Zones. The mud is also notable for a rich content of acritarchs, which may be readily seen in smear slides. The upper part of the in situ material in Section 1, to a depth of about 50 cm., contains *Discoaster diastypus, D. multiradiatus,* and *Fasciculithus tympaniformis,* and belongs to the *Discoaster multiradiatus* Zone. The lower part of Section 1 and all of Section 2 contain a coccolith assemblage lacking asteroliths or fasciculiths, referrable to the *Chiasmolithus danicus* Zone. The top of

TABLE 8
Calcareous Nannofossils in Cores 2 through 8, Hole 149

Sample Level	2-1(25-26)	2-1(100-101)	2-2(62-63)	2-3(25-26)	2-3(100-101)	2-4(25-26)	2-4(100-101)	2-5(51-52)	2-6(25-26)	2-6(100-101)	3-1(144-145)	3-3(100-101)	4-3(25-26)	4-5(25-26)	5-3(62-63)	5-4(102-103)	5-5(99-100)	6-2(25-26)	6-2(99-100)	6-3(25-26)	6-4(59-60)	6-5(35-36)	6-5(111-112)	6-6(23-24)	6-6(99-100)	7-1(69-70)	7-2(60-61)	7-3(25-26)	7-3(99-100)	7-5(25-26)	7-5(99-100)	7-6(125-126)	8-1(25-26)	8-2 (25-26)	8-2(99-100)	8-3(25-26)	8-4(19-20)	8-6(25-26)
Age	Pleistocene																				Pliocene																	
Zone	a			*Gephyrocapsa oceanica*																b	c		d			Mixed						e	Mixed				f	
Total Abundance	+2	+1	+1	+1	+2	+2	+1	+1	+1	+1	+1	+1	+2	+1	+2	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+2	+1	0	0	0	0	0	0
Ceratolithus cristatus	–1		–1	–1			–1	–1		–1			–1	–2	–2	–1	–1		–1	–1		–1	–1	–2	–1	–2	–2	–2	–1	–1		–1	–1		–1	–1		–1
C. rugosus																							–1	–2		–2							–1				–1	
C. tricorniculatus																																						
Coccolithus pelagicus	–1	–1	–1	–1											–1		–2		–2	–1		–1	–2		–1		–2		–2	–2	–1		–1	–2	–1	–1		–1
Cyclococcolithina leptopora	0	0		–1	0	0	0	–1	–1	–1	–1	–1	0	–1	–1	–1	0	–1	–1	–1	–1	–1		–1		–1	–1	–1	–1	–1	–2	–1	–1	–1	–1	–1	–1	0
C. macintryei																																						
Cyclolithella annula				–1			–2																															
Discoaster asymmetricus																																						
D. brouweri rutellus																					–2	–1	–1	–1	–1	–2		–2				–1	0	0	0	–1	0	–1
D. brouweri tamalis																																					–2	–2
D. brouweri triradiatus																					–2	–2	–2	–2		–2									–2			
D. extensus																															–2							
D. pentaradiatus																							–1									–1					0	
D. perplexus		–2		–1	–1								–1	–1																								
D. surculus																																					–2	–2
D. woodringi														–2																								
Discolithina cf. *macropora*						–1								–1																								
D. spp.			–1					–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1			–1	–1																
"Discolithus" phaseolus	+1	0	+1	0	+1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+1	0	0	0	0	0	0	0	+1	0			0	0	0
Ellipsodiscoaster lidzi				–1		–1	–1								–1																							
Emiliania huxleyi	+2	0	+1																																			

Gephyrocapsa californiensis				0	0		+1					0	0	0	+1	0	0	0	0	0	0	+1	0	0	0	+1	0	0	+1	+1		0		0				
G. kamptneri		0		+1	+2		+1					+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+2	+1	+1	+1	0	0	0	0
G. oceanica	+1	+1	+1	0	0		+1					+1	+1	0		0	0		0		0							-2										
G. sinuosa			-1	+1	+1	+1	0	+1	+1	0	-1	+1	+1	+1	0		0	+1	0	-1	-1	-1	0	0	0	+1	+1	+1	+1	+1	+2	+1						
G. sp.	0	0	0	0	0	+1	0	0	0	+1	0		0	0	0	0	0	+1	0	0	0	0																
Helicopontosphaera kamptneri	-1	-1	-1	-1	0	-1	-1	-1	-1	-1	-1	0	0	-1	0	0	-1	-1	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0
H. sellii							-1	0				-1				-1		-1				-1											0		-1	-1	-1	-1
Oolithotus antillarum		-1		-1	-2								-2																									
Pontosphaera scutellum	-1							-1	-1					-1	-1	-1				-1	-2			-1		-1		-1	-1		-1							
P. sp.	-1													-1	-1				-1				-1	-1		-1		-1	-1		-1			-2	-2			
Pseudoemiliania lacunosa (circular)			-1									-1	-1	0	-1	0	0	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0
P. lacunosa (elliptical)													-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reticulofenestra cf. *pseudoumbilica*	0				0		0										0										-1		-1					0			0	0
R. pseudoumbilica																																						
Rhabdosphaera clavigera				-1		-1									-1																					0		
R. stylifera	0	0	0	0	0		0						0	0	-1	0	0		-1	0	0		0	0	0	0	0		0	0	0	0					0	0
Scapholithus fossilis	0	-1	0	0	0	0	0	0	0	0	-1	0	-1	-1	-1	-1		-1	0								-1									-1		
Scyphosphaera apsteini														-2	-2	-2	-1					-1		-2				-2	-2	-2	-2				-2			
Sphenolithus abies													-2							-1															-2			
Syracosphaera clava																																						
S. decussata	0	-1	-1	0	0	0		-1	-1								0																					
S. historica	-1			-1			-1	0	-1	0	-1																											
S. jonesi	0	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	-1		0	0	0	0																	
Thoracosphaera pelagica				-1			-2						-2	0																								
T. saxea	-1	-1	0	-1	-1	-1	-1	-1	-1	-1		-1		-1	-1	-1	-1	-1	-1	-1	-1	-1																
Umbilicosphaera mirabilis	0	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	0	+1	0	0	0	0	0	+1	0	0	0	0	-1	0	-1	-1	-1	0	-1	0	0			
"Little u"	-1	-1	-1																																			

[a]*Emiliania huxleyi*

[b]*"Gephyrocapsa caribbeanica"*

[c]*Discoaster brouweri*

[d & e]*Discoaster pentaradiatus*

[f]*Discoaster surculus*

TABLE 9
Calcareous Nannofossils in Cores 9 through 14 (Section 3), Hole 149

Sample Level	9-1(140-141)	9-2(25-26)	9-6(8-9)	9-6(19-20)	9-6(33-34)	9-6(99-100)	9-6(120-121)	10-2(69-70)	10-5(90-91)	11-1(99-100)	11-2(25-26)	11-2(99-100)	11-3(21-22)	11-4(54-55)	11-5(25-26)	11-5(99-100)	11-5(115)	11-5(129-130)	11-6(25-26)	12-2(36-37)	12-6(99-100)	13-2(25-26)	13-2(100-101)	13-3(22-23)	13-4(25-26)	13-6(25-26)	14-1(120-121)	14-3(25-26)	14-3(96-97)
Age	Pliocene																	Miocene											
Zone	*Discoaster surculus*									a				b				c						*Discoaster calcaris*					
Total Abundance	0	0	0	-1	+1	-1	-1	0	-1	0	-1	+1	0	0	0	0	0	-1	0	+1	+1	-1	+1	+1	+1	+1	0	-1	-1
Ceratolithus cristatus		-1	-1							-2		-1																	
C. rugosus					-1			-1	-2	-2		-1		-2	-1	-1	-1												
C. tricorniculatus														-2		-2		-1	-2										
Coccolithus pataecus			-1																										
C. pelagicus	0	-1	-1		0			0				-1				-1	-1			0	0		0		0	-1	0	-1	0
Cyclococcolithina leptopora	0	-1	0		0			-1								-1							-2						
C. macintyrei		-2						-1				-1	-1												-1			-1	-1
Discoaster asymmetricus	-1	-1			0		-2	0		0	-1	0	0	-1	-2	0	0												
D. bollii																-1			-1	0						0		-1	0
D. brouweri calcaris																	-1									-1	-1		0
D. brouweri rutellus	0	0	0	-2	0	-2	-2	0	-1	0	-1	0	-1	0	0	0	0	-1	0	+1	+1	-1	0	+1	+1	+1	0	0	0
D. brouweri tamalis	-1		-1		-1	-2		-1		-1		-1			-2	-1	-1			-2		-2		-2					
D. brouweri tridenus																-2									0	0	-1	-1	0
D. brouweri triradiatus	-2				-1					-2			-2	-2		-2				-2	0	-2	-1	-1	-1	-2		-2	-2
D. challengeri																												-2	
D. extensus			-1		-1			-2		-1		0		-1	-1	-1			-1	0	0	-1	0	+1	0	0	0	0	0
D. neohamatus																?				?				0	0	0	?	-1	0
D. pentaradiatus	0	-1	0	-2	+1	-2	-2	0		0	-1	0	0	0	0	0			0	0	0			0	-1				
D. quinqueramus																		-1	-1	+1	+1	-1	+1						
D. surculus	-1	-1	-1		-1	-2	-2	-1						-1	-1	-1	-1		-1	0	0	-2	-2		-1				
D. variabilis																					0		0				0	0	0
"Discolithus" phaseolus					0																								
Helicopontosphaera intermedia																					0			0	0	0			
H. kamptneri	0		0	-2	0		-2					-1												0	0				
H. sellii	-1	-1	-1					0								0													
Pseudoemiliania lacunosa (circular)		0						0				-1																	
P. lacunosa (elliptical)		0	0					0				0	0			?													
Pontosphaera scutellum	-2																												
P. sp.																					-1					-2			
Reticulofenestra cf. *pseudoumbilica*		0	+1		+1		0					0	0			0													
R. pseudoumbilica										-1		-1	-1			-1								0	0	-1			-1
Scyphosphaera apsteini								-2																-1					
Sphenolithus abies		0			0							-1	-1		0	-1					0				0				
S. neoabies																-1						-2							
Triquetrorhabdulus rugosus																				-2			-1	-1					
Umbilicosphaera cricota		-1	-1				-2		-2															0	-1	-1			

[a]*Reticulofenestra pseudoumbilica*
[b]*Discoaster asymmetricus*
[c]*Discoaster quinqueramus*

Section 6 of Core 11 contains an assemblage similar to that of Section 2 of the superjacent core, but lacking *Chiasmolithus danicus.* It does contain *Cruciplacolithus tenuis* and is referred to the *Cruciplacolithus tenuis* Zone. Most of the rest of Section 6 lacks *C. tenuis* and belongs to the *Markalius astroporus* Zone.

Cores 12 and 13 contain a mixture of lumps of various color in a dark soupy matrix. Individual lithologies were examined for their nannofossil content. Most contain sparse assemblages, but the light green marly chips contain a diverse more or less well-preserved assemblage characteristic of the Late Cretaceous (Table 19).

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The distribution of species in Cores 1 through 9 is shown in Table 20. In Core 1, the highest occurrence of *Discoaster multiradiatus* is between Sections 1 and 2. Assemblages in both sections are rich and well preserved. *Discoaster diastypus* dominates in assemblages from Section 1, which is referred to the *D. diastypus* Zone. Section 2 is referred to the *Discoaster multiradiatus* Zone, but is very high in that unit. Core 2 recovered sediments with calcareous nannofossil assemblages very similar to those of the lower part of Core 1, and referred to the *Discoaster multiradiatus* Zone. The highest occurrence of *Fasciculithus tympaniformis* is

TABLE 10
Calcareous Nannofossils in Core 14 (Section 4) through 18, Hole 149

Age	Miocene														
Zone	a	b		c		d					e			f	
Sample Level	14-4(122-123)	15-1(25-26)	15-2(98-99)	15-3(25-26)	15-3(99-100)	15-4(22-24)	15-5(36-37)	16-1(99-100)	16-2(40-41)	16-2(105-106)	16-3(25-26)	17-4(23-24)	17-5(128-129)	18-2(23-24)	18-5(99-100)
Total Abundance	0	-1	+1	+1	+1	0	+1	+1	0	0	+1	+1	+1	0	+1
Catinaster calyculus			0						?						
C. Coalitus	0		0						?						
Coccolithus eopelagicus			0	0	0	-1	0	0	0	0	0	0	0	0	0
C. pelagicus	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
Coronocyclus nitescens														-1	-1
Cyclicargolithus floridanus								+1		0	+1	0			
Cyclococcolithina macintryei		-1								-1					0
Discoaster adamanteus														0	
D. aulakos													0		0
D. bollii			-1			-1	-1	-1	0		0			-1	
D. brouweri rutellus	0	-1	0	0	0	0	0		0		0	0	0		
D. deflandrei													0	0	0
D. divaricatus												-1	-1	-1	0
D. exilis	-2	-1	-1	-1	0	-1	0	0	0	0	0	0	0	0	
D. extensus	0	-1	0	0	0		0						0		
D. hamatus	0														
D. kugleri			-1	0	-1				?			?	?		
D. phyllodus	-1														
D. subsurculus													-1		
D. trinidadensis													-1		
D. variabilis		-1		0	0	-1	0	0		0	0				
Helicopontosphaera ampliaperta														-1	-1
H. intermedia				-1	-1										
Reticulofenestra pseudoumbilica	0	-1	0		0	-1	-1	-1							
Sphenolithus abies				0			0								
S. heteromorphus											0	-1	0	0	+1

[a] *Discoaster hamatus*
[b] *Catinaster coalitus*
[c] *Discoaster kugleri*
[d] *Discoaster exilis*
[e] *Sphenolithus heteromorphus*
[f] *Helicopontosphaera ampliaperta*

between the recovered sediments of Core 2 and Core 3. *Discoaster multiradiatus* is present in Core 3, but its concurrent appearance with *F. tympaniformis* suggests the lower part of the *Discoaster multiradiatus* Zone. Core 4 contains assemblages resembling those of Core 3.

The core catcher sample of Core 5 contains two kinds of rock, one pink and one gray. The gray rocks contain an abundant calcareous nannofossil flora with *Heliolithus kleinpelli* well developed and well preserved; the *H. kleinpelli* Zone is indicated. Core 6 contains a similar assemblage.

Cores 7 and 8 contain more or less rich, moderately well-preserved calcareous nannofossil assemblages with a typical early Paleocene aspect, but with *Fasciculithus tympaniformis* present, and are assigned to the *Fasciculithus tympaniformis* Zone.

Core 9 contains a typical early Paleocene assemblage, with *Chiasmolithus danicus* and *Cruciplacolithus tenuis*, and are referred to the *Chiasmolithus danicus* Zone.

Data from Cores 10 through 23 are presented in Table 21. Samples from Core 10 contain only rare, poorly preserved calcareous nannofossils, with a few Late Cretaceous forms and some specimens of Paleocene age. Core 11 contains equally poor calcareous nannofossils, but exclusively of Late Cretaceous age.

Cores 13 through 16 contain common, moderately well-preserved calcareous nannofossil floras which are more diverse than those encountered in the Late Cretaceous rocks at Sites 146 and 151. They appear to represent the interval of the *Chiastozygus initialis* Zone although the defining species is not present.

Cores 17 through 19 contain relatively diverse assemblages, in which *Tetralithus gothicus* var. *trifidus* is conspicuous. This probably represents the *Tetralithus aculeus* Zone, at least in part.

Deeper cores (Cores 20 through 24) contain very poor assemblages in which the only species of calcareous nannofossil present is *Watznaueia barnesae*, and no precise age assignment is possible.

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The distribution of calcareous nannofossils in Cores 1 through 3 is shown in Table 22. *Discoaster surculus* is a rare constituent of Cores 1 and 3. All of the material recovered in Core 1 is assigned to the *Discoaster surculus* Zone. *Gephyrocapsa californiensis* and *G. kamptneri* are present

TABLE 11
Calcareous Nannofossils in Cores 20 through 30, Hole 149

Age	Miocene																	?										Oligocene							
Zone	a			b	*Discoaster druggi*						*Triquetrorhabdulus carinatus*																			c		d		e	
Sample Level	20-3(25-26)	20-5(25-26)	20-5(99-100)	21-2(94-96)	21-2(99-100)	21-4(90-100)	21-5(25-26)	22-6(131-132)	23-3(25-26)	23-3(99-100)	23-4(25-26)	23-4(99-100)	23-5(100-101)	25-2(99-100)	25-3(99-100)	26-2(99-100)	26-3(99-100)	27-2(25-26)	27-2(99-100)	27-3(25-26)	27-3(99-100)	28-1(113-114)	28-2(25-26)	28-2(99-100)	28-3(25-26)	28-3(99-100)	28-4(25-26)	28-4(99-100)	29-1(99-100)	29-2(25-26)	29-2(99-100)	29-3(45-46)	29-3(133-134)	30-1(87-89)	30-2(25-26)
Total Abundance	+1	+1	0	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	+1	+1	0	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	+1	+1	+1	+1	+1	+1	+1	+1	+1
Coccolithus eopelagicus	–1	0		–1	–1	–1		–1	0	0	0	0	–1	–1	0				0	0	0	–1	0	0	–1			0	0	0	0	0	0	0	
C. pelagicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–1	0	0	0	0		0	0	0	0	0	0	0	0
Coronocyclus nitescens	–1	–1	–1	–1	–1	–1		–2		–1		–1	–1					–1						–1				–1	–1		–1			–1	
Cyclicargolithus floridanus	+1	0		0	0	0	+1	+1	+1	+1	+1	+1	0	+1	+1	0	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	+1	+1	+1	+1	+1	+1	+1	+1	+1
Discoaster adamanteus		–1			–1							–1	–1	–1		–1	–1	0	–1		–1	–1				–1	–1			–1		–1		–1	
D. aulakos	0	0	0				–1																												
D. deflandrei	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	–1	0	0	0	0	0	0	0	0	0	–1	0	0	0	0	0	0	–1	
D. dilatus	0	0	0	0	–1		–1			–1		–1		0	–1				–1					–1									–1		
D. druggi			0			–1		–1	–1	–1																									
D. cf. *druggi*							0									–1	0		–1	–1		–1	0	–1	–1	–1	–1	–1	–1		–1		–1		
D. lidzi						–1	–2																												
D. nephados	0	–1	0	0	0	–1	–1	–1			–1		–2	0	0		–1	0	0		0		–1					–1							
D. saundersi					0												0																		
D. tani ornatus											–2																			–2			–1		–1
D. trinidadensis					0																														
D. woodringi			–1										0										–1												
Helicopontosphaera ampliaperta	–1																																		
H. parallela	–1									–1	–1	–1			–1																				
H. recta																														–1	–1				–1
Reticulofenestra bisecta	+1	0		0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
Sphenolithus belemnos				0	–1																														
S. ciperoensis																							0					–1		–1					
S. distentus																						–1							–1						
S. heteromorphus	0	0	–1	0																															
S. moriformis	–1	0		–1				0	0	0	0	0			0			+1	–1		0	0		0	–1			0	0	0		0		0	0
S. pacificus		0	0																													0			
S. predistentus																															?	–1		–1	–1
Triquetrorhabdulus carinatus					–1	0	–1	–1	0	0	0	0	0	0	0	0		–1	0	–1	0			–1				–1		–1	–1				

[a]*Helicopontosphaera ampliaperta*

[b]*Sphenolithus belemnos*

[c]*S. ciperoensis*

[d]*S. distentus*

[e]*S. predistentus*

TABLE 12
Calcareous Nannofossils in Cores 31 through 41, Hole 149

Age																																															
Zone	? *Discoaster saipanensis*																	*Discoaster tani nodifer*												*Chiphragmalithus alatas*											*Discoaster sublodoensis*						
Sample Level	31-1(67-68)	31-2(25-26)	31-2(104-105)	32-1(129-130)	32-1(144-145)	32-2(8-9)	32-2(105-106)	32-2(25-26)	33-1(100-101)	33-2(25-26)	33-2(99-100)	34-1(99-100)	34-2(25-26)	34-2(99-100)	34-3(25-26)	34-3(57-58)	34-3(104-105)	35-1(23-24)	35-1(102-103)	35-2(41-42)	35-2(93-94)	35-3(25-26)	35-3(98-99)	35-4(54-55)	35-5(9-10)	35-5(99-100)	35-6(25-26)	35-6(99-100)	36-1(110-111)	37-1(123-124)	37-2(25-26)	37-2(99-100)	37-3(25-26)	37-3(99-100)	37-4(20-21)	38-2(25-26)	38-2(99-100)	38-3(25-26)	38-3(86-87)	39-1(114-115)	40-1(59-60)	40-2(24-25)	41-1(67-68)	41-2(25-26)	41-3(100-101)	41-4(25-26)	41-4(100-101)
Total Abundance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chiasmolithus gigas																						-1	-1	-1	-1					-1	-1	0	-1	0		-1			-1	-1			-1		-1		
C. grandis												-1				-1		-1		-1		-1	-1			-1					-1			-1	-1	-1											
C. oamaruensis											-2					-2																															
C. solitus																		-1		-1										0	-1	0		0		0				-1			-1			-1	
C. sp.																																														-1	-1
Coccolithus eopelagicus	-1			-1	-1	0	-2	-1	0	0	0	0	0	-1	-1	0		-1	0	-1	0	0		-1	0	-1	-1		-1	-1				-1				-1				-1	-1		-1		
C. pelagicus	-2			-1	-1						0	0	0		-1	-1	0	-1	0	0	0	0	0	0	0	0	0	-1	-1	0		0	0	0		+1	0	0	0	0	0	0	0		0	-1	0
Coronocyclus serratus	-2					-2	-1	-1			-1																																				
Cyclicargolithus cf. *floridanus*				0								0			0		0	0	0	0	0		0		0	-1	0		-1	0	0	0	0			+1	0	0	0	0	0	0	0		0	0	0
Discoaster aster																			0											-1																	
D. barbadiensis	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
D. cf. *gemmifer*																						-1																									
D. saipanensis	-1	-1	0	0	0	0	0	0	-1	-1	-1	-1						-1	-1		-1		-1	-1		-1																					
D. sublodoensis														?												-1																					
D. cf. *sublodoensis*																				-1								-2			-2	-1									-1						
D. cf. *tani nodifer*																	-1																														
D. tani tani												-1												-2																							
D. cf. *tani tani*				-1																																											
Reticulofenestra umbilica	-1		0		0	0	-1	0	0	0	0	0	0	-1	0	0	0	0	0	-1	0	0	0	-1		0	0				0		-1														
Sphenolithus furcatolithoides				0								0	0		0	0	-1							-1	0				-1	-1	0		-2	0					0	0	-1	-1					
S. moriformis												0																												0	0					-1	
S. radians																			-1																						-1	-1					
Syracosphaera labrosa										-1	-1	-2	-1			-1						-1										?															
Triquetrorhabdulus inversus												-1					?													-1	0			-1		0		0	0	0	0	0	-1			-1	

TABLE 13
Calcareous Nannofossils in Cores 1 through 13, Hole 150

Age						
Zone	*Discoaster surculus*					?
Sample Level	1-1(100-101)	1-3(25-26)	1-3(99-100)	1-4(35-36)	2-2(25-26)	3-4(99-100)
Total Abundance	+2	0	0	0	−2	−2
Ceratolithus cristatus	−1	−2	−1			
Coccolithus pelagicus	−1		−1	−1	−2	−2
Cyclococcolithina leptopora	−1	−1	−1			
Discoaster brouweri rutellus	0	0	0	−1		
D. brouweri tamalis				−1		
D. pentaradiatus	0	0	0	0		
D. surculus	−1	−2	−1	−1		
D. cf. *surculus*	−1					
"Discolithus" phaseolus	+1					
Gephyrocapsa kamptneri	+1	0	+1	0		
Helicopontosphaera kamptneri	0	0	0	0		
H. sellii	0					
Pontosphaera scutellum		−1	−1			
P. sp.	−1	−1				
Pseudoemiliania lacunosa (circular)	+1	−1	−1			
P. lacunosa (elliptical)	+1	−1	0			
Reticulofenestra cf. *pseudoumbilica*	0	0	0	0		
Rhabdosphaera stylifera	+1		0	−1		
Scapholithus fossilis	−1					
Sphenolithus neoabies	−2					
Umbilicosphaera mirabilis	−1	−1	−1			

throughout Core 1. In Hole 148, these species did not overlap with *D. surculus*, but in Hole 148, *G. kamptneri* did occur together with *D. surculus.* Because these two species of *Gephyrocapsa* are so common, some suspicion exists that the material recovered in Core 1 is a mixture of material of *D. surculus* Zone age and slightly younger sediment.

The age of Core 2 is questionable, but Core 3 contains *Discoaster quinqueramus* and belongs to the *Discoaster quinqueramus* Zone.

Sphenolithus abies and *Reticulofenestra pseudoumbilica* occur in the lower part of Section 1 of Core 3 so that the lower part of Core 3 is referrable to the *Reticulofenestra pseudoumbilica* Zone.

The distribution of calcareous nannofossils in Cores 4 through 7 is shown in Table 23. Core 4 and the upper part of Core 5, to the middle of Section 4, contain assemblages typical of the *Sphenolithus heteromorphus* Zone.

Helicopontosphaera ampliaperta was not found but *Sphenolithus belemnos* occurs in the lower part of Section 4, Core 5 and in Section 1, Core 6. Because *Triquetrorhabdulus carinatus* occurs throughout Core 6 only, the basal part of Core 5 can be referred to the *Sphenolithus belemnos* Zone.

Discoaster druggi was not found in any of the samples studied so all of Core 6 is assigned somewhat arbitrarily to the *Triquetrorhabdulus carinatus* Zone.

Core 7 contains a meager assemblage containing *Sphenolithus predistentus* and referred to the *Sphenolithus predistentus* Zone.

The distribution of calcareous nannofossils in Cores 8 through 11 and the top of Core 12 is presented in Table 24. Core 8 contains a poorly preserved assemblage including some very poorly preserved asteroliths which may be *Discoaster gemmeus* and is assigned questionably to the *Discoaster gemmeus* Zone.

Cores 9 through 11 contain *Fasciculithus tympaniformis*, and all appear to belong to the *Fasciculithus tympaniformis* Zone.

Section 1 of Core 12, to a point between 90 and 104 cm, contains an assemblage characteristic of the *Chiasmolithus danicus* Zone. Lower Paleocene calcareous nannoplankton zones are not present.

The distribution of calcareous nannofossils in the lower part of Core 12 and in subjacent cores taken from Hole 153 is given in Table 25. The assemblages are poor, with only a few species represented. *Arkhangelskiella cymbiformis* is present in a sample from 104 to 106 cm in Section 1 of Core 12, and *Tetralithus* cf. *murus* is present in samples from Cores 12 and 13, suggesting that these sediments are probably Maestrichtian in age. Samples from Cores 15 through 19 are very poor and most contain only *Watznaueria barnesae.*

Site 154

Hole 154 was cored discontinuously to establish the nature of the section present.

The distribution of calcareous nannofossils in Core 1 is indicated in Table 26. The assemblages are moderately well preserved. *Gephyrocapsa oceanica* and *Pseudoemiliania lacunosa* both occur in all samples from this core indicating that it represents the older part of the *Gephyrocapsa oceanica* Zone.

The distribution of calcareous nannofossils in Cores 2 and 3 is presented in Table 27. The assemblages tend to be somewhat impoverished and relatively poorly preserved, indicating that dissolution has occurred. An asterolith species closely resembling *Discoaster surculus* is present near the base of Core 2. The higher part of Core 2 is referred to the *Discoaster pentaradiatus* Zone and the bases of Core 2 and Core 3 are assigned somewhat arbitrarily to the *Discoaster surculus* Zone.

The calcareous nannofossils found in samples from Cores 5, 11, and 14 are indicated in Table 28. No diagnostic species were found in Cores 5 or 14, but *Ceratolithus tricorniculatus* occurs in Core 11. Although a zonal assignment cannot be made, a Late Miocene or Early Pliocene age is indicated.

Hole 154A was cored continuously and represents a section from Late Pleistocene, or Recent, to Middle Pliocene.

The distribution of species from Core 1 to the middle of Core 9 is presented in Table 29. The lowest occurrence of *Emiliania huxleyi* is between samples from Sections 2 and 3 of Core 1; Sections 1 and 2 of Core 1 belong to the *Emiliania huxleyi* Zone.

The highest occurrence of *Pseudoemiliania lacunosa* is near the top of Core 3, but the lowest occurrence of *Gephyrocapsa oceanica* is within Section 6 of Core 4. The entire sequence from Section 3 of Core 1 to the middle of Section 6 of Core 4 belongs to the *Gephyrocapsa oceanica* Zone.

TABLE 14
Calcareous Nannofossils in Cores 4 and 5, Hole 150

Age	Miocene												
Zone	a		b	c			d	e					
Sample Level	4-1(95-96)	4-1(105-106)	4-1(115-116)	4-1(124-125)	4-2(23-24)	4-2(84-85)	4-2(109-110)	4-3(25-26)	5-4(25-26)	5-4(99-100)	5-5(40-41)	5-5(99-100)	5-6(80-81)
Total Abundance	0	–1	0	–1	0	–1	+1	–1	0	0	0	0	0
Coccolithus eopelagicus	0	–1	0	–2	–1	–2	0		–1	0	–1	0	
C. pelagicus	0	–1	0	–2	0		0		–1	0	0	–1	–1
Coronocyclus nitescens	–1	–2	–1		–1		–1		–1			–1	
Cyclicargolithus floridanus	0	–1	0	–1	0	–1	+1	–1	0	0	0	0	0
Discoaster adamanteus	–1						–1		–1	–1	–1		
D. aulakos		–1	0	–1	–2								
D. brouweri brouweri		–1			?								
D. deflandrei	0	–1	0	–1	0	–1	0		–1	–1	0	0	0
D. druggi		–2											
D. exilis		–2			–1								
D. lidzi										–2	–1		
D. nephados			0		0		0		0	–1		–1	–1
D. trinidadensis			0							–1		–1	0
D. woodringi							0						
Helicopontosphaera ampliaperta			–1										
Reticulofenestra bisecta				–1	–1		0		–1		0	0	
Sphenolithus belemnos				–2	–2		–2				–2		
S. heteromorphus	–1	–1	0	–1	0	–1	–1						
S. moriformis				–1			0				0	–1	–1
S. pacificus	–1												
Triquetrorhabdulus carinatus							+1	–1	–1	0	0	0	0

[a]*Sphenolithus heteromorphus*
[b]*Helicopontosphaera ampliaperta*
[c]*Sphenolithus belemnos*
[d]*Discoaster druggi*
[e]*Triquetrorhabdulus carinatus*

TABLE 15
Calcareous Nannofossils in Cores 9 and 10, Hole 150

Age	Late Cretaceous												
Zone	a			b	?								
Sample Level	9-1(51-52)	9-1(80-81)	9-1(103-104)	9-1(133-134)	10-1(5-6)	10-1(7-8)	10-1(18-19)	10-1(24-26)	10-1(32-33)	10-1(99-100)	10-2(24-25)	10-2(52-53)	10-2(67-68)
Total Abundance	0	+1	+1	0	0	–1	0	0	0	+1	0	0	–1
Arkhangelskiella ethmopora	–2	–2	–2	–2									
A. specillata									–2				
Cretarhabdus crenulatus		0	0				–1	–1	–1	0	0	0	
Eiffellithus turriseiffeli	–1	0	0					–1	–1	+1	–1	–1	
Glaukolithus diplogrammus	–2	–1	–1					–1	–1				
Kamptnerius punctatus	–2	–2	–2										
Lithastrinus grilli	–2	–2	–2										
"*Loxolithus*"	0	0	0	0	0	–1	0	0	0	0	0	0	
Marthasterites furcatus	–2	–2	–2	–2									
Micula staurophora	–1	–1	–1										
Parhabdolithus embergeri	–2	–1	–2										
Prediscosphaera cretacea	–1	–1	–1				–1	–1	–1	+1	–1		
Tranolithus sp.	–2	–1	–1										
Watznaueria barnesae	0	+1	+1	0	0	–1	0	0	0	+1	0	0	–1

[a]*Kamptnerius punctatus*
[b]*Arkhangelskiella ethmopora*

TABLE 17
Calcareous Nannofossils in Cores 3 through 9, Hole 151

Age	? Oligocene																	
Zone	a	b		c			d	e		f						g		
Sample Level	3-1(65-66)	3-3(99-100)	3-6(99-100)	4-1(6-8)	4-1(14-15)	4-1(28-29)	4-1(73-74)	4-2(25-26)	4-2(141-142)	5-2(67-68)	6-1(92-93)	6-2(21-26)	6-3(90-91)	7-1(18-19)	7-2(103-104)	8-1(81-82)	9-1(108-109)	9-2(135-136)
Total Abundance	+1	+1	+1	0	+1	+1	+1	+1	0	+1	+1	+1	0	+1	0	+1	+1	+1
Coccolithus eopelagicus	0	-1		-1		0	-1	0	-1	-1	-1	-1	-1			-1		-1
C. pelagicus	0	0	0	0	0	0	+1	+1	0	0	0	0	0	0	0	0	0	0
Coronocyclus nitescens						-1		-1										-1
Cyclicargolithus floridanus			0	0	0	0	+1	+1		0	0	0	0	0	0	+1	+1	+1
Cyclococcolithina leptopora						0												
Discoaster adamanteus	-1					-1	-1	-1	-1				-1			-1	-1	-1
Discoaster aulakos	-1	0	0	-1	-1	-1												
Discoaster bolli	0		-1															
D. brouweri brouweri	-1																	
D. brouweri rutellus		-1																
D. deflandrei	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	-1	-1	-1			0
D. dilatus				-1														
D. divaricatus	-1	-1																
D. druggi								-1	-1									
D. cf. *druggi*											-1	-1	-1					
D. exilis	0	0	0	0	0	0												
D. extensus	0	-1		-1	-1													
D. kugleri	-1																	
D. lidzi											-1	0	-1	-1	-1	-1	-1	-1
D. cf. *lidzi*								-1		-1								
D. nephados							0	0	0		0	0	0	-1	0	0	0	0
D. tani ornatus																-1		
D. trinidadensis							0					0						
D. variabilis	-1	-1		-1														
D. woodringi						-1												
Helicopontosphaera intermedia						-1												
H. kamptneri					0													
H. parallela								-1			-1							
Reticulofenestra bisecta								0		0	0	0	0	0		0	0	0
R. cf. *pseudoumbilica*				0	0													
R. pseudoumbilica	0	0	0			?												
Scyphosphaera intermedia	-2																	
Sphenolithus belemnos							-1				-1							
S. ciperoensis																-1		-1
S. heteromorphus				0	-1	0												
S. moriformis			0				0	0	0	0	0	0	0	-1	-1	0	0	0
S. pacificus															-1			
Triquetrorhabdulus carinatus								0		-1	-1	-1	-1	0	-1	0	-1	0
T. rugosus	?	?																

[a] *Discoaster kugleri*

[b] *Discoaster exilis*

[c] *Sphenolithus heteromorphus*

[d] *Sphenolithus belemnos*

[e] *Discoaster druggi*

[f] *Triquetrorhabdulus carinatus*

[g] *Sphenolithus ciperoensis*

TABLE 16
Calcareous Nannofossils in Cores 1 and 2, Hole 151

Age	Pleistocene								Pliocene			
Zone	a		b					c	d			
Sample Level	1-2(25-26)	1-2(99-100)	1-3(25-26)	1-3(99-100)	1-4(99-100)	1-5(86-87)	1-6(25-26)	1-6(99-100)	2-1(98-99)	2-2(25-26)	2-2(99-100)	2-3(99-100)
Total Abundance	+2	+2	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1
Ceratolithus cristatus				–2			–2	–1				
C. rugosus									–2	–1	–1	–2
C. tricorniculatus									–2		–1	–2
Coccolithus carteri					–1							
C. pelagicus				–1			–1			–1	–1	–1
Cyclococcolithina leptopora		–1	–1	–1		0	0	–1	–1			–1
C. macintyrei										–1	–1	
Discoaster asymmetricus									–1	0		
D. brouweri rutellus								0	0	0	0	–1
D. brouweri tridenus								–1				
D. brouweri triradiatus										–1		–2
D. extensus									–2		0	–1
D. pentaradiatus										0	0	–1
D. surculus									–1	0	0	–1
Discolithina japonica										–1		
"Discolithus" phaseolus	0	0	0	0	0	0	0	0				
Gephyrocapsa californiensis	0	0	0	0	0	0	0	0				
G. kamptneri	+1	+1	+1	+1	+1	+1	+1	+1				
G. oceanica	–1	0										
G. sinuosa	+1	+1	+1	0	+1	+1	+1	0				
Helicopontosphaera kamptneri	0	0	–1	0	0	0	0	0	0	0	–1	–1
H. selli	–1			–1		–1	–1	–1		–1		
Pontosphaera discopora		–1	–1	–1	–1	–1						
P. scutellum	–1		–1	–1	–1	–1	–1	–1				
Pseudoemiliania lacunosa (circular)	0	0	0	0	0	0	0	0				
P. lacunosa (elliptical)	0	0	0	0	0	0	0	0				
Reticulofenestra cf. *pseudoumbilica*									+1	0	0	0
R. pseudoumbilica									0	0	0	0
Rhabdosphaera stylifera	0	0	0	0	–1	0	0	0				
Scapholithus fossilis					–1							
Scyphosphaera apsteini		–2		–2								
Sphenolithus abies									0	0	0	0
S. neoabies										0	0	0
Umbilicosphaera cricota									0		–1	–1
U. mirabilis	0		0	–1	–1	–1	–1	–1		–1		

[a]*Gephyrocapsa oceanica*

[b]*"Gephyrocapsa caribbeanica"*

[c]*Discoaster brouweri*

[d]*Discoaster asymmetricus*

[e]*Ceratolithus rugosus*

TABLE 18
Calcareous Nannofossils in Cores 10 and 11, Hole 151

Age	Paleocene									
Zone	a	b	c			d	e			
Sample Level	10-1(25-27)	10-1(33-34)	10-1(60-63)		10-2(139-140)	11-6(20-21)	11-6(107-108)	11-6(120-121)	11-6(127-128)	11-6(133-135)
Total Abundance	–2	0	0	0	0	0	0	0	0	0
Chiasmolithus bidens		–1	0	–1						
C. consuetus		–1								
C. danicus			–1		–1					
Coccolithus cavus		0	0	–1	0	0	0	0	0	0
C. crassus	–2	0								
Cruciplacolithus tenuis			0	–1	–1	–1				
Discoaster binodosus	–2									
D. diastypus	–2	–2								
D. lodoensis	–2									
D. mediosus	–2									
D. multiradiatus		–1								
Ericsonia subpertusa		0	0	0	0	0	0	0	0	0
Fasciculithus tympaniformis		–1								
Markalius astroporus							–1	–1	–1	–1
Marthasterites tribrachiatus	–2									
Neococcolithes protenus		–1								
Prinsius bisulcus			–1	–1		–1			–1	–1
Sphenolithus radians	–2									
Zygodiscus adamas		–1								
Z. sigmoides					–1					
Z. simplex			–1							

[a]Mixed *Discoaster*

[b]*Discoaster multiradiatus*

[c]*Chiasmolithus danicus*

[d]*Cruciplacolithus tenuis*

[e]*Markalius astroporus*

TABLE 19
Calcareous Nannofossils in Cores 12 and 13, Hole 151

Age	Late Cretaceous						
Zone	?						
Sample Level	12-1(73-74)	12-2(33-34)	12-2(44-46)	12-2(109-110)	12-3(85-87)	12-4(128-132)	13-2(106-107)
Total Abundance	0	0	–1	0	0	0	0
Ahmuellerella octoradiata				–1			
Arkhangelskiella specillata						–1	
Chiastozygus plicatus			–1		–1	–1	
Cretarhabdus crenulatus						–1	–1
Eiffellithus turriseiffeli	0	0		0	0	0	
Glaukolithus diplogrammus	–1	–1	–1			–1	–1
Lithastrinus grilli		–1					
Lithraphidites carniolensis				–1			
Micula staurophora		0	–1	0	–1	0	
Prediscophaera cretacea	–1	0		0	0	0	0
Watznaueria barnesae	0	0	–1	0	0	+1	0
Zygodiscus sp.			–1				–1

TABLE 20
Calcareous Nannofossils in Cores 1 through 9, Hole 152

Age	Paleocene																													
Zone	a	*Discoaster multiradiatus*																	b		c							d	
Sample Level	1-1(9-10)	1-1(99-100)	1-2(80-85)	2-2(35-36)	2-2(99-100)	2-3(25-26)	2-3(99-100)	2-4(25-26)	2-4(99-100)	2-5(25-26)	2-5(99-100)	3-2(123-124)	3-3(25-26)	3-3(99-100)	3-4(25-26)	3-4(99-100)	3-5(24-25)	3-5(99-100)	4-2(78-79)	4-3(100-101)	6-2(64-65)	6-5(108-109)	7-1(16-22)	7-3(143-145)	7-4(25-26)	7-4(99-100)	8-1(60-61)	8-1(127-128)	9-1(82-83)	9-1(138-140)
Total Abundance	0	0	+1	+1	0	+1	+1	+2	+2	+2	+1	+1	+1	+1	0	0	+2	0	+2	−1	+1	0	0	0	+1	0	+1	0	−1	0
Campylosphaera dela							−2	−2								−2														
Chiasmolithus bidens															−1	−1	−1		−2		−2	−2	−2			0	0	−1		
C. consuetus			−2	−2		−1		−1		−1	−1	0	−1		0	0	−1		−2			−2								
C. danicus																													−1	−1
C. grandis	−1	−1	−1	−1		−2																								
Coccolithus cavus	0	0	0	0		+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	+1	+1	−1	0	0	0	0	0	0	0	0	0	+1
C. crassus	+1	+1	+1	+1	0	0	0	0	0	0	0	0	0	0	0	−1	0	0	0	−2	0	0	0	−2						
Cruciplacolithus tenuis																						−2	−1	−1	−1	0	0	−1	0	0
Discoaster cf. *aster*						−1	0	−1	−1	−1	−1	−1	−1	−1					−1											
D. barbadiensis	−2	−2																												
D. diastypus	−2	−1	−1	−1	−1	−1	−1							−2	−2	−2	−2													
D. lenticularis							−2	−1	−1		−1																			
D. multiradiatus		−1	−1	0		0	0	+1	+1	−1	−1	0	−1	−2	−2	−2	−2	0	0	−1										
D. nobilis						−2	−2	−1			−2		−2	−2		−2		−1												
Discoasteroides kuepperi			−2						−2				−2																	
Ericsonia subpertusa	0	+1	+1	+1	0	+1	+1	+1	+1	+1	+1	+1	0	0	+1	+1	+1	0	+1	−1	0	0	0	0	0	+1	+1	0	0	+1
Fasciculithus involutus	−1																													
F. janii																								−1	−1					
F. tympaniformis												−2	−2	−2	−2	−2	−2	−2	−2	−1	−1	−1	0	0	−2	0	−1	−1		
Heliolithus kleinpelli																					−1	−1								
H. cf. *riedeli*																					−1	−1								
Heliorthus concinnus		−2		−2	−2	−2	−1	−2	−2	−1	−1	−1	−1	−2	0	0	0	−1	0		−1			−2						
Markalius astroporus																		−1			−2	−1	−2	−1	−1	−1	−1	−1	0	0
Neococcolithes protenus						−2											−2				−1					−1		−2		
Sphenolithus radians	−1	0	0	0																										
Zygodiscus adamas													−2			−2	−2	−1				−2		−2					−2	−2
Z. sigmoides												−2	−1	−1	−1	−1	−2							−2		−1		−1	−2	−2

[a]*Discoaster diastypus*

[b]*Heliolithus kleinpelli*

[c]*Fasciculithus tympaniformis*

[d]*Chiasmolithus danicus*

The highest occurrence of *Discoaster brouweri* is in Section 3 of Core 8. The base of Core 4, all of Cores 5, 6, and 7, and the top of Core 8 belong to the "*Gephyrocapsa caribbeanica*" Zone.

The distribution of calcareous nannofossils in the lower part of Core 9 and subjacent cores through 16 is shown in Table 30.

The highest occurrence of *Discoaster pentaradiatus* is between samples from Sections 4 and 5 of Core 10; the lower part of Section 3, and Sections 4, 5, and 6 of Core 9, and the first four sections of Core 10 belong to the *Discoaster brouweri* Zone.

The highest occurrence of *Discoaster surculus* is difficult to fix but is within Core 12. The lower two sections of Core 10, Core 11, and the upper part of Core 12 belong to the *Discoaster pentaradiatus* Zone.

The highest occurrence of *Sphenolithus abies* is probably near the top of Core 15; the highest occurrence of *Reticulofenestra pseudoumbilica* is between samples from Sections 2 and 3 of Core 15. The basal part of Core 12, all of Cores 13 and 14, and the top two sections of Core 15 are referred to the *Discoaster surculus* Zone. Sections 3 through 5 of Core 15 and Core 16 are referred to the *Reticulofenestra pseudoumbilica* Zone.

TABLE 21
Calcareous Nannofossils in Cores 10 through 23, Hole 152

Age																				
Zone	*Chiastozygus initialis*									?			*Tetralithus aculeus*							
Sample Level	10-1(129-130)	10-1(142-145)	13-1(85-90)	14-1(119-120)	15-2(136-137)	16-1(64-67)	16-1(120-124)	16-2(53-54)	16-2(140-143)	16-3(82-85)	17-1(75-76)	17-2(78-82)	18-1(60-64)	18-2(73-75)	19-1(27-33)	21-1(100-101)	22-1(120-121)	22-2(97-100)	22-3(10-11)	23-1(16-18)
Total Abundance	-2	-1	+1	-1	-1	-1	0	0	-1	0	0	0	+1	-1	+1	+1	0	0	0	0
Ahmuellerella octoradiata							-2													
Arkhangelskiella cymbiformis			-2	-2	-1	-2	-2		-2	-1	-1	-2							-2	
A. parca													-2							-2
Chiastozygus spp.													-2						-2	
Cretarhabdus conicus			-1							-2	-2		-2	-2	-1					
C. crenulatus			-1	0	0	0	0	0	+1	+1	0	0	0	0	+1	0	-1	-1	0	-1
Cribrosphaera ehrenbergi			0			-2	-2		-1		-1	-1				-1				
C. linea			0	0	0	0	0	0	0	+1	0	0	0	0		0	-1			
Cylindrolithus spp.			-1	-1	-1	-1	-1	-1	0	0	-1	-1	-1	-1		-1				-1
Eiffellithus turriseiffeli			-1	-1	0	0					-2			-2	0					
Kamptnerius magnificus			-1	-1	-1	-1														
Lithraphidites carniolensis						-2			0	0			-1							
"*Loxolithus*"			-1	-1		-2			-1	-1			-1							
Lucianorhabdus cayeuxi													-2							
Microrhabdulus decoratus													-2		0					
M. stradneri			-2	-2	-1	0	-2		-1	-1		-2	-2	-2						
Micula staurophora		-1	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	0	-1	-1
Parhabdolithus embergeri			-2	-2	-2	-2		-2		-2			-2	-2			-1		-2	
Prediscosphaera cretacea	-2	-2	-1	0	-1	0	-1		-1	-1		-1	-1		+1	-1				
Tetralithus cf. *murus*											-1	-1	-1	-1	-1	-1				-1
Tetralithus gothicus												-2	-2	-2	-1	-2				
T. gothicus trifidus			-2	-1				-2												
Tranolithus sp.												-2		-2						
Watznaueria barnesae	-2	0	+1	0	+1	+1	0	+1	+1	+1	0	+1	+1	+1	+1	0	0	0	0	0
Zygodiscus cf. *adamas*								-1	0	-1	-1	-1	-1			-1				

TABLE 22
Calcareous Nannofossils in Cores 1 through 3, Hole 153

Age	Pliocene							Miocene		
Zone	a						?	b		
Sample Level	1-1(129-131)	1-2(91-92)	1-3(99-100)	1-4(51-52)	1-5(83-84)	1-5(146-147)	2-1(74-75)	3-1(25-26)	3-1(99-100)	3-4(35-36)
Total Abundance	+1	+1	+1	+1	0	0	-2	-1	0	0
Ceratolithus cristatus	-2	-2	-2		-2	-2				
Coccolithus pelagicus	-1	0	-1	0	-1	-1				
Cyclococcolithina leptopora	-1	-1	-1	-1	-1	-1				
Discoaster asymmetricus						-2				
D. brouweri rutellus	-1	0	-2	0	-1	0		-2	-1	-1
D. brouweri tamalis								-2		
D. brouweri triradiatus						-2				
D. extensus									-2	-2
D. pentaradiatus	-1	-1	0	-1	0	-1		-2		
D. perclarus									-2	
D. quinqueramus							?	-2	-1	-1
D. surculus	-2	-2	-2			-2		-2	-2	
"*Discolithus*" *phaseolus*	0	0	0	-1		-1				
Gephyrocapsa californiensis	0	0	0	0	0	0				
G. kamptneri	+1	0	0	0	0	0				
Helicopontosphaera kamptneri	0	0	0	0		-1				
H. sellii	-1	-1	-1	-1		-1				
Pseudoemiliania lacunosa (circular)	0	0	0	0	0	-1				
P. lacunosa (elliptical)	0	0	0	0	0	0				
Reticulofenestra pseudoumbilica									-2	
Rhabdosphaera stylifera	-1	-1	-1	-1						
Sphenolithus abies								-2	-2	-1
Umbilicosphaera mirabilis		-1								

[a] *Discoaster surculus*

[b] *Discoaster quinqueramus*

TABLE 23
Calcareous Nannofossils in Core 4 through 17, Hole 153

Age	Miocene												?	Oligocene			
Zone	*Sphenolithus heteromorphus*											a	b				c
Sample Level	4-1(85-87)	4-3(22-23)	4-5(24-25)	4-5(99-100)	4-6(99-100)	5-1(98-99)	5-2(25-26)	5-2(99-100)	5-3(23-24)	5-3(99-100)	5-4(25-26)	5-4(128-130)	6-1(40-41)	6-1(115-116)	6-2(52-56)	6-2(133-134)	7-1(66-69)
Total Abundance	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1
Coccolithus eopelagicus	–1	–1	–1	–1	–1	–1	–1	0	–1	0	0	–1	0	0	0	0	0
C. pelagicus	0	–1	0	0	–1	0	–1	0	–1	0	0	0	0	0	0	0	0
Coronocyclus nitescens				–1				0									
Cyclicargolithus floridanus	0	+1	+1	+1	0	0	+1	0	+1	+1	0	+1	+1	+1	+1	+1	+1
Cyclococcolithina leptopora	0		–1														
Discoaster adamanteus									–1		–1	–1	–1		–1		
D. aulakos								–1	–1		–1	–1			–1		
D. bollii						–1											
D. deflandrei							–1		–1		0	0	0	0	0	0	
D. exilis	0	0	0	0	0	0	0	0	0	0	0	–1					
D. lidzi														–1			
D. nephados													0	0		0	0
D. saundersi															0	0	
D. trinidadensis													0		0		
Helicopontosphaera intermedia	0	–1	0	0		0		0	0	0	0						
H. parallela				–1													
H. recta																	–1
Reticulofenestra bisecta													0	0	0	0	0
R. pseudoumbilica	–1	–1								–1							
Sphenolithus belemnos												–1		–1			
S. heteromorphus	0		0	0	0	–1	–1	0	–1	0	0						
S. moriformis												0	0	0	0	0	0
S. predistentus																	–1
Triquetrorhabdulus carinatus												?	–1	0	0	0	

[a] *Sphenolithus belemnos*
[b] *Triquetrorhabdulus carinatus*
[c] *Sphenolithus predistentus*

TABLE 24
Calcareous Nannofossils in Cores 8 through 12 (Section 1, 88-90), Hole 153

Age	Paleocene									
Zone	a	*Fasciculithus tympaniformis*							b	
Sample Level	8-1(98-100)	9-1(106-108)	9-2(127-129)	10-2(116-117)	11-1(133-137)	11-2(79-81)	11-3(76-79)	11-3(126-128)	12-1(71-74)	12-1(88-90)
Total Abundance	0	0	0	0	0	0	0	0	0	0
Chiasmolithus bidens					–1					
C. consuetus					–1					
C. danicus					–1	–1	–1		–1	–1
Coccolithus cavus		–1	–1	–1	0	0	0	0	0	0
C. crassus	0									
Cruciplacolithus tenuis					–1	–1	–1	–1	–1	–1
Discoaster gemmeus	?									
Ericsonia subpertusa	0	–1		–1	0	0	–1	0	0	0
Fasciculithus tympaniformis		0	0	0	0	0	–1	–1		
Markalius astroporus			–2							
Sphenolithus moriformis	0									

[a] *Discoaster gemmeus*
[b] *Chiasmolithus danicus*

TABLE 25
Calcareous Nannofossils in Cores 12 (Section 1, 104-106) through 19, Hole 153

Age															
Zone															
Sample Level	12-1(104-106)	12-1(132-134)	12-2(137-139)	12-3(149-150)	13-4(53-57)	14-1(146-147)	15-1(115-117)	15-3(114-115)	16-2(117-118)	18-2(101-103)	18-3(67-69)	18-3(133-135)	18-4(14-15)	18-4(136-138)	19-1(110-112)
Total Abundance	+1	0	+1	0	0	0	–1	–1	–1	–1	0	0	–1	0	0
Arkhangelskiella cymbiformis	–1														
Braarudosphaera bigelowi						–2									
Cretarhabdus crenulatus			–1		–1	–1						–1			
Cribrosphaera linea	–1														
Cylindralithus sp.				–1											
Eiffellithus turriseiffeli			–1									–1			
Micula staurophora	0	0	0	–1	–1			–1							
Tetralithus cf. *murus*		–1			–2										
Watznaueria barnesae	+1	0	+1	0	0	0	–1	–1	–1	–1	0	0	–1	0	0

TABLE 26
Calcareous Nannofossils in Core 1, Hole 154

Age	Pleistocene											
Zone	*Gephyrocapsa oceanica*											
Sample / Level	1-1(25-26)	1-1(99-100)	1-2(25-26)	1-2(95-97)	1-3(10-11)	1-3(101-102)	1-4(25-26)	1-4(105-106)	1-5(25-26)	1-5(114-115)	1-6(25-26)	1-6(99-100)
Total Abundance	0	0	0	0	+1	0	0	0	0	0	0	0
Ceratolithus cristatus	-2				-2							
Cyclococcolithina leptopora			-2		-2	-2	-1	-2	-1	-1		
"Discolithus" phaseolus	-2				-2	-2			-2		-2	
Gephyrocapsa californiensis	-1	-1	-1	-1	0	-1	-1	-1	-1	-1	-1	-1
G. kamptneri	-1	0	-1	-1	0	-1	-1	-1	-1	-1	-1	
G. oceanica	-1	-1	-1	-1	0	-1	-2	-2	-1	-2	-2	-2
G. sinuosa	0	-1	0	0	+1	0	0	0	0	0	0	0
G. sp.	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Helicopontosphaera kamptneri	-2	-2	-2	-2	0	-1	-1	-2	-1	-1	0	0
H. sellii			-2									-2
H. wallichi	-2	-2			-2	-2	-2			-2		
Pontosphaera scutellum	-2											
Pseudoemiliania lacunosa (circular)		-2	-2	-2	-2	-1	-2	-2			-1	-1
P. lacunosa (elliptical)	-1	-2	-2	-2	-2	-2	-2	-1	-2	-2	-1	-1
Rhabdosphaera clavigera				-2	0							
R. stylifera			-2	-2		-2			-2			
Scapholithus fossilis	-2		-2	-2		-2	-2					
Syracosphaera clava	-1	-2			-1							
S. decussata					-2	-2					-2	
Umbilicosphaera mirabilis	-2	-2	-2	-2	-1	-2	-2		-2	-1	-1	-1
"Little u"		-2		-2								

TABLE 27
Calcareous Nannofossils in Cores 2 and 3, Hole 154

Age																	
Zone	*Discoaster pentaradiatus*									?	*Discoaster surculus*						
Sample / Level	2-1(25-26)	2-1(100-101)	2-2(25-26)	2-2(99-100)	2-3(22-23)	2-3(123-124)	2-4(25-26)	2-4(111-112)	2-5(34-35)	2-5(101-102)	2-6(25-26)	2-6(74-75)	2-7(25-26)	2-7(99-100)	3-2(2-4)	3-2(96-97)	3-3(5-6)
Total Abundance	0	0	+1	+1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0
Ceratolithus rugosus						-2						-2					
Coccolithus pelagicus	-2	-2	-2	-2	-2	-1	-1	-1		-2					-2	-2	
Cyclococcolithina leptopora	-2		-2	-2	-2	-2		-1					-2				
C. macintyrei						-1			-2	-2	-2		-2	-2	-2		-2
Discoaster brouweri rutellus	-2	-2	-1	-2	-2	-2	-2		-2	-2	-2	-2	-1	-2	-1	-2	-1
D. brouweri tamalis						-2			-2	-2		-2	-2		-2		
D. brouweri triradiatus													-2		-2		
D. pentaradiatus	-2	-2	-1	-2	-2	-2	-2		-2	-1	-1	-1	-1	-2	-1	-2	-1
D. perclarus						-2							-2				
D. cf. *surculus*												-2	-2				
"Discolithus" phaseolus			-1	-1		-2											
Helicopontosphaera kamptneri	0	0	-1	-1	-1	-1	-2		-2	-1	-1	0	-1	-1	-1		-1
H. sellii			-1	-1		-2	-2										
Pseudoemiliania lacunosa (circular)	-2	-2			-2	-2			-2	-1	-1	-1	-1	-2			-1
P. lacunosa (elliptical)	0	0	+1	+1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0
Scyphosphaera apsteini				-2													
Umbilicosphaera cricota					-2	-2	-2			-2	-1	-1	-2	-2			
U. mirabilis	-1	-1								-2							

TABLE 28
Calcareous Nannofossils in Cores 5, 11, and 14, Hole 154

Age	See Text				
Zone	?				
Sample / Level	5-1(17-18)	5-6(93-94)	11-2(82-83)	11-3(64-65)	14-1(73-74)
Total Abundance	0	-2	0	-2	-2
Ceratolithus tricorniculatus			-2		
Discoaster brouweri brouweri			-2		
D. sp.	-2				
Reticulofenestra cf. *pseudoumbilica*	0	-2	0	?	-3
R. pseudoumbilica			-1		
Sphenolithus abies	0		0		

TABLE 29
Calcareous Nannofossils in Cores 1 through 9 (Section 2, 100-101), Hole 154A

Sample Level	1-1(94-95)	1-2(30-31)	1-2(100-101)	1-3(23-24)	1-3(99-100)	1-4(25-26)	1-4(99-100)	1-5(25-26)	1-5(99-100)	2-2(25-26)	2-2(101-102)	2-3(25-26)	2-3(100-101)	3-1(120-121)	3-2(25-26)	3-2(100-101)	3-3(25-26)	3-3(99-100)	3-4(25-26)	3-4(99-100)	3-5(25-26)	3-5(99-100)	4-1(25-26)	4-1(99-100	4-2(25-26)	4-2(99-100)	4-3(25-26)	4-3(101-102)	4-4(25-26)
Age	Pleistocene																												
Zone	a			*Gephyrocapsa oceanica*																									
Total Abundance	+1	+1	0	+1	+1	+1	0	0	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1
Ceratolithus cristatus				-2		-2								-2			-2												
C. rugosus																													
Coccolithus pelagicus																													
Cyclococcolithina leptopora		-2	-2	-1	-1		-2		-2	-2		-1	-2	-1	-1		-1					-2			-2	-2		-2	-2
C. macintyrei																													
Discoaster brouweri rutellus																													
D. brouweri triradiatus																													
D. perclarus																													
"Discolithus" phaseolus	-1				-1	-1			-2	-1	-1	-1	-1	-2		-2		-2			-2	-2	-2	-2			-1	-2	-2
Discosphaera tubifera																					-2				-2	-2	-1	-2	-2
Ellipsodiscoaster lidzi											-2		-2																
Emiliania huxleyi	+1	+1	0																										
Gephyrocapsa californiensis				0	0	0	-1	0	0	+1	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1
G. kamptneri			-1	0	0	0	-2	0	+1	+1	0	0	0	+1	+1		0	0	0	0	0	0	0	0	0	0	0	0	0
G. oceanica	0	0	-1	-1	0	-1		-1	-1	-1	-1		-1	0	-1	-1			-1	-1	-1	-1	-2		-2	-2	-1	-1	-1
G. sinuosa			-1	0	0	0		-1	+1	0	0		0	0	0		0	0	-1	0	0	0	0	0	0	0	0	0	0
G. sp.							0			0	0	0	0	0	0	+1	+1	0	0	0	0	0	0	0	0	0	0	0	0
Helicopontosphaera kamptneri	-1	-1	-2	-2	-2	-1		-1	-2	-2	-1		-2		-2		-1	-2	-2	-1		-2		-2	-2	-2	-2	-2	-2
H. sellii				-2																									
H. wallichi																	-2												
Pontosphaera scutellum																							-2						
Pseudoemiliania lacunosa (circular)																-2	-2		-2			-2	-1	-1			-2		
P. lacunosa (elliptical)															-2				-2			-2				-2		-2	
Rhabdosphaera clavigera																													
R. stylifera	-1			-2	-2		-2	-2	-2	-1	-2		-2					-2	-2		-2	-2		-2		-2	-1	-2	-2
Scapholithus fossilis			-2	-2	-1		-2					-2	-1		-2		-2	-2		-2					-2	-2			
Syracosphaera clava								-2					-2		-2						-2						-2		
S. decussata	0			-2	-2		-2	-1	-2	-2	-1	-2	-2		-2									-2			-2		
S. histrica							-2	-1	-2		-2	-2		-1	-1			-2					-2				-2	-2	
S. jonesi	-1			-2	-1			-2		-2	-1	-1								-1	-2					-2			
Umbilicosphaera mirabilis	-2		-2	-2	-1				0		-2	-2	-2	-1	-1	-1	-1	-2	-2	-1	-2	-2	-1		-2	-2	-1	-1	-1
"Little u"																				-2									

[a] *Emiliana huxleyi*

PLEISTOCENE – RECENT CALCAREOUS NANNOFOSSILS FROM HOLES 147, 148, 149, AND 154A

Previous Studies

Pleistocene calcareous nannofossils generally have been neglected, chiefly because of their small size and lack of distinctive characters. Zonations of the Miocene and Pliocene rely on discoasters and large coccoliths easily identified in light microscopy. Pleistocene assemblages lack the readily recognized large species so useful in the Neogene.

The first description of a sequence of Pleistocene coccoliths was by Cohen (1964) who tabulated the occurrence of sixteen species in samples representing "warm" and "cold" environments from two cores from the Caribbean. These cores had been the subject of detailed isotopic geochemical investigations, one core (A240-Ml) by Rosholt et al. (1961), and the other (A254-BR-C) by Rosholt et al. (1962). The geochemical work included O^{16}/O^{18} temperature analysis and Pa^{231}/Th^{230} dating. They are both thought to represent the last two glaciations, the preceding and intervening interglacials, and the modern postglacial epoch. According to the Pa^{231}/Th^{230} determination, the bases of both cores are about 150,000 years BP. Cohen did not note any first or last occurrences among the sixteen species he studied in detail, but his statistical counts of specimens suggested several significant conclusions:

1) *Syracosphaera histrica* is an indicator of "cold" conditions.

2) *Discolithina* cf. *macropora, Discoaster perplexus, Discosphaera tubifera,* and *Oolithotus antillarum* tend to be more abundant in "cold" samples.

3) *Gephyrocapsa oceanica* tends to be more abundant in "warm" samples.

4) *Rhabdosphaera clavigera* and *Scapholithus fossilis* do not seem to have a preference for "cold" samples as had been suggested informally earlier.

TABLE 29–*Continued*

Sample Level	4-4(99-100)	4-5(25-26)	4-5(100-101)	4-6(25-26)	4-6(100-101)	5-2(112-113)	6-2(107-108)	6-3(101-102)	6-4(116-117)	6-6(108-109)	7-1(114-115)	7-2(25-26)	7-2(99-100)	8-1(25-26)	8-2(99-100)	8-2(22-23)	8-2(101-102)	8-3(25-26)	8-3(99-100)	8-4(25-26)	8-4(99-100)	8-5(25-26)	8-5(99-100)	8-6(25-26)	8-6(100-101)	9-1(15-16)	9-1(102-103)	9-2(25-26)	9-2(100-101)
Age	Pleistocene															Pliocene													
Zone	b				"*Gephyrocapsa caribbeanica*"														*Discoaster brouweri*										
Total Abundance	+1	+1	+1	+1	0	0	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	
Ceratolithus cristatus																	-2												-2
C. rugosus																													
Coccolithus pelagicus																	-3			-2			-2			-2		-2	-2
Cyclococcolithina leptopora	-2	-2									-2			-2	-2	-2	-2	-2	-2						-2				
C. macintyrei																-2	-2					-2	-2						
Discoaster brouweri rutellus																			-2	-2	-2	-2					-3	-2	-2
D. brouweri triradiatus																				-2							-3		
D. perclarus																-2													
"*Discolithus*" *phaseolus*		-2	-2	-2		-2			-2	-2	-2	-1	-2	-2	-2		-2	-2		-2	-2		-2		-2		-2	-1	
Discosphaera tubifera																													
Ellipsodiscoaster lidzi																													
Emiliania huxleyi																													
Gephyrocapsa californiensis	-1	0	0	-1	-1						-2	-1					-2												
G. kamptneri	0	0	0	0	-1						-1	-1	-1	-2															
G. oceanica	-1	-1	-1	-2																									
G. sinuosa	0	0	0	0	0	-1	+1	+1	+1	+1	+1	+1	+1	+1	+1	0	0	0	-1	0	0								
G. sp.	0	0	0	0	-1	-2	-1	-1	-1	-1	-1	-1	-1																
Helicopontosphaera kamptneri	-2	-2	-2	-2	-2	-2	-1		-2	-2	-1	0	-1	-2	-2	-2	-2	-2	-2	-1		-2	-2		-2	-2	-2	-2	-2
H. sellii																			-2										-2
H. wallichi					-2						-2																		
Pontosphaefa scutellum											-2	-2	-2							-2		-2							
Pseudoemiliania lacunosa (circular)		-2	-2	-2	-2	-2	-1	-1	-1	-2	-2	-2	-1	-1	-2	-2	-1	-2	-2		-2	-2	-1	-2		-2		-2	
P. lacunosa (elliptical)	-2		-2	-2	-2	-2	-1	-1	0	-1	-1	0	0	0	-1	-1	0	-2	-2	-2	-2	-1	-1	-1	-2	-1	-1	-1	-1
Rhabdosphaera clavigera																									-2		-2	-2	
R. stylifera				-2				-2	-1	-2					-2					-2		-1						-2	-2
Scapholithus fossilis			-2		-2				-2	-2				-2						-2			-2		-2		-2		
Syracosphaera clava																													
S. decussata							-2				-2	-1																	
S. histrica													-2	-2															
S. jonesi				-2		-2			-2	-2	-2	-2	-1	-2	-2	-2				-2	-2	-1	-2						
Umbilicosphaera mirabilis	-2	-2	-2	-1	-2	-2	-1	0	0	-1	-2	-1	-2	-1	-2	-2	-1	-2	-2	-2	-1	-2		-2				-2	-2
"Little u"												-2																	

[b] *Gephyrocapsa oceanica*

Boudreaux (1967) studied the Pleistocene calcareous nannofossils of the *Submarex* cores. A general description of these cores has been given by Bolli et al. (1968).

Cohen and Reinhardt (1968) described coccoliths from another Caribbean Pleistocene deep-sea core, CP-28, but although the paper contains much useful taxonomic information, data on nannofossil stratigraphic distribution are absent.

Zonation by Pleistocene calcareous nannofossils first was proposed by Boudreaux and Hay in Hay et al. (1967) in discussing the *Submarex* cores. A detailed account of the *Submarex* calcareous nannofossils was presented by Boudreaux and Hay (1969). The zonation proposed for the Pleistocene consisted of three units from base to top:

1) "*Gephyrocapsa caribbeanica*" Zone, defined as extending from the highest occurrence of *Discoaster brouweri* to the lowest occurrence of *Gephyrocapsa oceanica*;

2) *Gephyrocapsa oceanica* Zone, defined as extending from the lowest occurrence of *G. oceanica* to the lowest occurrence of *Emiliania huxleyi*; and

3) *Emiliania huxleyi* Zone, from the lowest occurrence of *E. huxleyi* to the top of the sediment.

Gartner (1969) suggested modification of Boudreaux and Hay's zonation. He redefined the lower two zones, proposing a "*Pseudoemiliania* Zone" for the *Gephyrocapsa caribbeanica* Zone and part of the *Gephyrocapsa oceanica* Zone, this new unit being defined as extending from the highest occurrence of *Discoaster brouweri* to the highest occurrence of *Pseudomiliania lacunosa*; the "*Gephyrocapsa* Zone" was proposed for part of the *Gephyrocapsa oceanica* Zone and defined as the interval from the highest occurrence of *P. lacunosa* to the lowest occurrence of *Emiliania huxleyi*.

Hay (1970) presented range charts showing the distribution of species in Pleistocene cores recovered on Leg 4 of

TABLE 30
Calcareous Nannofossils in Cores 9 (Section 3, 25-26) through 16, Hole 154A

Sample Level	9-3(25-26)	9-3(100-101)	9-4(78-80)	9-5(25-26)	9-5(100-101)	9-6(25-26)	9-6(100-101)	10-1(116-117)	10-2(25-26)	10-2(103-104)	10-3(25-26)	10-3(100-101)	10-4(15-16)	10-4(100-101)	10-5(20-21)	10-5(100-101)	10-6(25-26)	10-6(99-100)	11-1(100-101)	11-2(66-67)	11-3(35-36)	11-3(112-113)	11-4(25-26)	11-4(100-101)	11-5(33-34)	11-5(100-101)	11-6(21-22)	11-6(102-103)	12-1(14-15)	12-1(100-101)	12-2(25-26)	12-2(99-100)	12-3(25-26)	12-3(100-101)	12-5(25-26)	12-5(100-101)	12-6(23-24)	12-6(100-101)
Age	Pliocene																																					
Zone	*Discoaster brouweri*														*Discoaster pentaradiatus*																							
Total Abundance	0	0	0	0	0	0	0	-1	0	-1	0	-1	-1	-1	0	0	-1	0	0	0	0	-1	-1	-1	-1	-1	0	-1	-1	0	-1	0	-1	-1	0	-1	-1	0
Ceratolithus cristatus	-2			-2					-2		-2	-2	-2																						-2			
C. rugosus																																						
Coccolithus pelagicus	-2	-2	-2	-2	-2	-2		-2	-2		-2			-2			-2	-2	-2						-2				-2	-2					-1	-2	-2	-2
Cyclococcolithina leptopora	-1	-1		-2				-2			-2							-1						-2						-2		-2						
C. macintyrei	-2	-2		-2	-2	-2	-2	-2		-2	-2		-2		-2	-2				-2	-2						-2	-2		-2					-2	-2		-2
Discoaster brouweri rutellus	-1	-1		-2	-2	-2	-2	-2	-1	-2	-1	-2	-2	-2	-2	-2	-2	-2	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-2	-2
D. brouweri tamalis																																						
D. brouweri triradiatus																																						
D. extensus																																						
D. pentaradiatus															-2	-2		-2	-2	-2	-2	-2	-2	-2	-2	-2	-2			-2	-2	-2	-2	-2	-1	-2	-2	-2
D. perclarus																																						
D. cf. *surculus*							-2																			-2												
"*Discolithus*" *phaseolus*	-1	-2	-1	0				-2	-2	-1	-2	0	-1		-1		-2	0															-2	-2	0			
Helicopontosphaera kamptneri	-1	-1	-1	-1	-1	-1	-1	-2	-2	-1	-2	-1	-2	-2	-1	-2	-2	-2		-1	-2		-2	-2	-2	-2	-1	-2	-2	-2	-2	-2	-2	-2	-1	-1	-2	-2
H. sellii												-2	-2		-1					-2			-2		-2			-2				-2	-2	-2	-2	-2		
H. wallichi																												-2										
Pontosphaera scutellum																																-2						
Pseudoemiliania lacunosa (circular)	-2		-1	-1	-1	-1	-1	-2	-1			-1	-2		-1	-2	-2	-1	-1	-1	-2	-2																
P. lacunosa (elliptical)	0	0	0	0	0	0	0	-1	0	-1		0	-1	-1	0	0	-1	0	0	0	0	-1	-1	-1	-1	-1	0	-1	-1	0	-1	0	-1	-1	+1	+1	-1	0
Reticulofenestra pseudoumbilica																																						
Rhabdosphaera stylifera							-2		-2	-2	-2	-1		-2	-1	-2	-2	-1											-2									
Scyphosphaera apsteini																																						
Sphenolithus abies													-2																									
Umbilicosphaera cricota																																						
U. mirabilis	-1	-1	0	-2	-2	-1	-2	-2	-1	-1	-2	-2	-2		-2		-2				-2		-2			-2	-2				-2				-1			-2

TABLE 30–*Continued*

Sample Level	13-1(14-15)	13-1(89-90)	13-2(26-27)	13-2(100-101)	13-3(21-22)	13-3(115-116)	13-4(25-26)	13-4(100-101)	13-5(21-22)	13-5(100-101)	13-6(26-27)	13-6(97-98)	14-1(25-26)	14-1(118-119)	14-2(43-44)	14-2(107-108)	14-3(25-26)	14-3(101-102)	14-4(25-26)	14-4(100-101)	14-5(40-41)	14-5(102-103)	14-6(17-18)	14-6(100-101)	15-1(140-141)	15-2(15-16)	15-2(85-86)	15-3(23-24)	15-3(80-81)	15-4(25-26)	15-4(100-101)	15-5(25-26)	15-5(101-102)	16-1(25-26)	16-1(106-107)	16-2(35-36)
Age	Pliocene																																			
Zone	*Discoaster surculus*																							*Reticulofenestra pseudoumbilica*												
Total Abundance	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–2	0	0	–1	0	0	–1	–1	0	0	–1	–1	0	–1	–1	0	–1	–1
Ceratolithus cristatus																								–2				–2								
C. rugosus																				–2														–2		
Coccolithus pelagicus		–2	–2	–2	–2	–2	–2	–2		–2						–2							–2	–2					–2							
Cyclococcolithina leptopora			–2	–2		–2	–2	–2	–2	–2				–2	–2	–2	–2			–2	–2			–2	–2	–2	–2	–2								
C. macintyrei	–2	–2			–2	–2	–2	–2	–2	–2		–2					–2				–2		–2			–2	–2	–2			–2	–2	–2		–2	
Discoaster brouweri rutellus		–2	–2	–2	–2	–2	–2	–2	–2	–2		–2	–2	–2	–2	–2	–2			–1	–1	–2	–2	–2	–2	–2	–2	–2	–2	–2	–1		–2	–2	–2	–2
D. brouweri tamalis		–2	–2			–2	–2	–2	–2											–2	–2															
D. brouweri triradiatus									–2												–2															
D. extensus																													–2							
D. pentaradiatus	–2	–1	–2	–2	–2	–2	–2	–2	–2	–2		–2		–2	–2	–2	–2	–2	–2	–2	–1	–2	–1	–1	–1	–2	–2	–2	–2	–2	–2		–2	–2	–2	–2
D. perclarus																																				–2
D. cf. *surculus*		–2																					–2													
"Discolithus" phaseolus			–2							–2													–2													
Helicopontosphaera kamptneri	–2	–1	–2	–2	–2	–2	–2	–2	–2	–2	–2	–2			–2	–2	–2			–1	–2	–2	–2	–2		–2	–2									
H. sellii																																				
H. wallichi																																				
Pontosphaera scutellum		–2				–1		–2																			–2									
Pseudoemiliania lacunosa (circular)		–1		–2	–2	–2	–2	–2	–2	–2		–2	–2	–2		–2	–2			–1	–1			–1			–1	–1								
P. lacunosa (elliptical)	–1	0	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–1	–2	0	0	–1	0	0	–1		0	0	–2	–2	0			0		
Reticulofenestra pseudoumbilica																												–2			–2	–2		–2	–2	
Rhabdosphaera stylifera			–2				–2																													
Scyphosphaera apsteini																																				
Sphenolithus abies																–2									–2		0	0			0		–2	0	–2	–1
Umbilicosphaera cricota		–2				–2	–2								–2	–2	–2							–2												
U. mirabilis				–2		–2	–2			–2	–2					–2	–2			–2			–2	–2	–2	–2										

the Deep Sea Drilling Project, which included the Caribbean area.

Discussion

Calcareous nannofossils possess several pecularities which make them especially suitable for use as biostratigraphic indicators. The most important characteristics are (1) many groups have evolved very rapidly; (2) numerous species have worldwide distribution; and (3) in many samples, they are extremely abundant (Hay et al., 1967).

As with most fossils, their abundance within a sample is a function of many factors such as environmental conditions while living and at the site of burial, post mortem transportation, and chemical as well as physical changes over the span of geologic time since their burial. The abundance of a species from one area to another or from one sample to another is obviously a function of all these factors. The presence or absence of a species is an extremely valuable tool as a key to biostratigraphy. The presence of a coccolith indicates that either a living species produced coccoliths which survived solution, or that reworking or contamination introduced coccoliths into the sample. Reworked coccoliths are introduced upwards from their original stratigraphic position. Coccoliths may also be displaced downward in a section by slumping during drilling or coring; such coccoliths are referred to as contaminating the sample. Reworking and contamination are subjective explanations of the objective observation of specimens in samples "where they do not belong."

The absence of a coccolith from a sample is caused by (1) the species not living in the area at the time of sediment deposition, (2) the coccoliths dissolving during settling through the water or at the sediment-water interface, and (3) the coccoliths dissolving within the sediment. Because the sediments at Site 149 are from deep water while those at Sites 147 and 148 are from relatively shallow water, they provide a unique opportunity to determine differential solution of coccolith species. Of the species studied, *Discosphaera tubifera* and *Ellipsodiscoaster lidzi* seem to be dissolved in the water or at the sediment-water interface because they occur in the shallow-water sediments of Site 148 and do not occur in the deeper-water sediments of Site 149 (with the exception of very rare occurrences of *E. lidzi*). It is also interesting to note that *D. tubifera* and *E. lidzi* are absent at Site 147 with the exception of very rare occurrences of *E. lidzi*. In this case, solution can be attributed to diagenetic processes taking place in sediment accumulating under anaerobic conditions, which produce an acidic sediment as indicated by the presence of hydrogen sulfide and pyrite.

A biostratigraphic event may be defined as the lowest or highest stratigraphic occurrence of a fossil group. The size of the analyzed sample, as well as the abundance of the fossil group, affect the precision of determination of the lowest and highest stratigraphic occurrence of a fossil (Hay, 1972). Absence of a specific fossil group in an area is as important as the presence of fossil groups for determining the local biostratigraphic sequence. Cyclic appearance and disappearance of species in the same sections represent introduction of the species into an area with different water masses rather than absolute origin or extinction of taxa.

Within the cores taken from Holes 147, 148, 149, and 154A, the order of biostratigraphic events (highest or lowest occurrences of species) from the top through bottom sections is shown below.

For Hole 147:

Highest: Highest occurrence *Syracosphaera clava* in Section 1 of Core 4 (89-90 cm).

Highest occurrence of "little u" in Section 2 of Core 4 (50-51 cm).

Highest occurrence of *Syracosphaera decussata* in Section 3 of Core 4 (10-11 cm).

Highest occurrence of *Gephyrocapsa kamptneri* in Section 6 of Core 4 (90-91 cm).

Highest occurrence of *Gephyrocapsa sinuosa* in Section 2 of Core 7 (17-18 cm).

Lowest occurrence of *Emiliania huxleyi* in Section 2 of Core 7 (17-18 cm).

Highest occurrence of *Gephyrocapsa californiensis* in Section 3 of Core 8 (38-39 cm).

Lowest occurrence of *Gephyrocapsa parallela* in Section 5 of Core 9 (84-85 cm).

Highest occurrence of *Syracosphaera histrica* in Section 5 of Core 10 (62-63 cm).

Lowest occurrence of *Syracosphaera clava* in Section 3 of Core 12 (103-104 cm).

Lowest occurrence of "little u" in Section 4 of Core 12 (41-42 cm).

Highest occurrence of *Pseudoemiliania lacunosa* (circular) in Section 1 of Core 15 (21-22 cm).

Lowest occurrence of *Gephyrocapsa sinuosa* in Section 3 of Core 15 (27-28 cm).

Lowest: Lowest occurrence of *Syracosphaera histrica* in Section 3 of Core 16 (76-77 cm).

For Hole 148

Highest: (?) Highest occurrence of *Gephyrocapsa sinuosa Syracosphaera decussata, Syracosphaera clava,* and "little u" in Section 2 of Core 1 (52-53 cm).

Highest occurrence of *Gephyrocapsa kamptneri, Gephyrocapsa sinuosa,* and *Syracosphaera decussata* in Section 3 of Core 1 (40-41 cm).

Highest occurrence of *Syracosphaera clava* in Section 3 of Core 1 (100-101 cm).

(?) Highest occurrence of *Gephyrocapsa californiensis* in Section 4 of Core 1 (9-10 cm).

Highest occurrence of *Gephyrocapsa californiensis* and *Syracosphaera histrica* in Section 5 of Core 1 (20-21 cm).

(?) Highest occurrence of *Gephyrocapsa californiensis* in Section 1 of Core 2 (59-60) cm).

Lowest occurrence of "little u" in Section 3 of Core 2 (131-132 cm).

Lowest occurrence of *Emiliania huxleyi* in Section 4 of Core 2 (30-31 cm).

(?) Highest occurrence of *Pseudoemiliania lacunosa* (circular) in Section 4 of Core 2 (110-111 cm).

Lowest occurrence of *Syracosphaera clava* in Section 4 of Core 2 (110-111 cm).

Highest occurrence of *Pseudoemiliania lacunosa* (circular) in Section 3 of Core 3 (48-49 cm).
(?) Lowest occurrence of *Syracosphaera clava* in Section 1 of Core 4 (129-130 cm).
Lowest occurrence of *Syracosphaera histrica* in Section 4 of Core 4 (20-21 cm).
Lowest occurrence of *Ellipsodiscoaster lidzi* in Section 4 of Core 4 (90-91 cm).
Highest occurrence of *Pontosphaera* sp. in Section 4 of Core 4 (90-91 cm).
(?) Highest occurrence of *Pseudoemiliania lacunosa* (elliptical) in Section 4 of Core 4 (90-91 cm).
(?) Lowest occurrence of "little u" in Section 5 of Core 4 (120-121 cm).
(?) Lowest occurrence of *Syracosphaera clava* in Section 1 of Core 5 (50-51 cm).
Highest occurrence of *Pseudoemiliania lacunosa* (elliptical) in Section 3 of Core 5 (149-150 cm).
(?) Lowest occurrence of "little u" in Section 3 of Core 8 (105-106 cm).
(?)Highest occurrence of *Coccolithus pelagicus* in Section 2 of Core 9 (40-41 cm).
Lowest occurrence of *Discosphaera tubifera* in Section 2 of Core 9 (40-41 cm).
(?) Highest occurrence of *Coccolithus pelagicus* in Section 3 of Core 10 (34-35 cm).
Highest occurrence of *Pontosphaera scutellum* in Section 4 of Core 10 (100-101 cm).
Lowest occurrence of *Gephyrocapsa oceanica* in Section 1 of Core 12 (40-41 cm).
Highest occurrence of *Coccolithus pelagicus* in Section 2 of Core 12 (43-44 cm).
(?) Lowest occurrence of *Syracosphaera clava* in Section 4 of Core 13 (40-41 cm).

Lowest: Highest occurrence of *Discoaster brouweri rutellus* in Section 4 of Core 15 (90-91 cm).

For Hole 149

Highest: Highest occurrence of *Coccolithus pelagicus, Syracosphaera histrica, Syracosphaera decussata, Syracosphaera clava*, and "little u" in Section 1 of Core 2 (25-26 cm).
Highest occurrence of *Gephyrocapsa kamptneri* in Section 1 of Core 2 (100-101 cm).
Highest occurrence of *Gephyrocapsa sinuosa* in Section 2 of Core 2 (62-63 cm).
Lowest occurrence of *Emiliania huxleyi* in Section 2 of Core 2 (62-63 cm).
(?) Highest occurrence of *Pseudoemiliania lacunosa* (circular) in Section 2 of Core 2 (62-63 cm).
Lowest occurrence of "little u" in Section 2 of Core 2 (62-63 cm).
Lowest occurrence of *Coccolithus pelagicus* in Section 3 of Core 2 (25-26 cm).
Highest occurrence of *Gephyrocapsa californiensis* and *Gephyrocapsa sinuosa* in Section 3 of Core 2 (25-26 cm).
Lowest occurrence of *Syracosphaera histrica* in Section 1 of Core 3 (144-145 cm).
Highest occurrence of *Pseudoemiliana lacunosa* (circular) in Section 3 of Core 3 (100-101 cm).
Highest occurrence of *Pseudoemiliania lacunosa* (elliptical) in Section 3 of Core 4 (25-26 cm).
Lowest occurrence of *Gephyrocapsa oceanica* in Section 2 of Core 6 (99-100 cm).
(?) Highest occurrence of *Coccolithus pelagicus* in Section 3 of Core 6 (25-26 cm).
(?) Lowest occurrence of *Gephyrocapsa oceanica* in Section 4 of Core 6 (25-26 cm).

Lowest: Highest occurrence of *Discoaster brouweri rutellus* and *Discoaster pentaradiatus* in Section 5 of Core 6 (35-36 cm).

For Hole 154A

Highest: Highest occurrence of *Syracosphaera decussata* above Section 1 of Core 1 (94-95 cm).
Highest occurrences of *Gephyrocapsa kamptneri* and *Gephyrocapsa sinuosa* in Section 2 of Core 1 (100-101 cm).
Lowest occurrence of *Emiliania huxleyi* in Section 3 of Core 1 (23-24 cm).
Highest occurrence of *Gephyrocapsa californiensis* in Section 3 of Core 1 (99-100 cm).
Highest occurrence of *Syracosphaera histrica* in Section 4 of Core 1 (99-100 cm).
(?) Highest occurrence of *Pseudoemiliania lacunosa* (elliptical) in Section 2 of Core 3 (25-26 cm).
Highest occurrence of *Pseudoemiliania lacunosa* (circular) in Section 2 of Core 3 (100-101 cm).
Highest occurrence of *Pseudoemiliania lacunosa* (elliptical) in Section 2 of Core 4 (9-100 cm).
Lowest occurrence of *Gephyrocapsa oceanica* in Section 6 of Core 4 (25-26 cm).
Lowest occurrence of *Syracosphaera histrica* in Section 1 of Core 8 (25-26 cm).
Highest occurrence of *Coccolithus pelagicus* in Section 2 of Core 8 (101-102 cm).

Lowest: Highest occurrence of *Discoaster brouweri* in Section 3 of Core 8 (99-100 cm).

These highest and lowest occurrences were determined subjectively (using the data from Tables 5, 7, 8, 29, and 30) as the levels at which the species commenced or terminated rather consistent occurrence.

Some species mark no biostratigraphic events because they occur continuously throughout the cores from the four sites, or because their occurrences and nonoccurrences are very sporadic, thus defining sporadic events of questionable biostratigraphic value.

Analysis of the lists of events for each of the holes studied in detail reveals that nine stratigraphic events occur in the same sequence in each of the sections in which they occur. These events may be generally useful for biostratigraphic subdivision of the Pleistocene in the Caribbean:

Highest: HOS *Syracosphaera decussata*
HOS *Syracosphaera clava*
HOS *Gephyrocapsa kamptneri*
HOS *Gephyrocapsa sinuosa*

LOS *Emiliania huxlevi*
HOS *Pseudoemiliania lacunosa* (circular)
HOS *Pseudoemiliania lacunosa* (elliptical)
LOS *Gephyrocapsa oceanica*
Lowest: HOS *Discoaster brouweri rutellus*

The surfaces defined by these events divide the Pleistocene and Recent into nine intervals. The value of the highest occurrence surfaces of *Emiliania huxleyi* and *Discoaster brouweri* and the lowest occurrence surfaces of *Pseudoemiliania lacunosa* and *Gephyrocapsa oceanica* have long been known, but the surfaces above the lowest occurrence of *Emiliania huxleyi* are new and may be of considerable value in the study of younger Pleistocene deep-sea cores. The sequence of the highest occurrences of *Syracosphaera clava* and *Syracosphaera decussata* are suggested from data from the Cariaco Trench (Hole 147) and must be regarded as strictly tentative. These two species are known to occur widely in the Venezuelan Basin, and subsequent studies of piston and gravity cores should confirm or refute the sequence suggested here. The positions of the highest and lowest occurrence surfaces of general value in the Caribbean is indicated in Figure 3.

The nature of appearances and disappearances of species in the cores with high sedimentation rates deserves special attention. The appearances of species in this area are generally abrupt, even when a very high sedimentation rate permits high stratigraphic resolution. Only in a few instances are there sporadic occurrences of subsequently abundant species prior to the continuous part of their ranges. The disappearances of species from this area are more complex and may be either by gradual or abrupt reduction in abundance, then absence, followed by sporadic recurrence. This suggests that populations were reintroduced into the area from a parent stock in the Atlantic and survived for short periods, but were unable to effectively resettle the area.

At Site 147, occurrence of *Coccolithus pelagicus* in Cores 4 through 7 probably marks the last glaciation with the resultant introduction of colder water into the Caribbean regions. This interpretation is substantiated by McIntyre and Bé (1966) and McIntyre (1967) who noted that *Coccolithus pelagicus* does not occur in the tropics but is abundant in the North Atlantic to the area north of the 14°C isotherm. Boudreaux and Hay (1969) further substantiated this restricted occurrence of *C. pelagicus* to cold waters when analysis of the *Submarex* cores indicated its presence only in samples suggesting relatively colder conditions. Thus, occurrence of *Coccolithus pelagicus* indicates a cold water environment which may be directly related to cycles of glaciation.

At Sites 147 and 148, *Syracosphaera histrica* occurs at intervals throughout its range, probably marking intrusions of colder water, as suggested by Cohen (1964).

Certain species exhibit similar patterns of nonoccurrence. At Sites 147, 148, and 149, *Rhabdosphaera stylifer, Gephyrocapsa californiensis, G. kamptneri,* and *G. oceanica* are covariant and do not occur in a number of specific samples, as can be seen from Tables 2 through 4.

The cycles of nonoccurrence and occurrence of one or more of these species may indicate intermittent introduction of colder and warmer water into the Caribbean during the Pleistocene glacials and interglacials. From what is known of the ecology of these species (McIntyre & Bé, 1967), it appears that their absence probably indicates the influx of colder water, creating an unsuitable environment. At Site 147 in the Cariaco Trench, several other species such as *Syracosphaera jonesi, S. pulchra,* and *S. clava,* are also absent in the same intervals as *Rhabdosphaera stylifer, Gephyrocapsa californiensis, G. kamptneri,* and *G. oceanica;* this may reflect restricted connection with the Caribbean during times of lowered sea level. At Site 148, intervals of nonoccurrence of *Pseudoemiliania lacunosa* and *Pseudoemiliania cricota* are remarkably similar and nearly

	Hole:	147	148	149	154A
HOS	*Syracosphaera clava*	4-1(51-52)			
		4-1(89-90)			
HOS	*Syracosphaera decussata*	4-2(50-51)			
		4-3(10-11)	1-2(52-53)	2-1(25-26)	1-1(94-95)
HOS	*Gephyrocapsa kamptneri*	4-6(50-51)	1-2(84-85)	2-1(25-26)	1-2(30-33)
		4-6(90-91)		2-1(100-101)	
HOS	*Gephyrocapsa sinuosa*	7-1(127-128)		2-1(100-101)	
		7-2(17-18)	1-3(40-41)	2-2(62-63)	1-2(100-101)
LOS	*Emiliania huxleyi*	7-2(17-18)	2-4(30-31)	2-2(62-63)	1-2(100-101)
		8-1(43-44)	2-4(110-111)	2-3(25-26)	1-3(23-24)
HOS	*Pseudoemiliania lacunosa (c)*	14-5(100-101)	3-2(101-102)	3-1(144-145)	3-2(25-26)
		15-1(21-22)	3-3(48-49)	3-3(100-101)	3-2(100-101)
HOS	*Pseudoemiliania lacunosa (e)*		4-4(48-49)	3-3(100-101)	4-2(25-26)
			4-4(90-91)	4-3(25-26)	4-2(99-100)
LOS	*Gephyrocapsa oceanica*		12-1(40-41)	6-2(99-100)	4-6(25-26)
			12-1(128-129)	6-3(25-26)	4-6(100-101)
HOS	*Discoaster brouweri rutellus*		15-4(18-19)	6-3(25-26)	8-3(25-26)
			15-4(90-91)	6-4(59-60)	8-3(99-100)

Figure 3. *Relation of cores taken from holes 147, 148, 149, and 154A to surfaces of highest or lowest occurrence of calcareous nannofossils (HOS = highest occurrence surface; LOS = lowest occurrence surface).*

synchronous with the intervals for the *R. stylifer-G. californiensis-G. kamptneri-G. oceanica* group, suggesting that this now extinct group also preferred warmer waters.

Correlation of Holes 147, 148, 149, and 154A on the basis of the highest and lowest occurrences of selected species is indicated in Figure 3.

SYSTEMATIC PALEONTOLOGY

Kingdom PLANTAE

Subkingdom PROTOBIONTA

Phylum CHRYSOPHYTA

Class COCCOLITHOPHYCEAE Rothmaler, 1951

Order COCCOLITHALES Rood, Hay, and Barnard, 1971

Family COCCOLITHACEAE Kamptner, 1928, emend., Hay and Mohler, 1967

Subfamily COCCOLITHOIDEAE Kamptner, 1928, emend., Hay and Mohler, 1967

Tribe COCCOLITHEAE Kamptner, 1958, emend., Boudreaux and Hay, 1969

Genus COCCOLITHUS Schwarz, 1894

Type Species: Coccosphaera pelagica Wallich, 1877

Coccolithus pelagicus (Wallich)
(Plate 1, Figures 1-3)

Coccosphaera pelagica Wallich, 1877, Ann. Mag. Nat. Hist., vol. 18, (4th Ser.), p. 348, pl. 17, Figs. 1, 2, 5, 11, 12.

Coccolithophora pelagica (Wallich) Lohmann, 1920, p. 98, text-Fig. 21b.

Coccolithus pelagicus (Wallich) Schiller, 1930, in L. Rabenhorst: Kryptogamen-Flora, Leipzig, vol. 10, (pt. 2), p. 246 (pro parte) – Kamptner, 1954, Arch, Protistenk., vol. 100, pp. 20-21, Figs. 14-15 – Kamptner, 1963, Ann. Naturhistor. Mus. Wien, 66, pp. 159, 191, 194 – Stradner, 1963b, Mitt. Geol. Ges Wien, vol. 56, pp. 156-157 – Cohen, 1965, Leidse Geol. Meded., Vol. 35, p. 12, pl. 1, Figs. a-c – Martini, 1965, in W. F. Whittard and R. B. Bradshaw (Eds.): Submarine Geol. and Geophys., Proc. 17th Symp. Colston Res. Soc., London, p. 402, pl. 34, Figs. 103 – McIntyre & Bé, 1967, Deep Sea Res., vol. 14, pp. 569-570, pl. 8, Figs. A-C – McIntyre et al., 1967, in M. Sears (ed.): Progress in Oceanography, vol. 4, p. 11, pl. 4, Figs. A-B – Kamptner, 1967, Ann. Naturhistor. Mus. Wien, 71, pp. 124, 126, 140, 169, 170, 171, 173, 181, 184, Tafel 2, Fig. 14 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, num. 3., pp. 256-257, pl. 1, Figs. 1-9 – Clocchiatti, 1969, Revue Micropal., vol. 12, n°2, pl. 3, Fig. 6 – Geitzenauer, 1969, Nature, vol. 223, no. 5202, pp. 170-172 – Gartner, 1969, Gulf Coast Assoc. Geol. Socs. Trans., vol. 19, pp. 587-591 – Uschakova, 1970, in Funnel and Reidel (Eds.): The Micropaleontology of Oceans, pp. 247-248, pl. 15.1, Figs. 7-9 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 456 – Bartolini, 1970, Micropaleontology, vol. 16, no. 2, pp. 132-133, pl. 1, Figs. 2-7, text-Fig. 4 – Bukry, Douglas, Kling, Krasheninnikov, 1971, Initial Reports of the Deep Sea Drilling Project, vol. 6, pp. 1255, 1262-1266 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, p. 965-969, pl. 1, Figs. 1 and 2.

Remarks: This species occurs in transitional and subarctic waters (McIntyre and Bé, 1967) and is characteristic of subpolar water (McIntyre, Bé, and Roche, 1970). It is found living only in the Northern Hemisphere (McIntyre, Bé, and Roche, 1970) but occurs in South Atlantic sediments south of the Tropic of Capricorn (Bartolini, 1970). McIntyre and Bé (1967) have suggested that disappearance of this species in the South Atlantic occurred at the end of the last glacial period. Because this species lives only in cold water masses having a temperature range of 6 to 14°C, it can be used to indicate the intrusion of glacial cold water masses into more tropical regions during the Pleistocene. At Site 147, this species has an isolated occurrence at the top of Core 3, then a consistent occurrence from Section 1 of Core 4 through the base of Section 2 of Core 5, most probably marking the last introduction of glacial cold water masses into the Cariaco Trench. This is followed by sporadic occurrences in deeper sections.

Tribe GEPHYROCAPSEAE Boudreaux and Hay, 1969

Genus GEPHYROCAPSA Kamptner, 1943

Type Species: Gephyrocapsa oceanica Kamptner, 1943

Gephyrocapsa californiensis Kamptner
(Plate 1, Figures 4-5)

Gephyrocapsa californiensis Kamptner, 1956, Arch. Protistenk, vol. 101, pp. 179, 199.

Gephyrocapsa aperta Kamptner, 1963, Ann. Naturhistor. Mus. Wien, 66, pp. 173, 192, 194, 197, Taf. 6, Figs. 32 and 35 – Cohen and Reinhardt, 1968, N. Jb. Geol. Palaont. Abh., 131, 3, p. 293 – Gartner, 1969, Gulf Coast Assoc. Geol. Socs. Trans., vol. 19, pl. 2, Fig. 8 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 456 – Nishida, 1970, Jour. Mar. Geol., Vol. 6, no. 1, pl. II, Figs. 1-2 – Nishida, 1970, Trans. Proc. Palaeont. Soc. Japan, N. S., No. 79, pp. 363-364 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, pl. 1, Fig. 5.

Gephyrocapsa ericsonii McIntyre and Bé, 1967, Deep-Sea Research, vol. 14, p. 571, pl. 10, pl. 12, Fig. B – McIntyre, Bé, and Roche, 1970, Trans. New York Acad. Sciences, Ser. II, Vol. 32, no. 6, pp. 720-731, Fig. 5e – McIntyre, 1970, Deep-Sea Research, vol. 17, pp. 187-190, Figs. 1a and 3.

Gephyrocapsa undulatus Lecal, 1967, Hydrobiologia, vol. 29, pp. 322-323, text-figs. 16-17, Figs. 23-24.

Gephyrocapsa protohuxleyi McIntyre, 1969, in Degens and Ross (Eds.): Hot Brines and Recent Heavy Mineral Deposits in the Red Sea, pp. 299-305, Fig. 2, f – McIntyre, 1970, Deep-Sea Research, vol. 17, pp. 187-190, fig. 1b, d, f, g – Bukry, 1971, Initial Reports Deep Sea Drilling Project, Vol. 6, pl. 1, Fig. 6.

Remarks: Utilizing light microscopy, *Gephyrocapsa californiensis* is virtually indistinguishable from *G. aperta, G. ericsonii, G. undulatus,* and *G. protohuxleyi.* These are all small coccoliths differentiated primarily by closed versus open central areas, the character of the margin, and bridge angles differing by less than 20 degrees.

Gephyrocapsa californiensis resembles *G. oceanica* except that the bridge segment makes a greater angle, approximately 65 degrees, with the minor axis of the ellipse and the bridge extremities are slightly curved in a clockwise direction. No illustrations were provided with the original description.

Gephyrocapsa aperta differs from *G. oceanica* in having a larger open central area, a more coarsely constructed bridge, and a bridge segment making an angle of 55 to 65 degrees with the minor axis of the ellipse. The holotype was illustrated by electron micrographs, but no light micrographs of specimens have been published.

Gephyrocapsa ericsonii is similar to *G. oceanica* except that the bridge elements are thinner, blade-like, and highly arched. The central grille is a radial net-like structure, and the bridge segment makes an angle of approximately 65 degrees with the minor axis of the ellipse. The holotype was illustrated by electron micrographs, and no light micrographs have been published.

In *Gephyrocapsa undulatus* the central area has a perforate grille and the bridge segment makes an angle of 60 to 65 degrees with the minor axis of the ellipse. The holotype was illustrated by electron micrograph, but no light micrographs have been published.

Gephyrocapsa protohuxleyi is distinctive in electron micrograph. The central area is open and the bridge segment makes an angle of approximately 65 to 70 degrees with the minor axis of the ellipse. It resembles *G. ericsonii* in overall geometry (McIntyre, 1970), but its margin is composed of radiating "club-like" elements. The holotype has been illustrated only by electron micrograph. No light micrographs of specimens assigned to this species have been published.

Gephyrocapsa oceanica Kamptner
(Plate 1, Figures 6-7)

Pontosphaera huxleyi Lohmann, 1901 (part), Arch. Protistenk., vol. 1, p. 130, pl. 4, Figs. 1-9 – Schiller, 1925, Arch. Protistenk., vol. 51, p. 9, text-Figs. A-B – Kamptner, 1941, Naturhist, Mus. Wien, Ann., vol. 51, pp. 79, 99, pl. 2, Fig. 27, pl. 3, Figs. 29-30.

Gephyrocapsa oceanica Kamptner, 1943, Akad. Wiss. Wien, Anz., vol. 80, pp. 43-49 – Deflandre, 1954, Ann. Pal., vol. 40, p. 154, pl. 3, Fig. 7 – Halldal and Markali, 1955, Norske Vidensk. Akad., Avh., Math. Naturv. Kl., num. 1, p. 18, pl. 23, pl. 24, Figs. 1-2 – Black and Barnes, 1961, Roy, Micr. Soc. Jour., vol. 80, pt. 2. 143, pl. 25, Figs. 1-2 – Kamptner, 1963, Ann. Naturhistor. Mus. Wien, 66, pp. 173-192, 194, 197 – Cohen, 1964, Micropaleontology, vol. 10, p. 240, pl. 3, Fig. 3 a-e, pl. 4, Fig. 3 a-b – McIntyre and Bé, 1967, Deep Sea Res., vol. 14, p. 570, pl. 9, Figs. A-B – McIntyre et al., 1967, in M. Sears (Ed.): Progress in Oceanography, Pergamon Press, Oxford, vol. 4, p. 12, pl. 1, Figs. A-B – Hay et al., 1967, Gulf Coast Assoc. Geol. Socs. Trans., vol. 17, pls. 12-13, Figs. 5-6 – Kamptner, 1967, Ann. Naturhistor. Mus. Wien, 71, p. 182 – Cohen and Reinhardt, 1968, N.Jb. Geol. Palaont. Abh., 131, 3, p. 293, pl. 20, Fig. 10, text-Fig. 3 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, núm. 3, pp. 258, 262-262, pl. 1, Figs. 18-25, pl. 11, Fig. 1 – Kennett and Geitzenauer, 1969, Nature, vol. 224, no. 5222, pp. 899-901 – Gartner, 1969, Trans. Gulf Coast Asso. Geol. Socs., vol. 19, pl. 2, Fig. 7 – Bandy and Wilcoxon, 1970, Geol. Soc. Am. Bull. vol. 81, pp. 2939-2948 – McIntyre, Bé, and Roche, 1970, Trans. New York Acad. Sciences, Ser. II, vol. 32, no. 6, pp. 720-731, Fig. 5c – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 456 – Nichida, 1970, Trans. Proc. Palaeont. Soc. Japan, N.S., no. 79, pp. 363-364, pl. 40, Fig. 1-3 – Bartolini, 1970, Micropaleontology, vol. 16, no. 2, p. 136-140, pl. 5, Figs. 1-8 – Uschakova, 1970, in Funnel and Riedel (Eds.): The Micropaleontology of Oceans, pp. 245-251, pl. 15-1, Figs. 4-5 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, pl. 2, Fig. 1.

Gephyrocapsa dentata Halldal and Markali, 1955, Avh. Norske Vid. – Akad. Oslo, Mat. – Naturv., pp. 18, pl. 24, Fig. 3.

Remarks: The central area of this species is spanned by a grille similar to that of *Emiliania huxleyi* (Lohmann). The bridge makes an angle of approximately 20 degrees or less with the minor axis of the ellipse. This species is robust and it is readily recognizable using a light microscope. Cohen and Reinhardt, 1968, considered *Gephyrocapsa dentata* to be an etched form of *G. oceanica.*

Gephyrocapsa oceanica occurs in all major oceans in tropical, subtropical, and transitional waters (McIntyre and Bé, 1967) with a preference for warm waters (McIntyre, Bé, and Preikstas, 1967). It has also been found living in the Gulf of Mexico and in the Mediterranean (Cohen, 1964). It is one of the most abundant and widely distributed species in the Atlantic (McIntyre, 1967).

Gephyrocapsa kamptneri Deflandre and Fert
(Plate 1, Figures 8-9)

Gephyrocapsa kamptneri Deflandre and Fert, 1954, Ann. Paléont. 40, pp. 41, pl. 6, Fig. 4a, pl. 8, Fig. 4, text-Fig. 13.

Gephyrocapsa gracillima Lecal and Bernheim, 1960, Bull. Soc. d'Hist. Nat. de l'Afrique du Nord, vol. 51, pp. 290-291, pl. 18, photo 31, pl. 19, photo 32, sch. 12.

Gephyrocapsa caribbeanica Boudreaux and Hay, 1967, Gulf Coast Assoc. Geol. Socs., Trans., vol. 17, p. 447, pls. 12-13, Figs. 1-4 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, núm. 3, p. 262, pl. II, Figs. 3-9 – Bandy and Wilcoxon, 1970, Geol. Soc. Am. Bull., vol. 81, pp. 2939-2948 – McIntyre, Bé, and Roche, 1970. Trans. New York Acad. Sciences, Ser. II, vol. 32, no. 6, pp. 720-731, Fig. 5d – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 456.

Remarks: In light microscopy, *Gephyrocapsa kamptneri* is virtually indistinguishable from *G. caribbeanica* and *G. gracillima.* Because of their relatively small sizes, it is considered impossible to differentiate these species by the angle the bridge segment makes with the minor axis of the ellipse. This angle differs through a range of less than 10 degrees.

Gephyrocapsa kamptneri possesses a rib-like central area and the bridge makes an angle of approximately 40 to 50 degrees with the minor axis of the ellipse. Only electron micrographs of this species have been published.

Gephyrocapsa gracillima possesses a central area of radiating rib-like structures. The angle which the bridge makes with the minor axis of the ellipse is approximately 40 degrees. Only electron micrographs and one schematic diagram of this species have been published.

Gephyrocapsa kamptneri differs from *G. oceanica* by having a bridge that is wider and nearly fills the entire central area. The central area may be closed or very narrow and it lacks a grille. The bridge segment makes an angle of approximately 45 degrees with the minor axis of the ellipse.

Gephyrocapsa kamptneri ranges from tropical to subpolar seas with a definite preference for the cold waters of the subpolar regions. It is known to live in the Pacific Ocean and tolerates a temperature range of 5 to 15°C (McIntyre, Bé, and Roche, 1970.

Gephyrocapsa parallela n. sp.
(Plate 1, Figures 10-12)

Holotype: UI-H-147/3/2/99-100

Dimension: Holotype: length, 3μ; width, 2.5μ.

Type locality: DSDP, Leg 15, Site 147, Core 3, Section 2, (99-100 cm).

Diagnosis: An elliptical species distinguished by its large size, bridge occupying the minor axis of the ellipse, and appearance in polarized light.

Description: This species resembles *Gephyrocapsa oceanica* but is much larger and the central area is spanned by a narrow bridge which makes an angle of no more than a few degrees with the minor axis of the ellipse. The central area and margin of this species are both broad. Specimens are approximately twice as large as characteristic *G. oceanica.*

Remarks: At Site 147, *Gephyrocapsa parallela* first occurs in Section 2 of Core 2 (1-2 cm) and is present in every section through Section 3 of Core 7 with the exception of Section 1, Core 7. From Section 5 of Core 7 (20-21 cm) through Section 5 of Core 9 (84-85 cm), it markedly decreases in occurrence. Below this, it occurs very sporadically.

At Site 148, it occurs only in Section 1 of Core 4 (129-130 cm), Section 2 of Core 11 (20-21 cm), and Section 6 of Core 11 (104-105 cm).

It does not occur in cores from Sites 149 or 154.

Gephyrocapsa sinuosa n. sp.
(Plate 1, Figures 13-14)

Holotype: UI-H-149/2/3/25-26.

Dimension: Holotype: length, 1.2μ; width, 1.0μ.

Type locality: DSDP, Leg 15, Site 149, Core 2, Section 3, (25-26 cm).

Diagnosis: An elliptical species distinguished by its small size and distinctive appearance in polarized light; the pattern formed by the bridge and margin is that of an "S."

Description: The central area is spanned by a very wide bridge making an angle of approximately 45 to 50 degrees with the minor axis of the ellipse. The margin is very narrow and the central area large. This species does not closely resemble any other gephyrocapsid and specimens are approximately of the same size of the central area of *Gephyrocapsa oceanica.*

Remarks: At Site 147, *Gephyrocapsa sinuosa* does not occur above Section 1 of Core 3 and its occurrence from this section through Section 2 of Core 7 (17-18 cm) is very sporadic. It is abundant and occurs in every section from Section 2 of Core 7 (130-131 cm) through Section 4 of Core 15. Below this, its occurrence is sporadic with Section 2 of Core 17 (51-52 cm) having the greatest abundance within this portion of Site 147.

At Site 148, *Gephyrocapsa sinuosa* occurs in nearly every Section from Core 1 through Section 6 of Core 15 (18-19 cm). It is absent below this through Section 3 of Core 23. From Section 4 of Core 23 through Section 5 of Core 27 (25-26 cm), it exhibits a gradual and distinctive increase in abundance and occurrence. From Section 5 of Core 27 (100-101 cm) to the bottom of Site 148 it is absent, with the exception of Section 1 of Core 129.

At Site 149, it does not occur above Section 3 of Core 2, however, commencing with Section 3 of Core 2 (25-26 cm) through Section 2 of Core 6 it is abundant and occurs in every section except Section 5 of Core 5. A marked decrease in abundance occurs in the remaining cores of Site 149 below Section 2 of Core 6.

At Site 154, it is present in abundance in almost every sample from Section 2 of Core 1 (100-101 cm) through Section 4 of Core 8 (99-100 cm).

Gephyrocapsa sp.
(Plate 1, Figures 15-16)

Remarks: Elliptical to circular specimens lacking a bridge in polarized light are assigned to this taxon. The central area and margin are similar in size to those of *Gephyrocapsa oceanica*. Thus it is likely that these specimens are individuals of that species from which the bar has been dissolved.

Genus PSEUDOEMILIANIA Gartner, 1969

Type Species: Ellipsoplacolithus lacunosus Kamptner, 1963

Pseudoemiliania lacunosa (Kamptner)
(Plate 1, Figures 17-20)

Ellipsoplacolithus lacunosus Kamptner, 1963, Ann. Naturhistor, Mus. Wien, vol. 66, p. 172, pl. 9, Fig. 50.
Coccolithus doronicoides Black and Barnes (part), McIntyre, Bé, and Preikstas, 1967, Progress in Oceanography, vol. 4, p. 8, pl. 3, Fig. A.
Umbilicosphaera cricota (Gartner), Cohen and Reinhardt, 1968, vol. 131, 3, p. 296, pl. 19, Fig. 1, pl. 21, Fig. 3 – Nishida, 1970, Jour. Mar. Geol., vol. 6, no. 1, pp. 34-39, pl. 1, Fig. 10, pl. 2, Fig. 10-11.
Pseudoemiliania lacunosa Gartner, 1969, Trans. Gulf Coast Assoc. Geol. Soc., vol. 19, p. 598, pl. 2, Fig. 9-10 – Bandy and Wilcoxon, 1970, Geol. Soc. Am. Bull., vol. 81, pp. 2939-2948 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 456.

Remarks: Gartner (1969) stated that this species is the dominant placolith in late Pliocene and early Pleistocene sediments and described its total range as from middle Pliocene to middle Pleistocene.

Genus EMILIANIA Hay and Mohler, 1961

Type Species: Pontosphaera huxleyi Lohmann, 1902

Emiliania huxleyi (Lohmann)
(Plate 1, Figures 21-22)

Pontosphaera huxleyi Lohmann, 1902 (part), Arch, Protistenk, vol. 1, p. 130, pl. 4, Figs. 1-6, pl. 6, Fig. 69 – Kamptner, 1941, Naturhist. Mus. Wien. Ann., vol. 51, p. 79, pl. 2, Fig. 27, pl. 3, Figs. 29-30, pl. 99.
Coccolithus huxleyi (Lohmann) Kamptner, 1943, Anz. Akad. Wiss. Wien, Math. Naturw. K1., vol. 80, p. 44 – Kamptner, 1952, Microskopie, vol. 7, p. 234, Figs. 7-9 – Kamptner, 1954, Arch. Protistenk., vol. 100, pp. 67-69 – Braarud, 1954, Blyttia, vol. 12, pp. 103-104, pl. 1, Figs. a-c – Kamptner, 1956b, Arch. Protistenk., vol. 101, p. 178, pl. 1, Figs. 1-3 – Black and Barnes, 1961, Jour. Roy. Micr. Soc., vol. 80, p5. 2, pp. 141-152, pls. 20-21 – Black, 1965, Endeavour, vol. 24, no. 93, pl. 2, Fig. 24 – Cohen, 1965, Leidse Geol. Meded., vol. 35, pp. 11-12, pls. 8, 9, 10, 11, Figs. c-e, pl. 12, Figs. a-c – Lecal, 1966, Protistologica, vol. 2, pp. 57-70 – McIntyre and Bé, 1967, Deep Sea Res., vol. 14, pp. 568-569, pl. 5, Fig. D, pl. 6, Figs. A-B, pl. 12, Fig. B – Kamptner, 1967, Ann. Naturhistor. Mus. Wien, vol. 71, p. 125, pl. 3, Figs. 17 and 19 – McIntyre, 1970, 1970, Deep Sea Research, vol. 17, pp. 187-190, Fig. 1a – McIntyre, Bé, and Roche, 1970, Trans. New York Acad. Sciencces, Ser. II, vol. 32, no. 6, pp. 720-731.
Emiliania huxleyi (Lohmann) Hay and Mohler, 1967, Gulf Coast Assoc. Geol. Soc. Trans., vol. 17, p. 447, pls. 10, 11, Figs. 1, 2 – Gartner, 1969, Trans. Gulf Coast Assoc. Geol. Soc., vol. 19, p. 593, pl. 2, Fig. 5 – Kennett and Geitzenauer, 1969, Nature, vol. 224, no. 5222, pp. 899-901 – Geitzenauer, 1969, Nature, vol. 223, no. 5202, pp. 170-172 – Boudreaux and Hay, 1969, Rev. Esp. Micropal. vol. 1, núm. 3, p. 262, pl. 2, Figs. 10-12 – Nishida, 1970, Jour. Mar. Geol., vol. 6, no. 1, p. 35 – Nishida, 1970, Trans. Proc. Palaeont. Soc. Japan, N. S., no. 79, p. 363, pl. 41, Figs 1-3 – Bartolini, 1970, Micropaleontology, vol. 16, no. 2, p. 136, pl. 4, Figs. 1-8 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 456.

Remarks: This species occurs in tropical subtropical, transitional, subarctic and subantarctic waters (McIntyre and Bé, 1967). It has a temperature range of 6 to 14°C with highest concentrations between 9 and 12°C. It occurs in modern surface sediments that underlie the subpolar water masses in both the Northern and Southern Hemisphere (McIntyre, Bé, and Roche, 1970).

Subfamily CYCLOCCOLITHOIDEAE Hay and Mohler, 1967

Tribe CYCLOCOCCOLITHEAE Boudreaux and Hay, 1969

Genus CYCLOCOCCOLITHINA Wilcoxon, 1970

Type species: Coccosphaera leptopora Murray and Blackman, 1898

Cyclococcolithina leptopora (Murray and Blackman)
(Plate 1, Figures 23-24)

Coccosphaera leptopora Murray and Blackman, 1898, Roy. Soc. London, Phil. Trans., vol. 190, ser. B, p. 430, pl. 15, Figs. 1-7.
Coccolithophora leptopora (Murray and Blackman) Lohmann, 1902, Arch. Protistenk., vol. 1, p. 138, pl. 5, Figs. 52, 61-64.
Coccolithus leptoporus (Murray and Blackman) Schiller, 1930, in L. Rabenhorst: Kryptogamen-Flora, vol. 10, p. 245, text-Fig. 10 – Kamptner, 1941, Naturhist. Mus. Wien, Ann., vol. 51, p. 94, pl. 13, Figs. 137-139 – Deflandre, 1952, in P. Grasse: Traité de Zoologie, vol. 1, pt. 1, text-Fig. 343 – Gardet, 1955, Publ. Serv. Carte Géol. Algerie, n. ser., Bull. 5, p. 513, pl. 6, Fig. 50 – Black and Barnes, 1961, Roy, Micro. Soc. Jour., vol. 80, pt. 2, p. 143, pl. 24, Figs. 3-4.
Calcidiscus quadriforatus Kamptner, 1950 Oesterr. Akad. Wiss., Math. Naturw. Kl., Anz., vol. 87, pp. 153-155 – Kamptner, 1952, Mikroskopie, vol. 7, p. 236, Fig. 11 – Kamptner, 1952, Mikroskopie, vol. 7. p. 391, Figs. 20 a-b – Kamptner, 1954, Arch. Protistenk., vol. 100, pp. 33-34, Figs. 35-37 – Kamptner, 1958, Arch. Protistenk., vol. 103, p. 81 – Kamptner, 1963, Naturhist. Mus. Wien, Ann., vol. 66, p. 147 – Hay, 1967, Taxon, vol. 16, pp. 240-242.
Calcidiscus medusoides Kamptner, 1950, Oesterr. Akad. Wiss., Math-Naturw. Kl., Anz., vol. 87, pp. 153, 155 – Kamptner, 1954, Arch. Protistenk., vol. 100, p. 26, Figs. 24-34 – Martini and Bramlette, 1963, Jour. Paleont., vol. 37, p. 849, pl. 102, Figs. 1-2, 37, p. 849, pl. 102, Figs. 1-2 – Hay, 1967, Taxon, vol. 16, pp. 240-242.
Cyclococcolithus leptoporus (Murray and Blackman) Kamptner, 1954, Arch. Protistenk., vol. 100, p. 23, Fig. 20 – Deflandre, 1954, Ann. Paléont., vol. 40, pp. 150-151, text-fig. 76, pl. 9, Figs. 103 – Martini and Bramlette, 1963, Jour. Paleont., vol. 37, p. 850, pl. 102, Figs. 4-5 – Cohen, 1964, Micropaleontology, vol. 10, p. 237, pl. 1, Fig. 6 a-e, pl. 2, Fig. 4 a-b – Cohen, 1965, Leidse Geol. Meded., vol. 35, pp. 25-26, pl. 17, Figs. h-i, pl. 18, Figs. a-3, pl. 19, Figs. a-b, pl. 20, Figs. a-b – Hay, 1967, Taxon, vol. 16, pp. 240-242 – McIntyre and Bé, 1967, Deep Sea Res., vol. 14, p. 569, pl. 7, Figs. A-C – Hay et al., 1967, Gulf Coast Assoc. Geol. Socs., Trans., vol. 17, pls. 10-11, Fig. 3 – Bramlette and Wilcoxon, 1967, Tulane Stud. Geol., vol. 5, p. 103, pl. 3, Figs. 9-12 – Gartner, 1967, Univ. Kansas Paleont. Contrib. Paper 28, pp. 1-4, pl. 1, Figs. 1-4, pl. 2, Figs. 1-4 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, pp. 263-264, pl. II, Figs. 13-14, pl. 3, Figs. 1-6 – Nishida, 1969, Bull. Nara Uni. Education, vol. 18, no. 2, pp. 88-90, pl. 1, Figs. 4-5 – Gartner, 1969, Trans. Gulf Coast Geol. Socs., vol. 19, pp. 587-591 – Nishida, 1970, Jour. Mar. Geol., vol. 6, no. 1, pp. 34-39, pl. 1, Figs. 1-2 – McIntyre, Bé, Roche, 1970, Trans. New York Acad. Sciences, ser. II, vol. 32, no. 6, pp. 720-731, Fig. 5a – Nishida, 1970, Trans. Proc. Palaeont. Soc. Japan, N. S., no. 79, pp. 360-361, pl. 39, Figs. 1-3 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 457 – Bartolini, 1970, Micropaleontology, vol. 16, no. 2, pp. 134-135, pl. 2, Figs. 1, 4-10, text-Fig. 7 – Uschakova, 1970, in Funnell and Riedel (Eds.): The Micropaleontology of Oceans, pp. 245-251, pl. 15.1.1, 3 – Sachs, 1970, Ph.D. dissertation, Tulane Uni., pp. 66-69, pl. 2, Figs. 11-17, pl. 3, Figs. 1-9 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, pp. 965-1004, pl. 1, Fig. 3.
Tiarolithus medusoides (Kamptner) Kamptner, 1958, Arch. Protistenk., vol. 103, pp. 81, 85 – Kamptner, 1963, Naturhist. Mus. Wien, Ann., vol. 71, pp. 160, 178, pl. 23, Figs. 115, 124.

Calcidiscus uniforatus Kamptner, 1963, Naturhist. Mus. Wien, Ann., vol. 66, pp. 147-148, text-Fig. 2, pl. 2, Fig. 17.
Tiarolithus diversistriatus Kamptner, 1963, Naturhist. Mus. Wien, Ann., vol. 66, pp. 180-181, text-Fig. 28, pl. 2, Fig. 13, pl. 4, Fig. 27.
Tiarolithus pacificus Kamptner, 1963, Naturhist. Mus. Wien, Ann., vol. 66, p. 182, text-Fig. 30.
Tiarolithus rectilineatus Kamptner, 1963, Naturhis. Mus. Wien, Ann., vol. 66, pp. 182-183, text-Fig. 31, pl. 2, Fig. 11 – Kamptner, 1967, Naturhist. Mus. Wien, Ann., vol. 71, p. 160, pl. 23, Fig. 117.
Cycloplacolithus foliosus Kamptner, 1963, Naturhist. Mus. Wien, Ann., vol. 66, pp. 167-168, pl. 7, Fig. 38.
Cycloplacolithus sejunctus Kamptner, 1963, Naturhist. Mus. Wien, Ann., vol. 66, pp. 169-170, pl. 8, Fig. 43.
Cycloplacolithus laevigatus Kamptner, 1963, Naturhist. Mus. Wien, Ann., vol. 66, pp. 168-169, pl. 9, Figs. 47-49.
Cyclococcolithus atrematus Kamptner, 1967, Naturhist. Mus. Wien, Ann., vol. 71, p. 128, pl. 3, Figs. 22-23.
Cycloplacolithus renalis Kamptner, 1967, Naturhist. Mus. Wien, Ann., vol. 71, p. 130, pl. 4, Fig. 26.
Cyclococcolithus leptoporus (Murray and Blackman) Kamptner var. A. McIntyre et al., 1957, in M. Sears (Ed.), Progress in Oceanography, vol. 4, pp. 9-10, pl. 4, Figs. C-D.
Cycloccolithus leptoporus (Murray and Blackman) Kamptner var. B. McIntyre et al., 1967 in M. Sears (Ed.), Progress in Oceanography, vol. 4, p. 10, pl. 5, Fig. A.
Cyclococcolithus leptoporus (Murray and Blackman) Kamptner var. C. McIntyre et al., 1967, in M. Sears (Ed.), Progress in Oceanography, vol. 4, pp. 10-11, pl. 5, Figs. C-D.
Cyclococcolithina leptopora (Murray and Blackman) Wilcoxon, 1970, Tulane Stud. Geol., vol. 8, pp. 82-83

Remarks: This species is widely distributed in Neogene sediments. It is known to be living in all major oceans and seas. It is eurythermal and ranges from the equator to the arctic (McIntyre and Bé, 1967).

Tribe UMBILICOSPHAEREAE Boudreaux and Hay, 1969

Genus UMBILICOSPHAERA Lohmann, 1902

Type Species: Umbilicosphaera mirabilis Lohmann, 1902

Umbilicosphaera mirabilis Lohmann
(Plate 1, Figures 25-26)

Umbilicosphaera mirabilis Lohmann, 1902, Arch. Protistenk., vol. 1, p. 139, pl. 5, Figs. 66, 66a – Black and Barnes, 1961, Roy. Micr. Soc. Jour., vol. 80, p. 5. 2, pp. 140-141, pl. 25, Figs. 4-5 – McIntyre and Bé, 1967, Deep Sea Rs., vol. 14, pp. 471-572, pl. 11, Figs. B-C, pl. 12, Fig. A – McIntyre et al., 1961, in M. Sears (Ed.): Progress in Oceanography, vol. 4, p. 13, pl. 2, Figs. C-D – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, pp. 264-265, pl. 3, Figs. 7-15 – McIntyre, 1969, in Degens and Ross (Eds.): Hot Brines and Recent Heavy Metal Deposits in the Red Sea, pp. 299-305 – Geitzenauer, 1969, Nature, vol. 223, no. 5202, pp. 170-172 – Gartner, 1959, Trans. Gulf Coast Asso. Geol. Socs., vol. 19, pp. 585-599 – Uschakova, 1970, in Funnel and Riedel (Eds.): The Micropaleontology of Oceans, pp. 245-251 – Nishida, 1970, Jour. Mar. Geol., vol. 6, no. 1, pp. 34-39 – Nishida, 1970, Trans. Proc. Paleont. Soc. Japan, N. S., no. 79, pp. 365-366, pl. 39, Figs. 8-11 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 457 – Bartolini, 1970, Micropaleontology, vol. 16, no. 2, pp. 146 and 148, pl. 8, Figs. 4-9 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, pp. 965-1004, pl. 2, Fig. 6.
Cyclococcolithus mirabilis (Lohmann) Kamptner, 1954, Arch. Protistenk., vol. 100, p. 24, test-Figs. 21-23 – Cohen, 1964, vol. 10, p. 237, pl. 1, Fig. 4-a-f, pl. 2, Fig. 3-a-f.

Remarks: This species occurs in temperate to subtropical waters and is abundant in both the North and South Atlantic (McIntyre and Bé, 1967). It is found living in the South Pacific (Geitzenauer, 1969) and in Atlantic waters north to the 18°C isotherm (McIntyre, 1967).

Family THORACOSPHAERACEAE Deflandre, 1952

Genus THORACOSPHAERA Kamptner, 1927

Type species: Thoracosphaera pelagica Kamptner, 1927

Thoracosphaera saxea Stradner
(Plate 1, Figures 27-28)

Thoracosphaera sp. Bramlette and Riedel, 1954, Jour. Paleont., vol. 28, p. 393, pl. 38, Fig. 5.
Thorcosphaera saxea Stradner, 1961, Erdoel Zeitschr., vol. 77, p. 84, Fig. 71 – Stradner, 1963, Sixth World Petroleum Congr., Sec. 1, Paper 4, p. 9, pl. 3, Fig. 3 – Stradner, 1963, in K. Gohrbandt: Geol. Ges. Wien. Mitt., vol. 56, p. 78, pl. 10, Fig. 8 – Cohen, 1964, Micropaleontology, vol. 10, p. 248, pl. 5, Fig. 6 a-e, pl. 6, Fig. 6 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, p. 265, plate 4, Figs. 2-5 – Nishida, 1970, Trans. Proc. Palaeont. Soc. Japan, N. S., No. 79, p. 368, pl. 41, Fig. 13.

Remarks: This is a long-ranging species which has been recorded from the Upper Cretaceous of Austria and from Tertiary and recent marine sediments (Cohen, 1964).

At Site 147, *Thoracosphaera saxea* is not abundant and occurs only in several of the sections.

At Site 148, *Thoracosphaera saxea* does not occur above Section 4 of Core 2. Below this, it occurs in nearly every section of every core.

At Site 149, *Thoracosphaera saxea* occurs in almost every Section of Cores 2 through 6. It is not present at Site 154.

Family RHABDOSPHAERACEAE Lemmermann, 1908

Subfamily RHABDOSPHAEROIDEAE Kamptner, 1928, emend. Boudreaux and Hay, 1969

Genus RHABDOSPHAERA Haeckel, 1894

Type Species: Rhabdosphaera clavigera Murray and Blackman, 1908

Rhabdosphaera clavigera Murray and Blackman
(Plate 1, Figures 29-30)

Rhabdosphaera clavigera Murray and Blackman, 1898, Roy. Soc. London, Phil. Trans., vol. 190, ser. B., pp. 438-439, pl. 15, Figs. 13-15 – Cohen, 1964, Micropaleontology, vol. 10, pp. 240, 242, pl. 5, Fig. 2 a-g, pl. 6, Fig. 1 – Cohen, 1965, Leidse Geol. Meded, vol. 35, p. 22, pl. 3, Figs. a-c, pl. 22, Figs. a-b, pl. 23, Fig. 3.
Rhabdosphaera clavigera Murray and Blackman, Kamptner, 1944, Oesterr. Bot. Zeitschr., vol. 93, p. 140 – Hay et al., 1967, Gulf Coast Assoc. Geol. Socs. Trans., vol. 17, pls. 10-11, Fig. 4 – Boudreaux and Hay, 1969. Rev. Esp. Micropal., vol. 1, no. 3, pp. 266 and 269, pl. 4, Figs. 6-10 – Gartner, 1969, Trans. Gulf Coast Asso. Geol. Socs., vol. 19, pp. 585-599 – Geitzenauer, 1969, Nature, vol. 223, no. 5202, pp. 170-172 – Uschakova, 1970, in Funnell and Riedel (Eds.): The Micropaleontology of Oceans, p. 248 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 459 – Bartolini, 1970, Micropaleontology, vol. 16, no. 12, pp. 142-144, pl. 6, Figs. 8-9, pl. 7, Figs. 3-5 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, p. 966, pl. 2, Fig. 4.

Remarks: Cohen (1964) stated that this species has no temperature preference, occurs in the Atlantic, Pacific, and Mediterranean, and probably has world-wide distribution. According to McIntyre (1967), this species is found in subtropical and transitional waters. It also is present in many Caribbean cores (Boudreaux and Hay, 1969).

Rhabdosphaera stylifer (Lohmann)
(Plate 1, Figure 31)

Rhabdosphaera stylifer Lohmann, 1902, Arch. Protistenk., vol. 1, p. 143, pl. 5, Fig. 65 – Kamptner, 1941, Naturhist. Mus. Wien, Ann., vol. 51, p. 15, Figs. 148-149, p. 115 – Halldal and Markali, 1955, Norske Vidensk. Akad., Avh., Math. Naturv. Kl., no. 1, p. 16, pl. 20 – Cohen, 1964, Micropaleontology, vol. 10, pl. 5, Fig. 1, pl. 6, Fig. 2 – Cohen, 1965, Leidse Geol. Meded., vol. 35, pp. 22-23, pl. 3, Figs. d-f, pl. 21, Figs. e-f, pl. 23, Figs. b, c-d.

Rhabdosphaera stylifera Lohmann, Gran, and Braarud, 1935, Jour. Biol. Board Canada, vol. 1, p. 389 – McIntyre and Bé, 1967, Deep Sea Res., vol. 14, p. 567, pl. 4, Figs. A-C – McIntyre, 1969, in Degens and Ross (Eds.): Hot Brines and Recent Heavy Mineral Deposits in the Red Sea, pp. 299-305 – Geitzenauer, 1969, Nature, vol. 223, no. 5202, pp. 170-172 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 459.

Aspidorhabdus stylifer Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, pp. 269-270, pl. 4, Figs. 11-15 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 459.

Remarks: *Rhabdosphaera stylifer* is characteristic of tropical, subtropical, and transitional waters (McIntyre, 1967).

"Discolithus" phaseolus Black and Barnes
(Plate 1, Figure 32)

Discolithus phaseolus Black and Barnes, 1961, Roy, Micr. Soc. Jour., vol. 80, pt. 2, p. 144, pl. 26, Figs. 1-4.

Rhabdosphaera stylifera Lohmann, McIntyre & Bé in part, 1967, Deep Sea Res., vol. 14, p. 567, pl. 4, Fig. a (part).

Remarks: McIntyre and Bé (1967) illustrate coccoliths which correspond to "*Discolithus*" *phaseolus* Black and Barnes on the surface of *Rhabdosphaera stylifer* cells, thus proving that a single organism may produce both discoliths and rhabdoliths. The two coccolith forms are separated here because their occurrences in the sediment do not coincide.

Subfamily DISCOSPHAEROIDEAE Boudreaux and Hay, 1969

Genus DISCOPHAERA Haeckel, 1894

Type species: Discosphaera thomsoni Ostenfeld, 1899

Discosphaera tubifera (Murray and Blackman)
(Plate 2, Figure 29)

Rhabdosphaera tubifera Murray and Blackman, 1898, Roy. Soc. London, Phil., Trans., vol. 190, ser. B, pp. 438-439, pl. 15, Figs. 8-10.

Discosphaera tubifera (Murray and Blackman) Ostenfeld, 1900, Zool. Anz., vol. 22, p. 200 – Lohmann, 1902, Arch. Protistenk., vol. 1, p. 141, pl. 5, Figs. 47-48, 50 – Halldal and Markali, 1955, Norske Vidensk, Akad., Avh., Mat. Naturv. Kl., no. 1, p. 17, pl. 22 – Cohen, 1964, Micropaleontology, vol. 10, p. 242, 244, pl. 5, Fig. 3 a-c, pl. 6, Fig. 3 a-e – Cohen, 1965, Leidse Geol. Meded., vol. 35, p. 24, pl. 3, Figs. g-i, pl. 23, Fig. a.

Discosphaera tubifera (Murray and Blackman) Kamptner, 1944, Oesterr. Bot. Zeitschr, vol. 9, p. 139 – McIntyre and Bé, 1967, Deep Sea Res., vol. 14, p. 566, pl. 1, Figs. A-C – Geitzenauer, 1959, Nature, vol. 223, no. 5202, pp. 170-172 – McIntyre, 1969, in Degens and Ross (Eds.): Hot Brines and Recent Heavy Metal Deposits in the Red Sea, p. 301, Fig. 1 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, p. 270, pl. 4, Fig. 16, pl. 5, Figs. 1-7 – Gartner, 1969, Trans. Gulf Coast Asso. Geol. Socs., vol. 19, p. 591 – Oakda and Honjo, 1970, Pac. Geol., vol. 2, pp. 11-12, pl. 1, Fig. 3.

Remarks: This species occurs in tropical and subtropical waters. It characterizes subtropical water masses and tolerates a temperature range of 14 to 21°C (McIntyre, Bé, and Roche, 1970). It has been found living in the Mediterranean and Atlantic (Cohen, 1964).

Order PODORHABDINALES Rood, Hay, and Barnard, 1971

Suborder SYRACOSPHAERINEAE Boudreaux and Hay, 1969

Family PONTOSPHAERACEAE Lemmermann, 1908

Subfamily PONTOSPHAEROIDEAE Kamptner, 1937

Tribe PONTOSPHAEREAE Hay, 1966

Genus PONTOSPHAERA Lohmann, 1902

Type Species: Pontosphaera syracusana, Lohmann, 1902

Pontosphaera scutellum Kamptner
(Plate 1, Figure 34)

Discolithus scutellum Kamptner, 1950, Anz. Akad. Wiss. Wien, Math, Naturw. Kl., vol. 87, p. 153 (nomen nudum).

Pontosphaera scutellum Kamptner, 1952, Mikroskopie, vol. 7, p. 234, Fig. 1, p. 378, Fig. 17 a-f – Kamptner, 1954, Arch. Protistenk., vol. 100, pp. 12-16, Figs. 1-7 – Kamptner, 1955, Verh. Kon. Nederl. Akad. Wetensch., Afd. Natuurkunde, ser. 2, vol. 50, no. 2, p. 13, pl. 1, Fig. 12 a-b – Cohen, 1965, Leidse Geol. Meded., vol. 35, pp. 18-19, pl. 15, Figs. a-b – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, p. 271, pl. 5, Figs. 9-13 – Hay, 1970, Initial Reports of the Deep Sea Drilling Project, vol. 4, p. 458.

Remarks: This species has been reported alive in the Caribbean, Atlantic, Adriatic, and Mediterranean.

Pontosphaera spp.
(Plate 1, Figure 35)

Remarks: These specimens belong to the genus *Pontosphaera*, but the characters observable using light microscopy do not permit specific identification.

Genus HELICOPONTOSPHAERA Hay and Mohler, 1967

Type species: Helicopontosphaera kamptneri Hay and Mohler, 1967

Helicopontosphaera kamptneri Hay and Mohler
(Plate 1, Figure 33)

Coccolithophora pelagica (Wallich) of Lohmann, 1902 (part), Arch. Protistenk., vol. 1, p. 138, pl. 5, Fig. 58a, c.

Coccolithus pelagicus (Wallich) of Schiller, 1930 (part), in L. Rabenhorst: Kryptogamen-Flora, vol. 10, pt. 2, p. 246.

Coccolithus carteri (Wallich) of Kamptner, 1941, Naturhist. Mus. Wien, Ann., vol. 51, pp. 93, 11, pl. 13, Fig. 136.

Helicosphaera carteri (Wallich) of Kamptner, 1954, Arch. Protistenk., vol. 100, no. 1, p. 21, text-Figs. 17-19 – Deflandre, 1954, Ann. Pal., vol. 40, p. 152, text-Figs. 9-11, 75 – Black and Barnes, 1961, Roy. Micr. Soc., Jour., vol. 80, pt. 2, pp. 139-140, pls. 22-23 – Cohen, 1964, Micropaleontology, vol. 10, pp. 238, 240, pl. 3, Fig. 2 a-f, pl. 4, Fig. 1 a-c – Cohen, 1965, Leidse Geol. Meded., vol. 35, p. 21, pl. 3, Figs. o-q, pl. 17, Figs. a-d – McIntyre and Bé, 1967, Deep Sea Research, vol. 14, p. 571, pl. 11, Fig. A – McIntyre et al., 1967, in M. Sears (Ed.): Progress in Oceanography vol. 4, pp. 12-13, pl. 6, Figs. A-B.

Coccolithus pelagicus forma *diademata* Gardet, 1955, Serv. Carte Géol. Algerie, Publ., n. ser., Bull. 5, p. 511, pl. 5, Figs. 46-47.

Helicopontosphaera kamptneri Hay and Mohler, 1967, Gulf Coast Assoc. Geol. Socs., Trans., vol. 17, p. 448, pls. 10-11, Fig. 5 – Boudreaux and Hay, 1969, Rev. Esp. Micropal. vol. 1, no. 3, p. 272, pl. 6, Figs. 8, 10-15 – Geitzenauer, 1969, Nature, vol. 223, no. 5202, pp. 170-172 – Gartner, 1969, Trans. Gulf Coast Assoc. Geol. Socs., vol. 17, p. 587 – Hay, 1970, Initial Reports of the Deep Sea Drilling Project, vol. 4, p. 458 – Nishida, 1970, Trans. Proc. Palaeont. Soc. Japan, N. S., no. 79, p. 364, pl. 40, Figs. 14-15 – Nishida, 1970, Jour. Mar. Geol. vol. 6, no. 1, p. 35 – Bukry, 1971, Initial Reports of the Deep Sea Drilling Project, vol. 6, p. 966.

Remarks: This widely distributed species occurs in subtropical waters of the North Atlantic (McIntyre, 1967). Its geological range extends from early Pliocene or late Miocene to Recent.

Helicopontosphaera sellii Bukry and Bramlette

Helicopontosphaera sellii Bukry and Bramlette, 1969, Tulane Studies Geol. and Paleont., vol. 7, nos. 3 and 4, pl. 2, Figs. 3-7 – Bukry, 1971, Initial Reports of the Deep Sea Drilling Project, vol. 6, p. 966.

Remarks: This species is widespread in the Upper Miocene and Pliocene of the Atlantic Ocean, Gulf of Mexico, tropical Pacific Ocean, and Italy (Bukry and Bramlette, 1969).

Helicopontosphaera wallichi (Lohmann)
(Plate 1, Figure 36)

Coccolithophora wallichi Lohmann, 1902, Arch. Protistenk., vol. 1, p. 138, pl. 5, Figs. 58 a-b, 59, 60 – Lohmann, 1911, Int. Rev. Ges. Hydrobiol. Hydrograph., vol. 4, Fig. 5 (p. 39) – Lohmann, 1913, Deutsch. Zool. Ges., Verh., vol. 23, p. 146, Fig. 1/4 – Schiller, 1925, Arch. Protistenk., vol. 51, p. 37.

Coccolithus wallichi (Lohmann) Schiller, 1930, in L. Rabenhorst: Kryptogamen-Flora, vol. 10, pp. 274-248, Fig. 124c.

Coccolithus wallichi (Lohmann) Kamptner, 1941, Naturhist. Mus. Wien, Ann., vol. 51, p. 112.
Helicopontosphaera wallichi (Lohmann) Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, p. 272, pl. 6, Fig 9 – Hay, 1969, Initial Reports of the Deep Sea Drilling Project, vol. 4, p. 458.

Genus DISCOLITHINA Loeblich and Tappan, 1963

Type species: Discolithus vigintiforatus Kamptner, 1948

Discolithina cf. macropora (Deflandre)
(Plate 2, Figure 7)

Remarks: Small specimens of *Discolithina* with 6 to 12 holes were not differentiated in this investigation, but are categorized as *Discolithina* cf. *macropora.*

Discolithina spp.
(Plate 2, Figures 8-9)

Remarks: These are specimens belonging to the genus *Discolithina*, but whose observable characters using light microscopy do not permit specific identification.

Subfamily SCYPHOSPHAEROIDEAE Boudreaux and Hay, 1969

Genus SCYPHOSPHAERA Lohmann, 1902

Type species: Scyphosphaera apsteini Lohmann, 1902

Scyphosphaera apsteini Lohmann
(Plate 2, Figure 6)

Scyphosphaera apsteini Lohmann, 1902, Arch. Protistenk., vol. 1, p. 132, pl. 4, Figs. 26-30 – Deflandre, 1942, Bull. Soc. Hist. Nat. Toulouse, vol. 77, p. 130, Figs. 10-15 – Kamptner, 1955, Verh. Kon. Nederl. Akad. Wetensch., Afd. Natuurkunde, 2nd. ser., vol. 50, no. 2, p. 22, Figs. 109-112 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, pp. 274 and 277, pl. 6, Figs. 16-18 – Bukry 1971, Initial Reports Deep Sea Drilling Project, vol. 6, p. 966.

Remarks: The ranges of this species begins in the late Miocene and it is widespread in modern oceans (Boudreaux and Hay, 1969).

Family SYRACOSPHAERACEAE Lemmermann, 1908

Genus SYRACOSPHAERA Lohmann, 1902

Type Species: Syracosphaera pulchra Lohmann, 1902

Syracosphaera histrica Kamptner
(Plate 2, Figure 10)

Syracosphaera histrica Kamptner, 1941, Naturhist. Mus. Wien, Ann., vol. 51, p. 84, pl. 6, Figs. 65-58 – Boudreaux and Hay, 1959, Rev. Esp. Micropal., vol. 1, no. 3, p. 279, pl. 8, Figs. 10-19.
Discolithus histricus (Kamptner) Cohen, 1964, Micropaleontology, vol. 10, p. 236, pl. 1, Fig. 2 a-g, pl. 2, Fig. 1.
Discolithus aff. *histricus* (Kamptner) Cohen, 1965, Leidse Geol. Meded., vol. 35, p. 13, pl. 24, Fig. a.

Remarks: This species occurs in many Caribbean deep-sea cores; it has been reported living in the Adriatic. Cohen (1964) considered it an indicator of cool water.

Syracosphaera jonesi (Cohen) Beaudry & Hay (n. comb.)
(Plate 2, Figures 11 and 12)

Cricolithus jonesi Cohen, 1965, Leidsche Geologische Mededlingen, vol. 35, p. 16, pl. 2, Figs. j, k, pl. 16, Figs. a-c – Cohen and Reinhardt, 1968, N.Jb. Geol. Paleont. Abh., vol. 131, p. 299, pl. 19, Figs. 10, 14, text-Fig. 8 – Sachs, 1970, Ph.D. Dissertation. Tulane Uni., p. 94, pl. 3, Figs. 14-17.

Syracosphaera pulchra Lohmann
(Plate 2, Figures 13-14)

Syracosphaera pulchra Lohmann, 1902, Arch. Protistenk., vol. 1, p. 134, pl. 4, Figs. 33, 36, 35a, 37 – Schiller, 1930, in L. Rabenhorst: Kryptogamen-Flora, vol. 10, pt. 2, pp. 207-208, Figs. 11, 30, 90 a-b – Deflandre and Fert, 1953, C. R. Acad. Sci., vol. 236, Figs. 7 – Deflandre and Fert, 1954, Ann. Pal., vol. 40, Figs. 1, 27, 3, 4 – Halldal and Markali, 1955, Norsek Vidensk, Akad., Avh., Mat. Naturv. Kl., no. 1, pl. 12, pl. 11 – Black and Barnes, 1961, Roy. Micr. Soc., Jour., vol. 80, p. 139, pl. 19, Figs. 1-2 – Cohen, 1965, Leidse Geol. Meded., vol. 35, p. 20, pl. 12, Fig. d, pl. 14, Figs. a-b – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, p. 279, pl. 8, Figs. 1-9 – Geitzenauer, 1969, Nature, vol. 223, no. 5202, pp. 170-172 – Nishida, 1970, Trans. Proc. Palaeont. Soc. Japan, N. S., no. 79, pp. 364-365, pl. 40, Figs. 4-5 – Nishida, 1970, Jour. Mar. Geol. vol. 6, no. 1, p. 35 – Bartolini, 1970, Micropaleontology, vol. 16, no. 2, pp. 144 and 146, pl. 8, Figs. 1-3 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, p. 967.
Syracorhabdus pulchra (Lohmann) Lecal, 1967 Hydrobiol., vol. 24, pp. 315-316, text. Fig. 11, Fig. 15.

Remarks: This species lives in subtropical and transitional Atlantic waters (McIntyre and Bé, 1967) and in the South Pacific (Geitzenauer, 1969). It has been reported in sediments of the Atlantic, Mediterranean, and Caribbean (Boudreaux and Hay, 1969).

Syracosphaera clava n. sp.
(Plate 2, Figures 15-16)

Holotype: UI-H-149/2/3100-101.

Dimension: Holotype: length, 2.8μ; width, 1.0μ.

Type locality: DSDP, Leg 15, Site 149, Core 2, Section 3, (100-101 cm).

Diagnosis: An elliptical species distinguished in polarized light by a bar lying in the major axis of the ellipse.

Description: The coccolith is elongate elliptical, the central area is large. The bar and margin are narrow; the width of the bar approximately equals the width of the margin. The margin is almost ogival in the major axis of the ellipse. This species is smaller than *Syracosphaera histrica*.

Remarks: At Site 147, *Syracosphaera clava* occurs in approximately one-half of the sections. Marked intervals of absence occur from Section 2 of Core 2 through Section 4 of Core 2 (108-109 cm), from Section 1 of Core 3 (95-96 cm) through Section 1 of Core 4 (51-52 cm), in Section 5 of Core 6, from Sections 3 through 5 of Core 7, from Section 6 of Core 7 (73-74 cm) through Section 2 of Core 8 (28-29 cm), in Section 3 of Core 8, in Section 4 of Core 9, in Section 4 of Core 11, from Section 4 of Core 12 through Section 5 of Core 12 (71-72 cm), from Section 2 of Core 13 through Section 4 of 14, from Section 5 of Core 14 (100-101 cm) through Section 2 of Core 15 (90-91 cm), from Section 2 of Core 16 through Section 4 of Core 16 (30-31 cm), from Section 2 of Core 17 through Section 5 of Core 17 (30-31 cm), from Section 1 through Section 2 of Core 18, and from Section 5 through Section 6 of Core 18.

At Site 148, *Syracosphaera clava* consistently occurs from the top of Core 1 through Section 4 of Core 2. Occurrence below this is very sporadic and *S. clava* does not occur below Section 4 of Core 13 (40-41 cm).

At Site 149, *Syracosphaera clava* occurs in Sections 1 through 6 of Core 2 and Section 5 of Core 5. It is abundant in Section 1 of Core 2 (25-26 cm), Section 3 of Core 2 (25-26 cm) through Section 4 of Core 2 (25-26 cm), and Section 5 of Core 5.

Syracosphaera clava is rare at Site 154 and occurs in only a few samples.

Syracosphaera decussata n. sp.
(Plate 2, Figures 17-18)

Holotype: UI-H-149/2/3/100-101.

Dimension: Holotype: length, 3.0μ; width, 2.0μ.

Type locality: DSDP, Leg 15, Site 149, Core 2, Section 3, (100-101 cm).

Diagnosis: An elliptical species distinguished in polarized light by a "cross-like" pattern in the central area.

Description: This coccolith is elliptical with a large central area. The long and short segments of the "cross-like" pattern are narrow and lie in the major and minor axes of the ellipse, respectively. The margin of this species is wide and radially striated. This species is smaller than *Syracosphaera histrica*.

Remarks: At Site 147, *Syracosphaera decussata* occurs sporadically from the top of Core 1 through Section 1 of Core 6. Below this, it occurs in every section of every core with a pronounced increase in abundance occurring in Section 2 of Core 10 (33-34 cm), Section 1 of Core 11 (31-32 cm) through Section 2 of Core 11 (31-32 cm) and Section 5 of Core 12 (83-84 cm) through Section 6 of Core 12 (20-21 cm).

At Site 148, *Syracosphaera decussata* occurs in every section of every core except for Section 3 of Core 2, Section 5 of Core 12, Section 1 of Core 14, Section 1 of Core 24, Section 1 of Core 26, Section 4 of Core 27, Section 1 of Core 28, and Section 1 of Core 29. It exhibits an interval of increased abundance from Section 4 of Core 11 (20-21 cm) through Section 4 of Core 11 (90-91 cm).

At Site 149, *Syracosphaera decussata* is very abundant and occurs in every section of Cores 2 through 6. Marked increases in abundance occurs in Section 3 of Core 2 (100-101 cm) and Section 5 of Core 6.

At Site 154, *Syracosphaera decussata* is generally rare, but does occur continuously in the lower part of Core 1 and upper part of Core 2 from Hole 154A.

Syracosphaera sp.
(Plate 2, Figures 19-20)

Remarks: A number of specimens appear to belong to the genus *Syracosphaera*, but the character observable using polarized light do not permit specific identification.

Order EIFFELLITHALES Rood, Hay, and Barnard, 1971

Family CALCIOSOLENIACEAE Kamptner, 1937

Genus SCAPHOLITHUS Deflandre, 1954

Type species: Scapholithus fossilis Deflandre, 1954

Scapholithus fossilis Deflandre
(Plate 2, Figures 25-26)

Scapholithus fossilis Deflandre, 1954, Ann. Pal., vol. 40, p. 165, pl. 8, Fig. 12, 16, 17 – Cohen, 1964, Micropaleontology, vol. 10, no. 2, p. 244, pl. 3, Fig. 4 a-f, pl. 4, Fig. 2 a-c – Cohen, 1965, Leidse Geol. Meded., vol. 35, pp. 24-25, pl. 3, Figs. j-l, pl. 25, Figs. a-d – Cohen and Reinhardt, 1968, N.Jb. Geol. Palaeont. Abh., vol. 131, p. 293, pl. 19, Fig. 11, 15, pl. 20, Fig. 2 – Nishida, 1970, Trans. Proc. Palaeont. Soc. Japan. N. S., no. 79, p. 367, pl. 41, Figs. 9-10 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 459.

Remarks: This taxon includes isolated calceosolenid coccoliths not otherwise identifiable. Living representatives of this group are classified on the basis of cell shape and presence and location of spines. None of these criteria, however, are available in the fossils.

Family BRAARUDOSPHAERACEAE Deflandre, 1947

Genus BRAARUDOSPHAERA Deflandre, 1947

Type Species: Pontosphaera bigelowi Gran and Braarud, 1935

Braarudosphaera bigelowi (Gran and Braarud)
(Plate 2, Figure 5)

Pontosphaera bigelowi Gran and Braarud, 1935, Jour. Biol. Board Canada, vol. 1, p. 389, Fig. 67.

Braarudosphaera bigelowi (Gran and Braarud) Deflandre, 1947, C. R. Acad. Sci., vol. 225, p. 439, Figs. 1-5 – Deflandre, 1954, Ann. Pal., vol. 40, pp. 164-166, pl. 10, Figs. 8-13, pl. 13, Figs. 7-9 – Bramlette and Riedel, 1954, Jour. Paleont., vol. 28, pp. 393-394, pl. 38, Fig. 6 a-b. Gaarder, 1954, Rept. Sci. Results "Michael Sars" North Atlantic Deep Sea Exped. 1910, vol. 2, no. 4, pp. 5-6, Fig. 2 – Martini, 1958, Senck. Leth., vol. 39, p. 355, pl. 2, Fig. 6 a-b – Bramlette and Sullivan, 1961 Micropaleontology, vol. 7, p. 153, pl. 8, Figs. 1a-b, 2-5 – Hay and Towe, 1962, Science, vol. 137, p. 426, Fig. 1. Cohen, 1965, Leidse Geol. Meded., vol. 35, p. 31, pl. 6, Figs. a-d – Martini, 1967, N.Jb. Geol. Palaeont., vol. 10, pp. 598-600, Fig. 1a-b – Boudreaux and Hay, 1969, Rev. Esp. Micropal. vol. 1, no. 3, p. 281, pl. 8, Figs. 21-23 – Bartolini, 1970, Micropaleontology, vol. 16, no. 2, p. 152, pl. 1, Fig. 1.

Family DISCOASTERACEAE Tan Sin Hok, 1927

Genus DISCOASTER Tan Sin Hok, 1927

Type species: Discoaster pentaradiatus Tan Sin Hok, 1927

Discoaster brouweri rutellus Gartner
(Plate 2, Figure 4)

Discoaster brouweri rutellus Gartner, 1967, Univ. Kansas Paleont. Contr., Paper 28, p. 2, pl. 1, Figs. 1-2 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 461.

Remarks: This species appeared during the Middle Miocene; its extinction is widely used to mark the Pliocene-Pleistocene boundary.

A few scattered reworked specimens occur in Pleistocene samples.

Discoaster pentaradiatus Tan Sin Hok
(Plate 2, Figure 3)

Discoaster pentaradiatus var. Tan Sin Hok, 1927, Jaarb., Mijnw. Nederl. – Indie, vol. 55, p. 120, Fig. 14 – Tan Sin Hok, 1927, Proc. Sect. Sc. Kon. Akad. Wetensch. Amsterdam, vol. 30, p. 416, Fig. 14.

Discoaster pentaradiatus Tan Sin Hok Bramlette and Riedel, 1954, Jour. Paleont., vol. 28, pp. 401-402, pl. 39, Fig. 11, text Figs. 2 a-b – Martini and Bramlette, 1963, Jour. Paleont., vol. 37, p. 853, pl. 105, Fig. 5 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, p. 282, pl. 9, Figs. 1-3, 13 – Kenneth and Geitzenauer, 1969, Nature, vol. 224, no. 5222, pp. 899-901 – Gartner, 1969, Trans. Gulf Coast Assoc. Geol. Socs., vol. 19, p. 587 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 461 – Bukry, 1971, Micropaleontology, vol. 17, no. 1, pp. 46, pl. 1, Fig. 5 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, p. 966.

Remarks: This species appeared in late Miocene and became extinct during late Pliocene (Boudreaux and Hay, 1969).

A few reworked specimens have been seen in Pleistocene samples.

Discoaster surculus Martini and Bramlette
(Plate 2, Figure 2)

Discoaster surculus Martini and Bramlette, 1963, Jour. Paleont., vol. 37, p. 854, pl. 104, Figs. 10-12 – Hay et al., 1967, Gulf Coast Assoc. Geol. Socs. Trans., vol. 17, pl. 5, Fig. 6 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, pp. 285-286, pl. 9, Fig. 10 – Kenneth and Geitzenauer, 1969, Nature, no. 224, no. 5222, pp. 899-901 – Gartner, 1969. Trans. Gulf Coast Asso. Geol. Socs., vol. 19, p. 589 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 461.

Remarks: This species appeared in the Late Miocene and became extinct in the late Pliocene.

Reworked specimens occur rarely in Pleistocene samples.

Family CERATOLITHACEAE Norris, 1965

Genus CERATOLITHUS Kamptner, 1950

Type Species: Ceratolithus cristatus Kamptner, 1954

Ceratolithus cristatus Kamptner
(Plate 2, Figure 1)

Ceratolithus cristatus Kamptner, 1954, Arch. Protistenk., vol. 100, p. 43, Figs. 44-45 – Cohen, 1964, Micropaleontology, vol. 10, p. 244, 246, pl. 5, Figs. 5 a-d, pl. 6, Fig. 5 – Cohen, 1965, Leidse Geol. Meded., vol. 35, p. 36, pl. 3, Figs. m, n – Norris, 1965, Arch. Protistenk., vol. 108, pp. 19-21, pl. 11, Figs. 1-4, pl. 12, Figs. 1-4 – Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, nd. 3, pl. 10, Figs. 16-19 – Gartner, 1969, Trans. Gulf Coast Asso. Geol. Socs., vol. 19, p. 590 – Hay, 1970, Initial Reports Deep Sea Drilling Project, vol. 4, p. 459 – Bukry, 1971, Initial Reports Deep Sea Drilling Project, vol. 6, p. 965.

Remarks: This species, originally described as a fossil, is still living (Norris, 1965) and has been found in samples from all ocean floors (Bukry and Bramlette, 1968).

INCERTAE SEDIS

Genus ELLIPSODISCOASTER Boudreaux and Hay

Type species: Ellipsodiscoaster lidzi Boudreaux and Hay, 1969

Ellipsodiscoaster lidzi Boudreaux and Hay
(Plate 2, Figures 27-28)

Ellipsodiscoaster lidzi Boudreaux and Hay, 1969, Rev. Esp. Micropal., vol. 1, no. 3, p. 288, pl. 10, Figs. 4-15.

UNIDENTIFIED OBJECTS

Little "u"
(Plate 2, Figure 21)

Remarks: These "u" shaped objects occur in approximately one-half of the sections at Site 147. These objects increase markedly in abundance in Section 3 of Core 8 (114-115 cm).

At Site 148, these "u" shaped objects occur sporadically throughout all of the cores.

At Site 149, these "u" shaped objects occur only in Sections 1 and 2 of Core 2.

At Site 154, these objects are very rare.

"Truncate-elongate coccolith"
(Plate 2, Figure 22)

Remarks: At Site 147, this "truncate-elongate coccolith" occurs only in Section 4 of Core 12 (41-42 cm). At Site 148, it occurs only in Section 2 of Core 1 (52-53 cm) and Section 6 of Core 6 (50-51 cm). This coccolith was not found at Sites 149 or 154.

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PLATE 1

Figures 1-3	*Coccolithus pelagicus* (Wallich). (1) phase contrast 4000X; (2) crossed polarizers 4000X; (3) phase contrast 4000X.
Figures 4-5	*Gephyrocapsa californiensis* Kamptner. (4) crossed polarizers 4000X; (5) crossed polarizers 4000X.
Figures 6-7	*Gephyrocapsa oceanica* Kamptner. (6) crossed polarizers 4000X.
Figures 8-9	*Gephyrocapsa kamptneri* Deflandre & Fert. (8) crossed polarizers 4000X; (9) crossed polarizers 4000X.
Figures 10-12	*Gephyrocapsa parallela* n. sp. (10) crossed polarizers 4000X; (11) crossed polarizers 4000X; (12) crossed polarizers 4000X.
Figures 13-14	*Gephyrocapsa sinuosa* n. sp. (13) crossed polarizers; (14) crossed polarizers 4000X.
Figures 15-16	*Gephyrocapsa sp.* (15) crossed polarizers 4000X; (16) crossed polarizers 4000X.
Figures 17-20	*Pseudoemiliana lacunosa* (Kamptner). (17) crossed polarizers 4000X; (18) crossed polarizers 4000X. (19) crossed polarizers 4000X; (20) crossed polarizers 4000X.
Figures 21-22	*Emiliania huxleyi* (Lohmann). (21) crossed polarizers 4000X; (22) crossed polarizers 4000X.
Figures 23-24	*Cyclococcolithina leptopora* (Murray & Blackman). (23) crossed polarizers 4000X; (24) crossed polarizers 4000X.
Figures 25-26	*Umbilicosphaera mirabilis* (Lohmann. 25) crossed polarizers 4000X; (26) crossed polarizers 4000X.
Figures 27-28	*Thoracosphaera saxea* Stradner. (27) crossed polarizers 4000X; (28) crossed polarizers 4000X.
Figures 29-30	*Rhabdosphaera clavigera* Murray & Blackman. (29) crossed polarizers 4000X; (30) crossed polarizers 4000X.
Figure 31	*Rhabdosphaera stylifer* (Lohman). crossed polarizers 4000X.
Figure 32	*"Discolithus" phaseolus* Black & Barnes. crossed polarizers 4000X.
Figure 33	*Helicopontosphaera kamptneri* Hay & Mohler. Crossed polarizers 4000X.
Figure 34	*Pontosphaera scutellum* Kamptner. Crossed polarizers 4000X.
Figure 35	*Pontosphaera sp.* Crossed polarizers 4000X.
Figure 36	*Helicopontosphaera wallichi* (Lohmann). Phase contrast 4000X.

PLATE 1

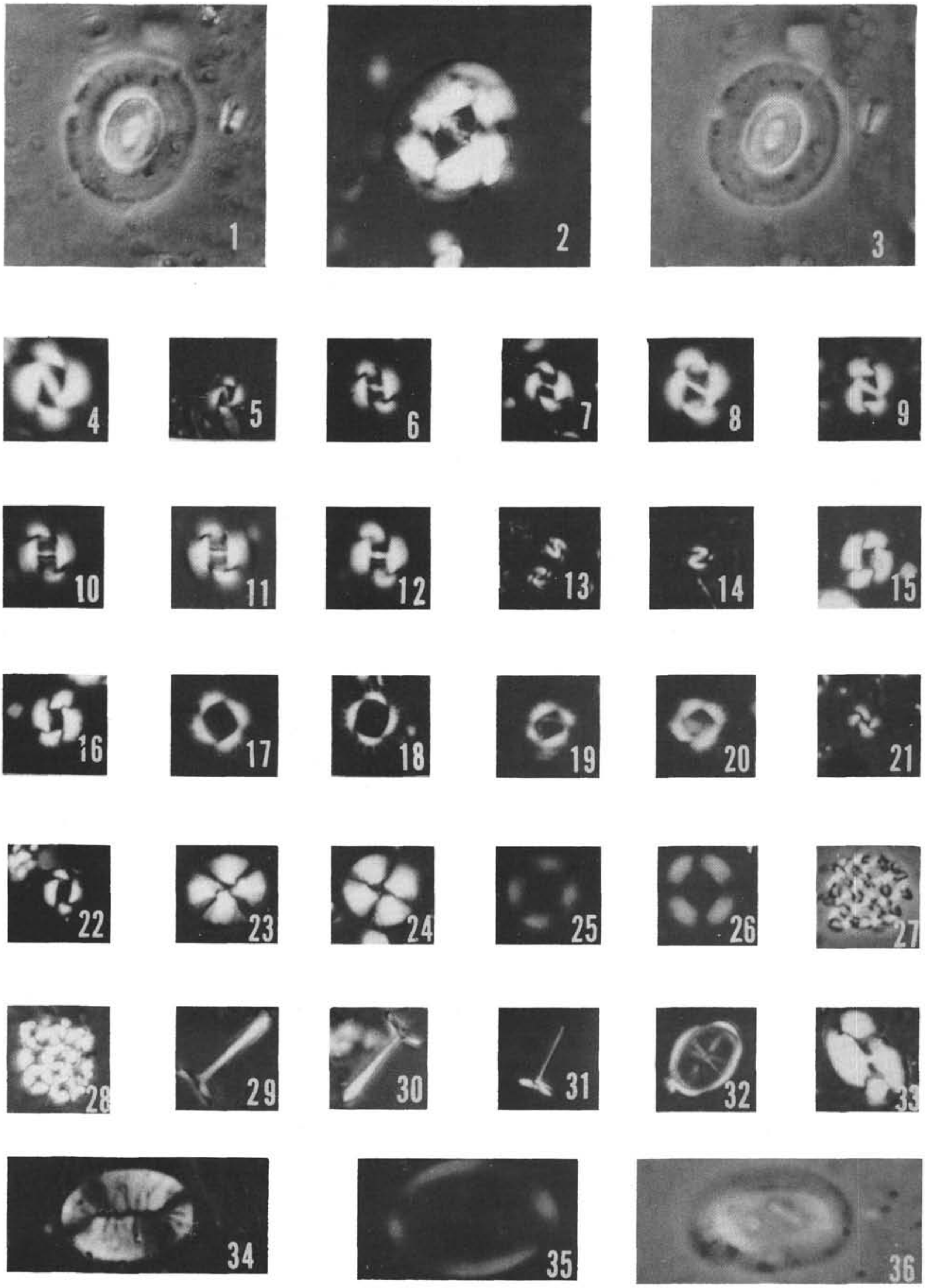
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PLATE 2

Figure 1	*Ceratolithus cristatus* Kamptner. Crossed polarizers 4000X.
Figure 2	*Discoaster surculus* Martini & Bramlette. Phase contrast 4000X.
Figure 3	*Discoaster pentaradiatus* Tan Sin Hok. Phase contrast 4000X.
Figure 4	*Discoaster brouweri rutellus* Gartner. Phase contrast 4000X.
Figure 5	*Braarudosphaera biglowi* (Oran & Braarud). Crossed polarizers 4000X.
Figure 6	*Scyphosphaera apsteini* (Lohmann). Crossed polarizers 4000X.
Figure 7	*Discolithina* cf. *macropora* (Deflandre). Crossed polarizers 4000X.
Figures 8, 9	*Discolithina spp.* Crossed polarizers 4000X.
Figure 10	*Syracosphaera histrica* Kamptner. Crossed polarizers 4000X.
Figures 11-12	(11) Crossed polarizers 4000X; (12) Crossed polarizers 4000X.
Figures 13-14	*Syracosphaera pulchra* Lohmann. (13) Crossed polarizers 4000X; (14) Crossed polarizers 4000X.
Figures 15-16	*Syracosphaera clava* n. sp. (15) Crossed polarizers 4000X; (16) Crossed polarizers 4000X.
Figures 17-18	*Syracosphaera decussata* n. sp. (17) Crossed polarizers 4000X; (18) Crossed polarizers 4000X.
Figures 19-20	*Syracosphaera* sp. (19) Crossed polarizers 4000X; (20) Crossed polarizers 4000X.
Figure 21	Little "u". Crossed polarizers 4000X.
Figure 22	"Truncate-elongate coccolith". Crossed polarizers 4000X.
Figures 23-24	*Sphenolithus abies* Deflandre. (23) Crossed polarizers 4000X; (24) Crossed polarizers 4000X.
Figures 25-26	*Scapholithus fossilis* Deflandre. (25) Phase contrast 4000X; (26) Crossed polarizers 4000X.
Figures 27-28	*Ellipsodiscoaster tidzi* Boudreaux & Hay. (27) Crossed polarizers 4000X; (28) Crossed polarizers 4000X.
Figure 29	*Discosphaera tubifera* (Murray & Blackman). Phase contrast 4000X.

PLATE 2