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36. CENOZOIC CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY ON THE EXMOUTH PLATEAU, EASTERN INDIAN OCEAN[1]

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ABSTRACT

Six sites (759–764) were drilled on the Exmouth Plateau during Ocean Drilling Program Leg 122. Nannofossil-rich Cenozoic sediments were recovered at all six sites, reflecting the open-ocean conditions that prevailed over the Exmouth Plateau during the Cenozoic. Calcareous nannofossils are abundant, diverse (250 different species identified), and generally well preserved throughout the composite lower Paleocene to Quaternary section. The diversity and preservation of nannofossils permits a high degree of stratigraphic resolution at each site. Site 762 on the central part of the Exmouth Plateau contains an almost unbroken Cenozoic record (only Miocene Zones NN3, NN8, and NN10 are missing). This site may prove to be a useful Cenozoic biostratigraphic and biomagnetochronologic reference section for the eastern Indian Ocean.

INTRODUCTION

The Exmouth Plateau is a rifted and subsided fragment of continental crust lying off the coast of northwestern Australia (Fig. 1). The relatively thin cover of post-rift sediments over this plateau makes it an ideal location for study of the evolution of the plateau by drilling through the overburden to pre-rift rocks. The Exmouth Plateau has, moreover, consistently remained elevated above the calcite compensation depth during its post-rift history, a circumstance favorable for preservation of the carbonate record.

Six sites (759–764) were drilled on the Exmouth Plateau during Leg 122 of the Ocean Drilling Program (ODP). Two of the sites (762 and 763) are located on the central Exmouth Plateau; the remaining four are on a northern marginal horst named the Wombat Plateau (Fig. 1). Sedimentology, lithostratigraphy, and other details of these sites are described in detail in the Leg 122 *Initial Reports* (Haq, von Rad, O'Connell, et al., 1990).

Results of the Exmouth Plateau drilling have provided a much clearer understanding of the evolutionary development of this part of the Indian Ocean from the time of initial rifting (Triassic), through breakup and separation (Late Jurassic–Neocomian) and the development of a juvenile ocean (Aptian-Coniacian), to the establishment of mature ocean conditions (post-Coniacian).

Integrated geologic studies on the plateau rely on a refined stratigraphic framework for placing events in an accurate chronostratigraphic context. The purpose of this paper is to document the biostratigraphy of the major portion of the mature ocean phase, the Cenozoic, using calcareous nannofossils.

BIOSTRATIGRAPHY

Smear slides of core samples were examined using a light microscope. The appendix lists the calcareous nannofossil species found in the Cenozoic sediments on the Exmouth and Wombat plateaus.

Nannofossils are abundant in almost all Cenozoic samples examined and preservation ranges from moderately well preserved to very well preserved. Where range charts are given in the following sections, the relative abundances of individual species are indicated as follows: A = abundant, more than 10 specimens of a single species per field of view at a magnification of 1000×; C = common, 1 to 10 specimens per field of view; F = few, one specimen per 2–10 fields; R = rare, one specimen per 11–100 fields; and V = very rare, one specimen per 101–1000 fields (Tables 1–5).

Selected species (mostly those used in the biomagnetochronologic assessment) are illustrated in Plates 1–5. Smear slides and photographic negatives of these species are stored in the Micropaleontology Collection, Department of Geology, Vanderbilt University.

TAXONOMIC NOTES

The following notes on taxa are arranged in the general order the taxa are encountered in the cores, from oldest to youngest.

Prinsius spp. A number of small (2–6 μm) species of *Prinsius* occur in Zones NP1 and NP2. Perch-Nielsen (1985) has recognized *P. petalosus, P. dimorphosus, P. tenuiculum, P. africanus,* and *P. martinii*. These small forms could not be resolved with consistency using the light microscope, so all have been included in the range-chart tables under the category "small *Prinsius* spp." *P. bisulcus* is a larger (>6 μm), distinctive form, which is listed separately in the tables.

Zygodiscus bramlettei/Z. herlynii. The distinction between these two species is based on the relative thickness of the coccolith wall and the relative size of the central openings. We found it difficult to make confident assignments to one species or the other, and have elected to combine the two forms into a single category in the range charts.

Ericsonia cava and *Coccolithus pelagicus*. Where both species occur together in the Paleocene, we have used *E. cava* for elliptical forms with a distinctive open central area that is usually about one-third the total width of the specimen. *C. pelagicus* looks somewhat similar at the start of its range, but has a smaller central opening, or contains a structural element in the central opening.

Dictyococcites callidus and *Dictyococcites daviesii*. We could not differentiate these two species using the light

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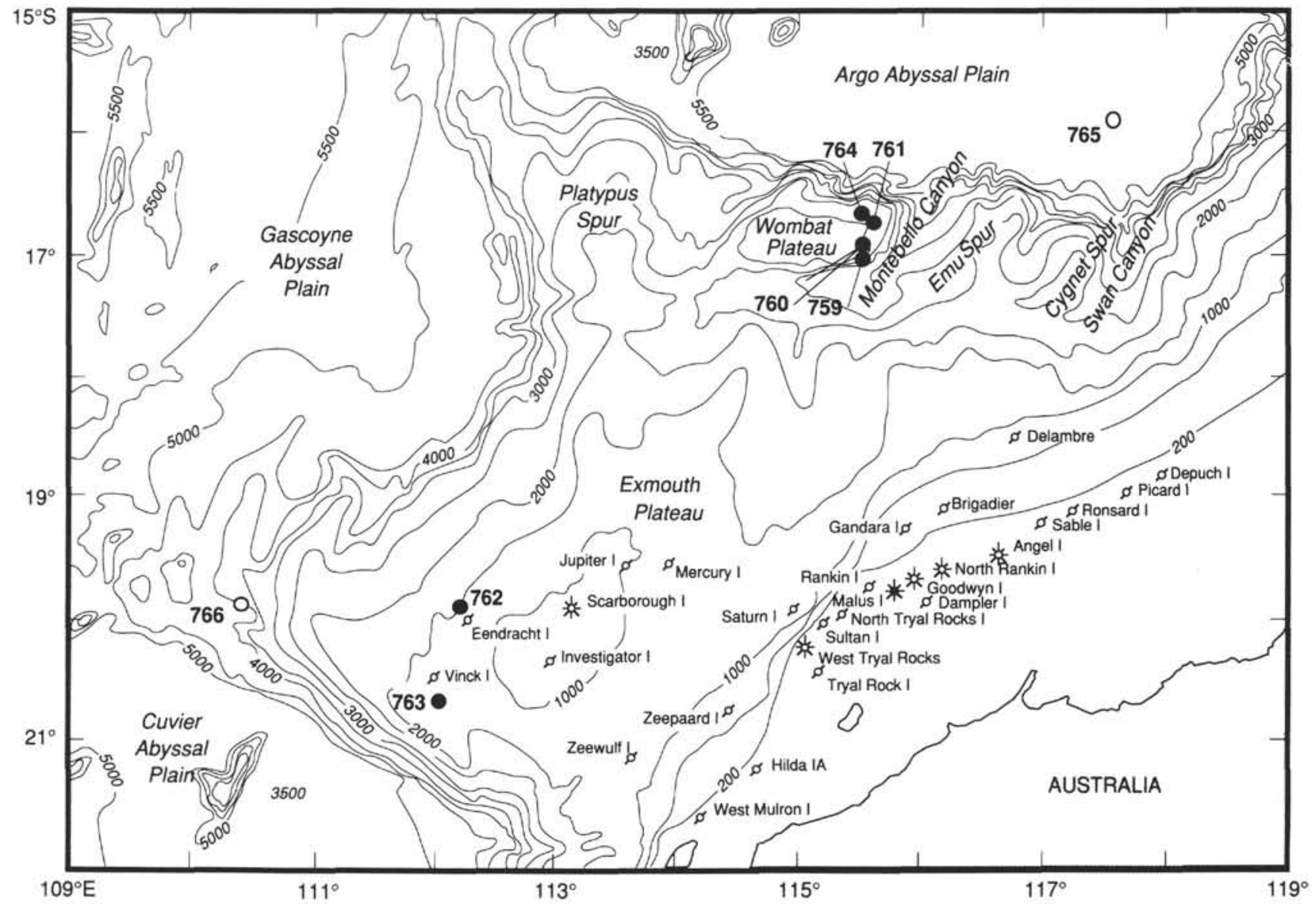

Figure 1. Location map showing Leg 122 drill sites on the central Exmouth Plateau (Sites 762 and 763) and on the Wombat Plateau (Sites 759, 760, 761, and 764). Contours are in meters below sea level. Map is from Haq et al. (1988).

microscope; they are accordingly listed together under *D. callidus* s.l.

Blackites spinosus/B. tenuis. The majority of specimens of these species are found as tapering spines with the heads missing (only an occasional specimen is complete and can be definitely assigned to either *B. spinosus* or *B. tenuis*). All specimens are therefore listed as *Blackites spinosus/B. tenuis* on the range charts.

Chiasmolithus altus. We found some variation in the shape of the central cross in this species in Zones NP22 and NP23. Some specimens have bars that meet at 90° angles (*C. altus* s.s.), but others have a slight curvature of one bar (see Pl. 1, Fig. 4). We believe this is merely intraspecific variation and have recorded both types under *C. altus* s.l. in the range charts.

Discoaster variabilis. Considerable variation exists in the size and angle of ray bifurcations of this species (thus the

Table 1. Calcareous nannofossils in Hole 760A.

Zone	Core, section, interval (cm)	*Coccolithus pelagicus*	*Cyclicargolithus floridanus*	*Thoracosphaera deflandrei*	*Discoaster variabilis* s.l.	*Hayaster perplexus*	*Coronocyclus nitescens*	*Sphenolithus moriformis*	*Thoracosphaera saxea*	*Pontosphaera* sp. B.	*Discoaster kugleri*	*Discoaster exilis*	*Reticulofenestra pseudoumbilica*	*Calcidiscus leptoporus*	*Umbilicosphaera sibogae*	*Helicosphaera carteri*	*Scyphosphaera* spp.	*Sphenolithus abies/S. neoabies*	*Ceratolithus rugosus*	*Catinaster coalitus*	*Catinaster calyculus*	*Discoaster hamatus*	*Discoaster neohamatus*	*Discoaster calcaris*	*Discoaster brouweri*	*Discoaster challengeri*	*Discoaster surculus*	*Discoaster pentaradiatus*	*Discoaster neorectus*	*Discoaster bellus*	*Sphenolithus intercalaris*
	122-760A-																														
NP11	3H-5, 30–32	R	C		F			R		R			C	R		R	R		F				F	R	C		R	R			R
NP10	3H-6, 63–65	R	C		C			R		R			C	R		R	R	R	R			V	F	F	F					R	
NP9	3H-7, 71–72	R	C		F			F				C	C	R		F	R	R	R		F	R	R		F				V		
	3H-CC	R	C		C	R	R	C		R		F	C	R		F	R		R		C	C	F		R	R				R	
NP8	4H-2, 90–92	R	C		C			C	R	R			C	R		F	F		F	F											
	4H-3, 90–92	F	C		C		R	F	R			R	C	F	R	R			F	C									R		
NP7	4H-4, 90–92	F	C	R	C		R	C		R	R		C	F			R		F										R		

Table 2. Calcareous nannofossils in Hole 761B.

Zone	Core, section, interval (cm)	*Markalius astroporus*	*Thoracosphaera operculata*	*Thoracosphaera saxea*	*Thoracosphaera* sp. A.	*Placozygus sigmoides*	*Cruciplacolithus primus*	*Cruciplacolithus edwardsii*	*Cruciplacolithus tenuis*	Small *Prinsius* spp.	*Ericsonia subpertusa*	*Zygodiscus bramlettei/Z. herlynii*	*Prinsius bisulcus*	*Chiasmolithus danicus*	*Neochiastozygus* spp.	*Ericsonia cava*	*Chiasmolithus bidens*	*Coccolithus pelagicus*	*Fasciculithus pileatus*	*Bomolithus elegans*	*Fasciculithus magnicordis*	*Fasciculithus tympaniformis*	*Toweius pertusus*	*Heliolithus kleinpelli*	*Chiasmolithus consuetus*	*Toweius eminens*	*Pontosphaera* sp. A.	*Discoaster mohleri*	*Zygodiscus plectopons*	*Ericsonia robusta*	*Fasciculithus involutus*	*Neochiastozygus chiastus*	*Heliolithus riedelii*	*Discoaster bramlettei*	*Zygrhablithus bijugatus*	*Cruciplacolithus latipons*	*Ellipsolithus distichus*	*Neochiastozygus junctus*	*Discoaster multiradiatus*	*Scapholithus rhombiformis*	*Fasciculithus hayi*
	122-761B-																																								
	16X-1, 134–136									V	V							A		R		A			R	C							V		F				F		R
NP9	16X-2, 134–136			R													R	A				A				C	R								F				R		R
	16X-3, 134–136		R	R					R						R		R	A		F		A				C		R							F				R		R
	16X-4, 134–136			R							R						R	A				C				F	R	R											R		
NP7/8	16X-CC			R					R	R	R	R			F		R	A				C			F	F		R	R	R		R						R		V	
	17X-1, 134–136			R					R	R	R	R					R	C				C		F	F	C	R	R	R												
	17X-2, 134–136			R					R	F	R	R	R				R	C				C		F	R	C					V										
NP6	17X-3, 134–136			R					F	F	R	F	R		R		F	A				C		F	F	C	R			R	R							R			
	17X-4, 100–101			R		R			F	F	R	F	R		F		F	A				C	R	R		C															
	17X-5, 134–136			F		R			F	R	R	F	R				F	A		R		F	R	F		C				R	F										
	17X-6, 134–136			R					F	R	R	F	R				F	A				F				C					F										
	17X-CC			R					F	R	F	F	R		R		F	A				F	F		R	C					C										
	18X-1, 99–101			R					F	F	C	F					C	A		R		F	C		R	C					F										
NP5	18X-3, 99–101			R					F	F	C	F	R				C	A		F		F	C			F					F										
	18X-5, 90–101			R					F	C	F	R	R	V			C	C	R	R		R	R			R					C										
	18X-CC			R					R	C	C	F	R		R		C	C	F	R		R	F		F	R					C						R				
	19X-1, 100–101			R					F	C	F	F	R	V	R		F	F	A	R			R								A										
	19X-3, 100–101			R					F	C	F	F	R		R		F	F	F	R		V	R								F										
	19X-4, 100–101			R					F	C	F	F	R		R		F	F	F	R			R																		
	19X-CC	R		R					F	C	C	F	R		R	F	C	F	R	R	R		R																		
	20X-1, 118–119			R					F	C	C	F	R	R		C	R	C					R																		
	20X-2, 99–100			R					F	C	C	F	R	R		C	R	F					R																		
NP3/4	20X-3, 100–102			R			R		F	C	C	C	R	R	R	A	R	F					R													V					
	20X-4, 100–101			R					F	C	C	C	R	R		A		F					V																		
	20X-5, 100–102			F	R	F	F		F	C	C	C	R		R	A	V	F																							
	20X-CC		R	R		F	F		C	C	C	C	R	R	F	A	R	R																							
	21X-1, 100–101		R	R			F		R	F	C	F	R	R		C		C																							
	21X-2, 100–101		R	R		R	R	R	R	F	C	F	R	F		C		C																							

Table 2 (continued).

Zones	Core, section, interval (cm)	*Thoracosphaera saxea*	*Coccolithus pelagicus*	*Cyclicargolithus floridanus*	*Discoaster druggii*	*Discoaster deflandrei*	*Triquetrorhabdulus challengeri*	*Triquetrorhabdulus carinatus*	*Hayaster perplexus*	*Coronocyclus nitescens*	*Sphenolithus conicus*	*Sphenolithus moriformis*	*Helicosphaera intermedia*	*Helicosphaera euphratis*	*Helicosphaera carteri*	*Sphenolithus belemnos*	*Sphenolithus heteromorphus*	*Sphenolithus grandis*	*Calcidiscus leptoporus*	*Pontosphaera* sp. B.	*Coccolithus eopelagicus*	*Sphenolithus capricornutus*	*Triquetrorhabdulus milowii*
NN4/5	6H-5, 100–101		C	A		C			R	F			R				C						
NN3	6H-6, 45–47		C	A	R	C		V	R	F	F	F	R			R	F		R				
	6H-CC	R	C	A	R	C		V	R	F	F	C	R		R	V	F	R					
	7H-1, 100–101	R	C	A	V	C	V	R		F	F	C	R										V
NN2	7H-2, 45–47		C	A	R	C	F	R		F	F		R			C		R					
	7H-3, 100–101		F	A	R	C	R	F		F	C	F				F		R		R	V	C	

species epithet). Bifurcations range from relatively small and narrow-angled to large, broadly bifurcate tips (e.g., Pl. 5, Fig. 12). The broad-tipped forms have been named *D. variabilis pansus* by Bukry and Percival (1971) and *D. pansus* by Bukry (1973). *Discoaster variabilis* s.s. and *D. pansus* appear to grade into one another in our samples, and we have therefore elected to list both end members and intermediate forms under *D. variabilis* s.l. in the range charts.

Rhabdosphaera procera. This species is distinguished from *R. claviger* by the parallel sides of the spine of the former taxon. *R. procera* is small at the beginning of its range but becomes larger than *R. claviger* in the Pleistocene.

Sphenolithus abies/S. neoabies. We found it difficult to distinguish these two small species consistently and so have combined them where they occur together in the late Miocene interval.

Table 3. Calcareous nannofossils in Hole 762B.

Zone	Core, section, interval (cm)	*Thoracosphaera saxea*	*Coccolithus pelagicus*	*Reticulofenestra haqii/R. minutula/ R. minuta*	*Pontosphaera* spp.	*Ceratolithus rugosus*	*Ceratolithus cristatus*	*Helicosphaera carteri*	*Calcidiscus leptoporus*	*Calcidiscus macintyrei*	*Discoaster brouweri*	*Discoaster pentaradiatus*	*Discoaster surculus*	*Discoaster asymmetricus*	*Discoaster variabilis* s.i.	*Discoaster tamalis*	*Discoaster decorus*	*Pontosphaera discopora*	*Scapholithus fossilis*	*Hayaster perplexus*	*Scyphosphaera tubifera*
	122-762-																				
	1H-CC																				
	1H-1, 110–112	R		C	R		R	C	F	V	R	V							F		R
NN20/21	1H-2, 110–112			C			R	F	F	R									R		
	1H-3, 110–112			C			R	F	F	R									F		
	1H-CC	R		F			R	F	F	R									F		
	2H-1, 100–101			F			R	C	F												
	2H-2, 100–101	F		F			R	C	F												
	2H-3, 100–101	F		F	F	V	V	C	F	R											
	2H-4, 100–101	F		F	F		R	C	F												
	2H-5, 100–101	F		F	C		V	C	F										F		
	2H-6, 100–101	F		F	F		R	C	F										R		
NN19	2H-CC	F		F	F	R		C	C												
	3H-1, 99–100	R		F	F	V	V	F	C	R									F		
	3H-3, 100–101	F		F	F	R		C	C		V								R		
	3H-5, 100–101	F		F	F			C	F	R									R		
	3H-CC	F		F	F	R		C	F												
	4H-1, 100–101	F		A	C	R		C	F	F	V							F			
	4H-2, 100–101	R		A	F			C	F												
	4H-3, 100–101	F	R	A	F	R	V	C	F												
	4H-4, 100–101			A				C	R		R										
	4H-5, 100–101	R	R	A	R	R		C	R		R										
NN17/18	4H-CC	R	R	A		R		C	C		C										
	5H-1, 100–101	F		C	F	R		C	F	R	C										
	5H-2, 100–101	R		C	F			C	F		C										
	5H-3, 100–101	R	R	A	F			C	F	F	C	R	F				V		R		
	5H-5, 100–101	R	R	A	F	R		C	C		C	R	V				V				
	5H-6, 100–101	R		A	F	R		C	C		C	R	R								
	5H-CC	F		A	F	R		C	C		C	C	R		R	R			R		
NN16	6H-1, 100–101	F	R	A	F	R		F	F	F	C	C	R	R	R	R					
	6H-2, 100–101	F		A	F	R		F	F		C	C	R	R		R					R
	6H-3, 100–101	F		A	F	F		F	F	F	C	C	R	R		F			R		
	6H-5, 100–101	F		C	F	R		F	F		F	F	R	R	R	R				V	
	6H-CC			A	F	R		C	C	R	F	C	R	R		R	R		R		

Core, section, interval (cm)	*Rhabdosphaera procera*	*Scyphosphaera apsteinii*	*Scyphosphaera pulcherrima*	*Scyphosphaera ventriosa*	*Scyphosphaera piriformis*	*Scyphosphaera conica*	*Scyphosphaera procera*	*Scyphosphaera globulosa*	*Scyphosphaera globulata*	*Scyphosphaera amphora*	*Scyphosphaera aranta*	*Scyphosphaera deflandrei*	*Scyphosphaera recurvata*	*Scyphosphaera kamptneri*	*Scyphosphaera porosa*	*Scyphosphaera campanula*	*Discosphaera tubifer*	*Scyphosphaera recta*	*Scyphosphaera turris*	*Scyphosphaera abelei*
122-762-																				
1H-CC																				
1H-1, 110–112							R													
1H-2, 110–112																				
1H-3, 110–112		R													V					
1H-CC																				
2H-1, 100–101					V															
2H-2, 100–101																				
2H-3, 100–101		R			R		R	R			R	R								V
2H-4, 100–101	V																			
2H-5, 100–101	R	R	V		R			R	R		R	R	R							V
2H-6, 100–101	R																			
2H-CC	R			R																
3H-1, 99–100	R							V	R		R							V		
3H-3, 100–101	R	R		R							R			R				V		
3H-5, 100–101	R			R	R															
3H-CC	R		V																	
4H-1, 100–101																				
4H-2, 100–101																				
4H-3, 100–101	R		R	R			R	R												
4H-4, 100–101	R																			
4H-5, 100–101	R	R	R	R																
4H-CC	R		R	R					R			R								
5H-1, 100–101	R	R	R	R																
5H-2, 100–101	R																			
5H-3, 100–101	R		R	R	R	R								R		R				
5H-5, 100–101	F	R	R	R	R			R	R			R	R		V				V	
5H-6, 100–101	R																			
5H-CC	R		R	R			V						V							
6H-1, 100–101	R	R	R	R			R	R		V					R		V	V		
6H-2, 100–101		R																		
6H-3, 100–101	R	R	R	R			R	R	R		R		V							
6H-5, 100–101	R		R	R		R	R		R			R								
6H-CC	R	R	R			R	R													

Core, section, interval (cm)	*Scyphosphaera pacifica*	*Scyphosphaera gladstonensis*	*Scyphosphaera ampla*	*Cruciplacolithus tenuis*	*Pseudoemiliania lacunosa*	*Discoaster blackstockae*	*Rhabdosphaera claviger*	*Syracosphaera* sp.	*Helicosphaera wallichii*	*Gephyrocapsa oceanica*	*Gephyrocapsa caribbeanica*	*Rhabdosphaera longistylis*	*Emiliania huxleyi*
122-762-													
1H-CC													
1H-1, 110–112				R			F		R	A	A	F	A
1H-2, 110–112							R		R	A	A	R	R
1H-3, 110–112								R	R	A	A	R	
1H-CC					R				R	A	A		
2H-1, 100–101					F		R		R	A	F		
2H-2, 100–101					F		R		V	C	F	V	
2H-3, 100–101					C		R	R		C	F	R	
2H-4, 100–101					C					F	F	V	
2H-5, 100–101					A		R			F	F	R	
2H-6, 100–101					A		R		F	F	F	V	
2H-CC	R				A		R			F	F		
3H-1, 99–100					A		R			F	F		
3H-3, 100–101	R	V	V		A		C			R	F		
3H-5, 100–101					A		C		F	F			
3H-CC					A		F			F	F		
4H-1, 100–101	R				A		F				R		
4H-2, 100–101					A		R						
4H-3, 100–101					A								
4H-4, 100–101					C								
4H-5, 100–101					C		R						
4H-CC					A		R						
5H-1, 100–101					A								
5H-2, 100–101					A								
5H-3, 100–101						A		R					
5H-5, 100–101		V			C		R					V	
5H-6, 100–101					F		R						
5H-CC					F	V	R						
6H-1, 100–101					F		R						
6H-2, 100–101					F	R							
6H-3, 100–101					F		R						
6H-5, 100–101					F		R						
6H-CC					F	R							

Table 3 (continued).

Zone	Core, section, interval (cm)	*Thoracosphaera saxea*	*Coccolithus pelagicus*	*Cyclicargolithus floridanus*	*Calcidiscus leptoporus*	*Reticulofenestra pseudoumbilica*	*Reticulofenestra haqii/R. minutula/ R. minuta*	*Calcidiscus protoannulus*	*Umbilicosphaera sibogae*	*Thoracosphaera operculata*	*Discoaster variabilis* s.l.	*Discoaster exilis*	*Discoaster brouweri*	*Discoaster pentaradiatus*	*Discoaster surculus*	*Discoaster blackstockae*	*Discoaster quinqueramus*	*Discoaster challengeri*	*Sphenolithus abies/S. neoabies*	*Triquetrorhabdulus rugosus*	*Helicosphaera carteri*
NN16	7H-1, 100–101	R			F		A				R		C	C	R						C
	7H-3, 100–101	R			R		A				R		C	C	R						C
	7H-5, 100–101	R			F		A				R		C	C	R				R		C
	7H-6, 100–101	R			R		A				R		C	C	R				R		C
	7H-CC	R			R	V	A				R		A	C	R				F		C
	8H-1, 100–101	R			R	V	A				R		A	C	R				F		C
NN14/15	8H-3, 100–101	R			R	F	A				R		C	C					F		C
	8H-4, 100–101	R			R	F	A				R		C	C					F		C
	8H-5, 100–101	R			R	F	A				R		C	C	R				F		C
	8H-6, 100–101	R			R	F	A				R		F	C	R				F		C
	8H-CC	R				C	A				R		F	C	R				F		C
NN13	9H-1, 100–101	R			F	C	A				R	V	F	C	R				C		C
	9H-3, 100–101	R			F	C	A				R		C	C	F				C		C
	9H-5, 100–101	F			F	C	A				R		C	C	F				A		C
	9H-CC	R			R	C	A						F	C	R				C		F
	10H-1, 100–101	R			F	A	C				R		C	A	R				C		
	10H-3, 100–101	R			R	A	C				R		C	A					F		
	10H-5, 100–101	R			R	A	C						C	C	F				C		F
	10H-CC	F	R		R	C	A			V	R		C	C	F				C		R
	11H-1, 100–101	R	F		V	C	A				R		C	C	F				C	R	F
	11H-2, 100–101	R	R			C	C				R		C	R	F				F		R
NN12	11H-3, 100–101	R	R			C	C				R		C	R	F				F		R
	11H-4, 99–100		R			C	C				R		F	R	F				F		R
	11H-6, 100–101	R	R		R	C	A				C		F	R	F	V		R	C	V	F
	11H-CC	R	F			C	A	R			F		R	F	C	R		R	C		R
NN11	12H-1, 125–127	R	F		R	C	C	V			F		R	F	F	R	C	R	F	R	F
	12H-2, 100–102		F			C	C				F	R	R	R	R		F	R	F		R
	12H-4, 139–141	R	R		R	C	C		R		C	R	R	R	R	R	A	R	F		R
	12H-6, 101–102	R	R			C	C				C		R	R	R		C	R			R
	12H-CC		F			C	A				C	R	R	F	R		C	R	C		F

Zone	Core, section, interval (cm)	*Pontosphaera* spp.	*Pontosphaera* sp. B.	*Scyphosphaera apsteinii*	*Scyphosphaera piriformis*	*Scyphosphaera intermedia*	*Scyphosphaera pulcherrima*	*Scyphosphaera cylindrica*	*Scyphosphaera recurvata*	*Scyphosphaera conica*	*Scyphosphaera recta*	*Scyphosphaera ampla*	*Scyphosphaera procera*	*Scyphosphaera globulosa*	*Scyphosphaera amphora*	*Scyphosphaera campanula*	*Scyphosphaera deflandrei*	*Scyphosphaera lagena*	*Scyphosphaera penna*	*Scyphospaera globulata*	*Scyphosphaera aranta*
NN16	7H-1, 100–101	F			R	R	R							R						R	
	7H-3, 100–101	F		R	R	R	R						R			R		V	V		
	7H-5, 100–101	F			R		R			R	V		R	R		R					
	7H-6, 100–101	F																			
	7H-CC	F		R	R		R			R							R				R
	8H-1, 100–101	F	R	R	R		F						R	R		R	R			R	
NN14/15	8H-3, 100–101	F			R		F			R			R	R		R				R	R
	8H-4, 100–101	F																			
	8H-5, 100–101	F		R	R	R	R			R			R	R		V	R			R	R
	8H-6, 100–101	R																			
	8H-CC	R	R	R			R	R	V	R			R							R	
NN13	9H-1, 100–101	R		R			R	R		R							R			R	R
	9H-3, 100–101	F					R			F				R						F	
	9H-5, 100–101	F		R			R		V	R			R	R	R		R				
	9H-CC	F		R	R		R			F					R		R				
	10H-1, 100–101	F	R	R	R			R		F			R		V		R			R	R
	10H-3, 100–101	F		V					V	R							R			R	
	10H-5, 100–101	R	R	R			R			F			R		R		R				R
	10H-CC	R		R	R		R		V	R				F			R			R	R
	11H-1, 100–101	R	R	R	R		R			R			R	R	R		F			F	
	11H-2, 100–101	R																			
NN12	11H-3, 100–101	R	R	R			R	R		F		V	R				R			F	
	11H-4, 99–100	R																			
	11H-6, 100–101	R		R	V	R	R	R					F			R	R			R	R
	11H-CC		R	R		R	R	R		R				R							R
NN11	12H-1, 125–127	R	R	R			R	R							R	F				R	R
	12H-2, 100–102																				
	12H-4, 139–141		R																		
	12H-6, 101–102				R		F						R								
	12H-CC		R	R	R		R	R	V					R	V				V		

Zone	Core, section, interval (cm)	*Scyphosphaera oremesa*	*Scyphosphaera ventriosa*	*Scyphosphaera apsteinii dilatata*	*Scyphosphaera canescens*	*Scyphosphaera kamptneri*	*Scyphosphaera porosa*	*Scyphosphaera tubifera*	*Ceratolithus armatus*	*Discoaster decorus*	*Amaurolithus delicatus*	*Amaurolithus primus*	*Amaurolithus amplificus*	*Amaurolithus tricorniculatus*	*Amaurolithus bizzarus*	*Pseudoemiliania lacunosa*	*Discoaster asymmetricus*	*Rhabdosphaera procera*	*Ceratolithus rugosus*	*Ceratolithus acutus*	*Scapholithus fossilis*	*Discoaster tamalis*
NN16	7H-1, 100–101				V											F	R	R	R			R
	7H-3, 100–101		R					V		R						F	F	R	F			F
	7H-5, 100–101		R													F	R	R	R			R
	7H-6, 100–101															F	R	R	R			
	7H-CC		R							R						F	R	R	R		R	
	8H-1, 100–101		R					R		R						R	R	R	R			
NN14/15	8H-3, 100–101								R	R						F	R	R	R			R
	8H-4, 100–101															R	R	R	R			
	8H-5, 100–101		R				F		R		R						R	R	R			
	8H-6, 100–101										R						R	R	R			
	8H-CC		R				V			R	R	V					R	F	R			
NN13	9H-1, 100–101		R	V							R							R	R			
	9H-3, 100–101										R							R	R			
	9H-5, 100–101		R			V					R							R	R			
	9H-CC																		R			
	10H-1, 100–101										V							R	R			
	10H-3, 100–101		R							R	R							R	R			
	10H-5, 100–101										R							R	R			
	10H-CC									R				R	V				R	V		
	11H-1, 100–101			R	R													R	R			
	11H-2, 100–101																		R			
NN12	11H-3, 100–101		R										V									
	11H-4, 99–100																	R				
	11H-6, 100–101	R									R							R				
	11H-CC									R	R				V			R		R		
NN11	12H-1, 125–127									R	R	R		R								
	12H-2, 100–102																					
	12H-4, 139–141												R									
	12H-6, 101–102																					
	12H-CC									R	R	R	R									

Table 3 (continued).

Zone	Core, section, interval (cm)	*Coccolithus pelagicus*	*Cyclicargolithus floridanus*	*Coccolithus eopelagicus*	*Dictyococcites bisectus*	*Zygrhablithus bijugatus*	*Discoaster druggii*	*Discoaster deflandrei*	*Discoaster variabilis* s.l.	*Triquetrorhabdulus carinatus*	*Hayaster perplexus*	*Coronocyclus nitescens*	*Calcidiscus protoannulus*	*Sphenolithus predistentus*	*Sphenolithus ciperoensis*	*Sphenolithus conicus*	*Sphenolithus moriformis*	*Sphenolithus pseudoradians*	*Sphenolithus dissimilis*	*Helicosphaera intermedia*	*Helicosphaera euphratis*	*Helicosphaera perch-nielseniae*	*Braarudosphaera bigelowii*	*Micrantholithus pinguis*	*Thoracosphaera saxea*	*Ericsonia subdisticha*
NN11	13H-1, 100–101	F							C			C													R	
	13H-2, 100–101	R	R						C																R	
NN9	13H-3, 100–101	R	R						C								F								F	
	13H-4, 100–101	R	R						C								F								R	
	13H-5, 100–101	R	R						C								F			R					R	
	13H-6, 100–101	R	R					R	F								F								R	
	13H-CC	R	F					V	F		R						F								R	
NN6/7	14H-1, 100–101	R	F					C	F								R								R	
	14H-2, 18–20	R	C					R	C								R								R	
	14H-4, 18–20	R	A					R	C		R	R					C			R					R	
	14H-5, 100–101		A					R	F			R					C								R	
NN4/5	14H-6, 4–6	R	A				R	F	R	R		F		V			C			R					R	
	15H-1, 88–90	R	A		V			F	F	R		R					F			V		V			R	
	15H-2, 100–101	R	A					C				R					F						R		R	
	15H-3, 88–90	R	A				R	F			R	R					F						R		F	
	15H-4, 100–101	R	A					F				R					F						C	R	R	
NN1/2	15H-5, 88–90	R	A				R	C		R	R	R			V	R	F						C	R	R	R
	15H-6, 88–90	R	A		V	V	R	C		R	R	R					C					V	F		R	
	15H-CC	R	A		V			C		R	R	R					F				R		F	R	R	R
	16H-1, 100–101	R	A	V		R		C		F	R	R	V			F	C			R		V	R		F	R
	16H-3, 100–101	R	A		V	R		C		R		R				R	F		F		R	V	F	V	R	
	16H-4, 100–101	R	A			R		C		R		R					R		R				R		R	R
	16H-5, 100–101	R	A	R	V	R		C		F	R	F					R		R		R		R		R	R
NP24/25	16H-6, 100–101	R	A	R		R		C		F		F					R						F		R	R
	16H-CC	R	A	R	R	R		C		C	R	F		R		F	F	R					F		R	R

Core, section, interval (cm)	*Sphenolithus belemnos*	*Sphenolithus grandis*	*Sphenolithus heteromorphus*	*Calcidiscus leptoporus*	*Pontosphaera* sp. B.	*Triquetrorhabdulus challengeri*	*Discoaster kugleri*	*Discoaster exilis*	*Triquetrorhabdulus milowii*	*Helicosphaera obliqua*	*Helicosphaera granulata*	*Umbilicosphaera sibogae*	*Reticulofenestra pseudoumbilica*	*Helicosphaera carteri*	*Discoaster braarudii*	*Discoaster signus*	*Scyphosphaera apsteinii*	*Scyphosphaera piriformis*	*Scyphosphaera intermedia*	*Scyphosphaera pulcherrima*	*Scyphosphaera cylindrica*	*Scyphosphaera recurvata*	*Scyphosphaera conica*	*Scyphosphaera recta*	*Scyphosphaera ampla*
13H-1, 100–101				R				R					C	F		R	R	R	R	R	R		R		
13H-2, 100–101				R				R					C												
13H-3, 100–101				R	F			F			R	R	C			F	R			R					
13H-4, 100–101				R	R								C	F											
13H-5, 100–101				F	R							R	C	F			V	F	R	F	R		R		
13H-6, 100–101				R	R								C	R											
13H-CC				R	R			R				F	C	R			R	R		R			R	V	R
14H-1, 100–101				R									C	R											
14H-2, 18–20		R		C	R		V			V		R	C	F	F		R	R	R	R	R	R	V	V	
14H-4, 18–20		F		R	R			R				F	F	R							R	R			
14H-5, 100–101				R									R	R											
14H-6, 4–6		R	F	R	R				R	V	R	R	R	R						R					
15H-1, 88–90			F	F				R			R		V	R		C									
15H-2, 100–101			F	R																					
15H-3, 88–90	R	F	C	R	F							R		R			R	R							
15H-4, 100–101			F	R																					
15H-5, 88–90	F	F		R	R							R													
15H-6, 88–90	F			R																					
15H-CC	R			F													R								
16H-1, 100–101		R		R								R													
16H-3, 100–101		R		R		R			R			R													
16H-4, 100–101						R			R																
16H-5, 100–101		R				R			R																
16H-6, 100–101		R							R																
16H-CC		F																							

Core, section, interval (cm)	*Scyphosphaera tubifera*	*Scyphosphaera procera*	*Scyphosphaera lagena*	*Scyphosphaera globulosa*	*Scyphosphaera amphora*	*Scyphosphaera campanula*	*Scyphosphaera deflandrei*	*Sphenolithus abies/S. neoabies*	*Triquetrorhabdulus rugosus*	*Catinaster coalitus*	*Catinaster calyculus*	*Discoaster neohamatus*	*Discoaster hamatus*	*Discoaster calcaris*	*Discoaster brouweri*	*Discoaster challengeri*	*Discoaster surculus*	*Discoaster pentaradiatus*	*Discoaster quinqueramus*	*Amaurolithus primus*
13H-1, 100–101		R		R		R		C	R					R	R	R	R	C	C	V
13H-2, 100–101								F											F	R
13H-3, 100–101				R					F	V	C	R	F	R	R					
13H-4, 100–101														R						
13H-5, 100–101		R	R	R	R	F	V		R	F	R	R	F							
13H-6, 100–101									R	F	R		R							
13H-CC	V								F	F	R	V	F		R					
14H-1, 100–101																				
14H-2, 18–20									R											
14H-4, 18–20									R											
14H-5, 100–101									F											
14H-6, 4–6																				
15H-1, 88–90																				
15H-2, 100–101																				
15H-3, 88–90																				
15H-4, 100–101																				
15H-5, 88–90																				
15H-6, 88–90																				
15H-CC																				
16H-1, 100–101																				
16H-3, 100–101																				
16H-4, 100–101																				
16H-5, 100–101																				
16H-6, 100–101																				
16H-CC																				

Table 3 (continued).

Zone	Core, section, interval (cm)	*Markalius astroporus*	*Thoracosphaera saxea*	*Coccolithus pelagicus*	*Cyclicargolithus floridanus*	*Reticulofenestra umbilica*	*Dictyococcites bisectus*	*Zygrhablithus bijugatus*	*Ericsonia formosa*	*Chiasmolithus oamaruensis*	*Dictyococcites callidus* s.l.	*Coccolithus eopelagicus*	*Discoaster deflandrei*	*Discoaster saipanensis*	*Discoaster nodifer*	*Discoaster barbadiensis*	*Discoaster tanii*	*Sphenolithus radians*	*Sphenolithus moriformis*	*Bramletteius serraculoides*	*Helicosphaera compacta*
	17H-1, 100–102			F	A		F	F				R	C						C		
NP24/25	17H-3, 100–102			F	A	V	R	F			R	R	C	V					C		
	17H-4, 100–102			F	A		R	F			R	R	F						F		
	17H-5, 100–102		R	F	A		C	F				R	F						F	V	
	17H-6, 100–101			F	A		F	F			R	R	C				R		F		
NP23	17H-CC			R	A		C	C	V			R	F		R		V		F	V	
	18H-1, 100–102																				
	18H-3, 100–102		R	F	A		C	C				F	C	V		R	R		R		R
	18H-4, 101–102			F	A	V	C	C				R	C			R			R		
	18H-5, 100–102		R	R	A	R	C	C			R		C	V	R	R	F		F		R
	18H-6, 101–102		R	R	A	R	C	C	V			R	F				R		F		R
	18H-CC		R	F	A	R	C	C			R	R	R	V	R	V	R		F	R	F
NP22	19H-1, 100–101		R	F	A	R	C	C	V			R	F	V	F	V	R		R	R	C
	19H-2, 100–101			F	A	R	C	C				R	F				R		R	R	R
	19H-3, 100–101			F	A	R	C	C				R	R				R		R	V	R
	19H-5,100–101		R	F	A	F	C	F	V			R					R		R	R	R
	19H-6, 100–101		R	F	A	F	C	R	F	R			R			R	R		R	R	R
NP21	19H-CC		R	F	A	R	C	R	R			V	R				R		R		R
NP22	2X-1, 100–101		R	C	A	R	C	C	V			R	R						R	F	
	2X-2, 100–101		R	C	A	R	C	C				R		V					R	R	R
	2X-3, 100–101		R	F	A	F	C	F	R	V		R	R	V		V		R	R	R	F
	2X-CC		R	R	A	R	C	C	F		R	R	R	V					R	R	F
	3X-1, 100–101			F	A	C	C	C	C			R							R	V	R
	3X-3, 100–101			R	A	C	C	C	F		R	R	R		R		F	V	R	V	R
NP21	3X-4, 100–101			F	A	C	C	C	F	V		R	R		R		R		R	R	R
	3X-CC	R		F	A	C	C	C	F	V	R	R	R		R		R		R	R	
	4X-1, 100–101		R	F	A	C	C	C	F			R	R		R		F		R	R	R
	4X-3, 100–101		R	R	A	F	C	C	F	R		R	R		F		F		R	R	F
	4X-CC			R	A	C	C	C	F	R		R	F	V	F		F		R	R	R
	5X-1, 54–56			R	A	C	C	C	F	R		R	R	V	R		F			F	R
NP19/20	5X-2, 36–38		R	F	C	C	C	A	F	F	R	R		R	R	R	R		F	R	F
	5X-CC		R	F	C	C	C	A	F	R		R	V		R	R	R			R	R

Core, section, interval (cm)	*Helicosphaera reticulata*	*Thoracosphaera prolata*	*Ericsonia subdisticha*	*Coronocyclus nitescens*	*Calcidiscus protoannulus*	*Sphenolithus conicus*	*Braarudosphaera bigelowii*	*Discolithina segmenta*	*Isthmolithus recurvus*	*Sphenolithus predistentus*	*Corannulus germanicus*	*Helicosphaera intermedia*	*Helicosphaera wilcoxonii*	*Sphenolithus pseudoradians*	*Hayella situliformis*	*Helicosphaera euphratis*	*Transversopontis pulcheroides*	*Micrantholithus pinguis*	*Scyphosphaera expansa*	*Blackites spinosus/B. tenuis*
17H-1, 100–102			R	R		R	R									R				
17H-3, 100–102				R			R													
17H-4, 100–102				R			R													
17H-5, 100–102			F	F	R		F		V	F										
17H-6, 100–101				R			C			F										
17H-CC				R			F			C		R				R				
18H-1, 100–102							F													
18H-3, 100–102				R			F			F										
18H-4, 101–102	V			R			R			R										
18H-5, 100–102	R		R	R			R			R										R
18H-6, 101–102	R						R			R										R
18H-CC	R	V	F				F			C		R		R						F
19H-1, 100–101	F			R			C			F				R					R	F
19H-2, 100–101	F						C			R										F
19H-3, 100–101	F		R				C			R						R				F
19H-5,100–101	F						F													
19H-6, 100–101	R						F													R
19H-CC							R		R			R								R
2X-1, 100–101	R						C			R										R
2X-2, 100–101	R		R				C			R										R
2X-3, 100–101	R		R				R		R	R		R					R		V	R
2X-CC	R		R				R		R	R							R			R
3X-1, 100–101			R				C										R	R		F
3X-3, 100–101	R		R		R		R	R		R					R	R	R			F
3X-4, 100–101							R							R						R
3X-CC							R		R	R				R						R
4X-1, 100–101									R											F
4X-3, 100–101					R				R											R
4X-CC	R			R					R		V		R							R
5X-1, 54–56	R								R					R	V					R
5X-2, 36–38	R			R				R				R	R							R
5X-CC		V																		R

Core, section, interval (cm)	*Blackites spinosus*	*Blackites tenuis*	*Lanternithus minutus*	*Pontosphaera enormis*	*Helicosphaera obliqua*	*Rhabdosphaera vitreus*	*Pontosphaera versa*	*Peritrachelina joidesa*	*Chiasmolithus altus* s.l.	*Braarudosphaera discula*	*Scyphosphaera apsteinii*	*Pontosphaera plana*	*Helicosphaera perch-nielseniae*	*Sphenolithus distentus*	*Sphenolithus ciperoensis*	*Sphenolithus dissimilus*	*Triquetrorhabdulus carinatus*	*Hayaster perplexus*	*Discoaster variabilis* s.l.	*Pontosphaera multipora*	*Thoracosphaera* sp. A.
17H-1, 100–102															R	R	F	V			
17H-3, 100–102															R	R	F				
17H-4, 100–102														V	R		F				
17H-5, 100–102								R						R			F				
17H-6, 100–101								R									F				
17H-CC																	F				
18H-1, 100–102											R								R		
18H-3, 100–102									R					R			R		R		
18H-4, 101–102																	V				
18H-5, 100–102								R	R				R								
18H-6, 101–102																					
18H-CC	R		R					R	R				R								R
19H-1, 100–101	F		V				R		R												
19H-2, 100–101			F						R												
19H-3, 100–101	R		F			V		R		V	V										
19H-5,100–101																					
19H-6, 100–101	R		R																		
19H-CC	R		F	R			R													R	
2X-1, 100–101	R		F					R													
2X-2, 100–101	R		R					R													
2X-3, 100–101	R		F				V					R								R	
2X-CC	R	R	F	R		V						R									
3X-1, 100–101	R		C									R									
3X-3, 100–101					V																
3X-4, 100–101																					
3X-CC																					
4X-1, 100–101																					
4X-3, 100–101																					
4X-CC																					
5X-1, 54–56																					R
5X-2, 36–38																					
5X-CC																					

Table 4. Calcareous nannofossils in Hole 762C.

Zone	Core, section, interval (cm)	*Markalius astroporus*	*Thoracosphaera saxea*	*Coccolithus pelagicus*	*Cyclicargolithus floridanus*	*Reticulofenestra umbilica*	*Dictyococcites bisectus*	*Zygrhablithus bijugatus*	*Ericsonia formosa*	*Chiasmolithus oamaruensis*	*Dictyococcites callidus* s.l.	*Coccolithus eopelagicus*	*Discoaster deflandrei*	*Discoaster saipanensis*	*Discoaster nodifer*	*Discoaster barbadiensis*	*Discoaster tanii*	*Sphenolithus radians*	*Sphenolithus moriformis*	*Bramletteius serraculoides*	*Helicosphaera compacta*	*Helicosphaera reticulata*	*Thoracosphaera prolata*	*Ericsonia subdisticha*	*Coronocyclus nitescens*	*Calcidiscus protoannulus*
NP22	2X-1, 100–101		R	C	A	R	C	C	V			R	R						R	F		R				
NP21	2X-2, 100–101		R	C	A	R	C	C				R		V					R	R	R	R		R		
	2X-3, 100–101		R	F	A	F	C	F	R	V		R	R	V		V		R	R	R	F	R		R		
	2X, CC		R	R	A	R	C	C	F		R	R	R	V					R	R	F	R		R		
	3X-1, 100–101			F	A	C	C	C	C			R							R	V	R	R				
	3X-3, 100–101			R	A	C	C	C	F		R	R	R		R		F	V	R	V	R	R		R		R
	3X-4, 100–101			F	A	C	C	C	F	V		R	R		R		R		R	R	R					
	3X, CC	R		F	A	C	C	C	F	V	R	R	R		R				R	R						
	4X-1, 100–101		R	F	A	C	C	C	F			R	R		R		F		R	R	R					
	4X-3, 100–101		R	R	A	F	C	C	F	R		R	R		F	F			R	R	F					R
	4X, CC			R	A	C	C	C	F	R		R	F	V	F		F		R	R	R	R			R	
	5X-1,54–56			R	A	C	C	C	F	R		R	R	V	R		F			F	R	R				
NP19/20	5X-2, 36–38		R	F	C	C	C	A	F	F	R	R		R	R	R	F		F	R	F	R			R	
	5X, CC		R	F	C	C	C	A	F	R		R	V		R	R	R			R	R		V			

Reticulofenestra haqii/R. minuta/R. minutula. These three small species are also difficult to separate, so we have also listed them under a single category.

Thoracospheara sp. A. This species resembles *T. saxea* but has smaller crystal elements making up the test.

Pontosphaera sp. A. This is a large (10–15 μm), elliptical form that appears bright white between crossed nicols.

Pontosphaera sp. B. This large (8–12 μm), thick form shows bright multicolors between crossed nicols.

ZONATION

Although we used Martini's (1971) biostratigraphic zonation in this study, some modifications to the standard scheme were necessary, owing to the rarity or absence of several marker species. The following paragraphs describe the zonational conventions we used and add some relevant stratigraphic comments.

Evolutionary first appearances are more sharply defined than extinctions, largely because upward reworking blurs true extinction horizons. In Tables 1–5, if the first occurrence of a zonal marker species was designated as "very rare," that level was still considered to be the evolutionary first occurrence and the zonal boundary was drawn below that level. If the last occurrence was "very rare," however, the boundary was usually drawn just below that level, especially if the relative abundance had dropped from "few" or "rare" (but consistently "rare") down to "very rare," then "absent." A few "very rare" to "rare" specimens are expected to be reworked above any extinction level.

Zone NP1–NP2 boundary. We used the first appearance of *Cruciplacolithus primus* to mark this boundary in our study. Romein (1979) described *C. edwardsii* as a form that evolved from *C. primus,* and which first appears somewhat later than *C. primus.* In Hole 762C, however, both species make their first appearance in the same sample, although with *C. primus* being much more common than *C. edwardsii* (Table 4). *Cruciplacolithus tenuis* s.s. first appears slightly above *C. primus* and *C. edwardsii* at Site 762.

Zone NP2–NP3/NP4 boundary. NP3 and NP4 are often combined, because *Ellipsolithus macellus* is almost always a rare form. The NP2–NP3/NP4 boundary is drawn at the level of the first appearance of definite *Chiasmolithus danicus* at Site 762. The zonal boundary drawn on Table 4 and Figure 4 is considered tentative, and could be slightly lower, because *C. danicus* is not always readily distinguishable from *Cruciplacolithus edwardsii.*

Zone NP3/4–NP4 boundary. An approximate lower boundary for NP4 is drawn based on the first appearance of the secondary marker species *Chiasmolithus bidens,* whose first occurrence is considered to be in NP4 (Romein, 1979; Perch-Nielsen, 1985).

Zone NP7/NP8. Zones NP7 and NP8 are combined because *Heliolithus riedelii,* whose first occurrence defines the NP7–NP8 boundary, is too rare to be useful in these cores.

Zone NP15–NP16 boundary. The taxon defining this boundary (*Rhabdosphaera gladius*) is absent here. We have therefore used the last occurrence of *Nannotetrina* spp. and the first occurrence of *Discoaster nodifer* to approximate the boundary (see Perch-Nielsen, 1985).

Zone NP16–NP17 boundary. The last occurrence of the marker species *Chiasmolithus solitus* is not reliable here owing to its rarity. We have used the last occurrences of *Reticulofenestra reticulata* (just below the boundary) and *Helicosphaera compacta* (just above the boundary) to approximate the true zonal boundary (Perch-Nielsen, 1985).

Zone NP19/NP20. These zones are combined because the marker species (*Sphenolithus pseudoradians*) that divides the zones is rare here; furthermore, the range of this species is now considered to be diachronous (Perch-Nielsen, 1985).

Zone NP24/NP25. Zones NP24 and NP25 are combined because the boundary marker, *Sphenolithus distentus,* is too rare to be reliable in these cores.

Zone NP24/NP25–NN1/NN2 boundary. The unreliability of the range of *Helicosphaera recta,* which is the official marker of the NP25–NN1 boundary, is well known (Perch-Nielsen, 1985). The boundary here is approximated by the last occurrence of *Dictyococcites bisecta* (Perch-Nielsen, 1985).

Zone NN1/NN2. These zones are combined because *Discoaster druggii* is rare and difficult to distinguish consistently when any calcitic overgrowth obscures the ray points.

Table 4 (continued).

Sphenolithus conicus	*Braarudosphaera bigelowii*	*Discolithina segmenta*	*Isthmolithus recurvus*	*Sphenolithus predistentus*	*Corannulus germanicus*	*Helicosphaera intermedia*	*Helicosphaera wilcoxonii*	*Sphenolithus pseudoradians*	*Hayella situliformis*	*Helicosphaera euphratis*	*Transversopontis pulcheroides*	*Micrantholithus pinguis*	*Scyphosphaera expansa*	*Blackites spinosus/B. tenuis*	*Blackites spinosus*	*Blackites tenuis*	*Lanternithus minutus*	*Pontosphaera enormis*	*Helicosphaera obliqua*	*Rhabdosphaera vitreus*	*Pontosphaera versa*	*Peritrachelina joidesa*	*Chiasmolithus altus* s.l.	*Braarudosphaera discula*	*Scyphosphaera apsteinii*	*Pontosphaera plana*	*Helicosphaera perch-nielseniae*	*Sphenolithus distentus*	*Sphenolithus ciperoensis*	*Sphenolithus dissimilus*	*Triquetrorhabdulus carinatus*	*Hayaster perplexus*	*Discoaster variabilis* s.l.	*Pontosphaera multipora*	*Thoracosphaera* sp A.
	C			R										R	R		F					R													
	C			R										R	R		R					R													
	R		R	R		R					R		V	R	R		F				V					R								R	
	R		R	R							R			R	R	R	F	R		V						R									
	C										R	R		F	R		C									R									
	R	R		R					R	R	R			F					V																
	R							R						R																					
	R		R	R				R						R																					
			R											F																					
			R											R																					
			R		V		R							R																					
			R					R	V					R																					R
		R				R	R							R																					
														R																					

Zone NN4/NN5. These zones are combined because of the absence of the NN4–NN5 boundary marker, *Helicosphaera ampliaperta*.

Zone NN6/NN7. These zones are combined because the boundary marker, *Discoaster kugleri*, is rare and occurs sporadically.

Zone NN14/NN15. These zones are combined because the boundary marker, *Amaurolithus tricorniculatus*, is too rare to be reliable.

Zone NN17/NN18. Zone NN17 is an exceptionally thin zone; the extinction of *Discoaster surculus* (base of NN17) occurs only slightly before the extinction of *D. pentaradiatus* (top of NN17) (Perch-Nielsen, 1985). We could not separate the extinction levels of these two species here, so the two zones are therefore combined.

Zone NN20/NN21. These zones are combined in this light microscope study because the first appearance of *Emiliania*

Table 4 (continued).

Zone	Core, section, interval (cm)	*Markalius astroporus*	*Thoracosphaera saxea*	*Coccolithus pelagicus*	*Chiasmolithus consuetus*	*Chiasmolithus grandis*	*Chiasmolithus expansus*	*Campylosphaera dela*	*Zygrhablithus bijugatus*	*Ericsonia formosa*	*Coronocyclus nitescens*	*Discoaster gemmeus*	*Discoaster germanicus*	*Discoaster deflandrei*	*Discoaster saipanensis*	*Discoaster nodifer*	*Discoaster barbadiensis*	*Discoaster tanii*	*Sphenolithus radians*	*Sphenolithus moriformis*	*Sphenolithus furcatolithoides*
	6X-1, 100–101			F					C	F	R				F	R	R	F		R	
	6X-4, 100–101			F					C	F					C		F	F		R	
NP19/20	6X, CC		R	F					C	F					C	R	F	F		R	
	7X-1, 100–101		R	F					A	F	R			R	C	R	R	F		R	
	7X-3, 100–101	R	R	F					C	C					C	R	R	F		F	
	7X-4, 100–101			F					C	C					C	R	R	F		F	
	7X, CC			C					C	C					C	F	R	F		F	
	8X-1, 100–101	R	R	F					A	C					C	R	F	F		R	
NP18	8X-3, 100–101	R		F					A	F		R			F	F	R	C			
	8X, CC	R		F					C	F		R			C	F	F	C		R	
	9X-1, 67–68			F					C	F					C	R	F	C		F	
	9X, CC			F					C	F					F		F	C		R	
	10X-1, 105–106	R	R	F		F			A	F					C	R	F	C	V	R	
	10X-3, 105–106		R	F		F			A	F		V	R	R	C	R	F	F			
	10X, CC			C		R			C	F					C	R	R	F		R	
	11X-1, 99–100			C		F			A	F					F	F	F			R	
NP17	11X-2, 99–100			C		F		V	A	F					C	F	F				
	11X-3, 99–100		R	C	R	F		R	A	C	R				C	F	F			V	
	11X-4, 99–100			C		F			A	C					C	F	R				
	11X-5, 99–100			C		C	R	R	C	C		R			C	F	R	V	R	R	
	11X-6, 99–100			C		F			C	C					C	F	R			R	
	11X, CC	R	R	C		F	R		A	C	R				C	F	R	R	R		R

Zone	Core, section, interval (cm)	*Cyclicargolithus floridanus*	*Reticulofenestra umbilica*	*Reticulofenestra reticulata*	*Dictyococcites callidus* s.l.	*Bramletteius serraculoides*	*Helicosphaera compacta*	*Thoracosphaera prolata*	*Discoaster strictus*	*Ericsonia subdisticha*	*Calcidiscus protoannulus*	*Reticulofenestra dictyoda*	*Chiasmolithus oamaruensis*	*Dictyococcites bisectus*	*Coccolithus eopelagicus*	*Helicosphaera reticulata*	*Blackites spinosus/B. tenuis*	*Cyclococcolithus luminis*	*Chiasmolithus oamaruensis*	*Sphenolithus intercalaris*	*Discolithina segmenta*	*Isthmolithus recurvus*	*Clathrolithus ellipticus*	*Sphenolithus predistentus*	*Corannulus germanicus*
	6X-1, 100–101	C	C			R	F							C		R	R		F			R		R	R
	6X-4, 100–101	C	F	R		R					R			C	F		R								
NP19/20	6X, CC	A	C			R								F	R		F								
	7X-1, 100–101	A	R			R					R			A	F		R		R			R			
	7X-3, 100–101	A	F			R								C	R	R	R		F			R	R		
	7X-4, 100–101	A	F			R								C	R		R		R						
	7X, CC	A	A	R		R	R	V				R		C	R	R	R		R						
	8X-1, 100–101	A	C	R	R	F				R	F			C	R	R	R				R				
NP18	8X-3, 100–101	A	F	F	F	R						R		C	R	R	R		R						
	8X, CC	A	F	R	R	R					R	R		C	R	R	F		R						
	9X-1, 67–68	A	F	R	F	F								F	R		R		R	R					
	9X, CC	A	F	R	R	F					R			C	F		R		R						
	10X-1, 105–106	A	F	F		F				R	R	R		C	F		R								
	10X-3, 105–106	A	F	F		F				R	F			F	F		R	R							
	10X, CC	C	F	R		F			R		F	R		C	F		R							R	
	11X-1, 99–100	A	F	R		F		R	F	R				C	F		R							R	
NP17	11X-2, 99–100	A	F	R		F			R					C	F		R							R	
	11X-3, 99–100	A	F	R		F			R	R		F		F	F	R	R							F	
	11X-4, 99–100	A	F	R		F								F	F		R								
	11X-5, 99–100	A		R		F	R	R	R	R			R	C	C		R							R	
	11X-6, 99–100	A	C	R		R			R	R					F		R								
	11X, CC	A	F	F		R		F	R						F		R								

Table 4 (continued).

Zone	Core, section, interval (cm)	*Markalius astroporus*	*Thoracosphaera saxea*	*Neochiastozygus* spp.	*Ericsonia cava*	*Coccolithus pelagicus*	*Chiasmolithus consuetus*	*Chiasmolithus solitus*	*Chiasmolithus grandis*	*Chiasmolithus expansus*	*Zygrhablithus bijugatus*	*Discoaster salisburgensis*	*Discoaster gemmeus*	*Discoaster lodoensis*	*Discoaster germanicus*	*Discoasteroides kuepperi*	*Discoaster deflandrei*	*Discoaster sublodoensis*	*Tribrachiatus orthostylus*	*Sphenolithus radians*	*Neococcolithes dubius*	*Clathrolithus ellipticus*	*Coronocyclus nitescens*	*Reticulofenestra dictyoda*
NP17	12X-1, 100–101					C			C		C		R										F	R
	12X-5, 100–101		R			C			C		A		F		F					R			F	R
NP16	12X-6, 100–101					C			F		A									R			R	
	12X, CC					C			F		A									F			R	
	13X-1, 99–100		R			C	R		C		A				R		R			R			R	
	13X-2, 99–100		R			C			C		A									R			R	
	13X, CC	V	R			C		R	R		C						R			R			F	R
NP15	14X-1, 100–101		F			F		R	C	R	A									R			F	R
	14X-3, 100–101		F			C		C	F		A						R							R
	14X-5, 100–101		R			C		R	F		C		F										R	R
	14X-6, 100–101					C		R	F		A												R	R
	14X, CC		R			C		R	F	F	A												R	R
	15X-1, 100–101					C		R	C		C											R	F	R
	15X-2, 100–101					F			C		A												R	R
	15X, CC					F			C	R	A					F	R			R			R	R
	16X-1, 99–100					R			F	R	A									R			F	R
	16X-3, 99–100					F			F	R	A					R				R		R	R	C
NP14	16X, CC					C		R	F	R	A									R			R	C
	17X-1, 99–100		R	R		F		R	R		C			R		R	R	F		R		R	F	R
	17X-4, 104–105					F			R		C			R				F		R			F	R
	17X-5, 99–100					R-F	V		R		C			R				F		R			F	
	17X, CC	V				F		F	F	F	A			R		R		R		F			F	R
	18X-1, 100–101		F			F			C	R	A			R		R	R	F		R			F	R
	18X-2, 100–101		R			F		R	F		A	V		R		R		R		R			F	R
	18X-3, 100–101		R	R		C		R	F		A			R		R	R	R		R			C	R
	18X-5, 100–101					C			C	C	A			C		R		R		R			F	F
NP13	18X-6, 100–101					C			F	C	A	V		C		R				F			R	R
	18X, CC		R			C	R		F		A			C		F				F			R	F
	19X-1, 100–101	V			F	C			F		A			C		R				R		R	R	F
	19X-2, 100–101					C			R		A			C		R							R	F
NP12	19X-3, 100–101		R		F	C	R		R	F	A			C		F	R		R	R	R		R	F
	19X, CC		R			R			F		A			C		R			R	R			R	R

huxleyi can only be determined accurately using the electron microscope.

Figures 2 to 7 show the biostratigraphic zonation (Martini, 1971) for individual sites. Species used for recognizing each zonal boundary are described in detail in Haq, von Rad, O'Connell, et al. (1990) and will not be repeated here. Remarks on the biostratigraphy of each site are given in the following paragraphs. Site 762 may be considered an important reference section for the eastern Indian Ocean because of its stratigraphic continuity. The nannofossil assemblage at Site 762 is therefore described in considerably greater detail than the other sites.

Site 759

Two holes were drilled at this site: 759A and 759B (16°57.24–.25′S, 115°33.61–.63′E; 2092 m water depth). There was no core recovery at Hole 759A. Hole 759B was rotary-cored to a depth of 308 meters below sea floor (mbsf), penetrating 40.5 m of Cenozoic sediments.

The interval from the top of Core 122-759B-3R to Section 122-759B-4R-4, 25 cm, is Quaternary in age (Zones NN19–NN21). A hiatus exists at this level, with the underlying sediments from Sections 122-759B-4R-4, 26 cm, through 122-759B-5R-CC assignable to lower Miocene Zones NN4/NN5. Core 122-759B-5R rests unconformably on Triassic rocks.

Site 760

Two holes were drilled at Site 760: 760A and 760B (16°55.32′S, 115°32.48′E; 1970 m water depth). Hole 760A was cored using the advanced piston corer (APC) to a depth of 83.7 mbsf (the base of the Tertiary), then continued to a depth of 284.9 mbsf using the extended core barrel (XCB).

Figure 2 shows the zonation of Cenozoic sediments in Hole 760A. The sequence ranges from upper Pleistocene (NN20/NN21) to lower Eocene (NP10/NP11). Several hiatuses occur as shown by the missing zonal intervals NP21–NP22 (uppermost Eocene–lower Oligocene), NN4 (lower Miocene), NN12–NN15 (upper Miocene–lower Pliocene), and NN17–NN18 (upper Pliocene). Zones NN8 and NN10 are missing at our almost complete "standard" Cenozoic Site 762, but are present here in Hole 760A; Table 1 is a checklist of species occurring across this interval.

Site 761

Three holes were drilled at this site: 761A, 761B, and 761C (16°44.22–.26′S, 115°32.09–.10′E; 2168 m water depth). Only one core (Quaternary) was taken at Hole 761A. Hole 761B was APC-cored to a depth of 89.7 mbsf (middle Eocene), then XCB-cored to a depth of 286.7 mbsf (Triassic); the Cretaceous/Tertiary (K/T) boundary was encountered at 175.7 mbsf. Hole 761C was rotary-cored and two additional cores

Table 4 (continued).

Toweius gammation	*Ericsonia subdisticha*	*Blackites spinosus/B. tenuis*	*Braarudosphaera bigelowii*	*Campylosphaera dela*	*Sphenolithus moriformis*	*Ericsonia formosa*	*Discoaster barbadiensis*	*Chiphragmalithus* sp.	*Cyclicargolithus floridanus*	*Chiphragmalithus acanthodes*	*Helicosphaera lophota*	*Coccolithus eopelagicus*	*Triquetrorhabdulus inversus*	*Discoaster strictus*	*Ericsonia fenestrata*	*Discoaster saipanensis*	*Reticulofenestra umbilica*	*Nannotetrina fulgens*	*Chiasmolithus gigas*	*Cruciplacolithus staurion*	*Sphenolithus furcatolithoides*	*Rhabdosphaera inflata*	*Bramletteius serraculoides*	*Thoracosphaera heimi*	*Thoracosphaera prolata*	*Nannotetrina cristata*	*Sphenolithus spiniger*	*Discoaster nodifer*	*Helicosphaera compacta*	*Reticulofenestra reticulata*	*Pontosphaera plana*	*Dictyococcites callidus* s.l.
		R																														
	R			R	R	C	F		A			F		R			C				F		R					R	R	R		
				R	R	C	F		A			F				F	C				F		R		R			R	R	F	R	R
				R	R		F		A			R				R	F				F		R					R		R		
	R		V	R	R	F	F		A			F				R	F				F		R		R		F	F				
		R		R	R	F	F		A			F				F	C				F		R	R			R	R				
				F		F	R		A												F		R									
	R			F	F	F	F		A		R	F				R	C				F		R		R		R	R				
	R			F		F	R		A		R	F	R				R				F		R			V						
	R	R		R	R	R	R		A			V	F			R	R				R		R									
	R			R		F	F		C				F				F				F		R									
	R			R		F	F		C				F				F		R		F		R									
				R		F	F		C				F			R	F	R	C		F		R									
	R			R	R	F	R		A				F			R	F		C		R		R									
	R			R		F	F		A								F															
	R	R		R	V	F	F		A			R	C			F	F	R	F		R											
	R	R				F	C		A	R		R	C				R															
	R			R		R	F		A	V			C		R	F	R	R		R												
		R		R		R	F		A	R			F			R				V						V						
		R				F	F		A	R		R	F									R										
						F	F		A	R			F																			
R	R					C	F		A		R	R	F		F							R										
R	R			F		F	F		A	F		R	C																			
R				R		F	F	R	C	R	R																					
R			V	F		F	F		C	R			F																			
				F			F		C	R			F																			
F	R			R	R	F	R		C			V	C																			
F	R			R		F	R						R																			
F	R		R	C		F	R	R		F																						
R	R			C		R	R		R					R																		
	R		R	F		F																										
V	R		R	F		F																										
V				R		F																										

(122-761C-2R and -3R) were taken across the K/T boundary in this hole.

The Cenozoic sequence at Hole 761B has a number of missing intervals. Hiatuses occur at the K/T boundary (NP1), in the lower Eocene (NP10–NP13), from the middle Eocene to the upper Oligocene (NP17–NP24), in the upper Miocene to lower Pliocene (NN9 (in part) to NN10 and NN12 to NN15), and in the upper Pliocene (NN17 to NN18) (Fig. 3). Hole 761C recovered a thin NP1 zonal interval, which is missing at Hole 761B.

The Paleocene at this site contains an assemblage of radiolarians suitable for establishing a Paleocene radiolarian zonation (Blome, this volume). This was an important discovery, since the Paleocene is currently unzoned by radiolarians. We have included a calcareous nannofossil range chart for the important Paleocene interval (Table 2), which also provides complementary data for the radiolarian zonation. We also include a range chart (Table 2) for the upper part of the lower Miocene (Zones NN2–NN4/NN5), since Zone NN3 is missing in our standard section at Site 762.

Site 762

Three holes were drilled at Site 762: 762A, 762B, and 762C (19°53.23–.24′S, 112°15.24–.26′E; 1360 m water depth). At Hole 762A, a single core of Quaternary age was recovered. Hole 762B was APC-cored to a depth of 175.4 mbsf (lower Oligocene). Hole 762C was XCB-cored to a depth of 940 mbsf (Lower Cretaceous). The K/T boundary was penetrated at 554.5 mbsf.

Holes 762B and 762C together form one of the most complete Cenozoic sequences ever recovered at a single site (Fig. 4). Only a few calcareous nannofossil zones are missing, and these are exclusively in the Miocene (NN3, NN8, and NN10). Tables 3 and 4 are detailed range charts and biozonation of the Cenozoic at Site 762. Figure 5 plots the first occurrence and last occurrence of biochronologically important species against core positions and biozones at Site 762. The continuity of the section and good preservation of the taxa offered an opportunity to perform a rigorous biomagnetochronologic analysis of the nannofossils at Site 762 by integrating biostratigraphy and magnetostratigraphy. The first stage of this study, a late Miocene–Quaternary biomagnetochronologic synthesis, is presented elsewhere (Siesser et al., chapter 40, this volume).

Site 763

Three holes were drilled at this site: 763A, 763B, and 763C (20°35.19–.21′S, 112°12.50–.52′E; 1368 m water depth). Hole 763A was APC-cored to a depth of 194.9 mbsf (upper Eocene). Hole 763B was XCB-drilled to a depth of 653.5 mbsf (Lower Cretaceous). The K/T boundary occurs at 247.0 mbsf in Hole 763B.

Table 4 (continued).

Zone	Core, section, interval (cm)	*Thoracosphaera saxea*	*Biantholithus sparsus*	*Neochiastozygus* spp.	*Fasciculithus tympaniformis*	*Neochiastozygus junctus*	*Ericsonia cava*	*Coccolithus pelagicus*	*Chiasmolithus bidens*	*Chiasmolithus consuetus*	*Discoaster salisburgensis*	*Discoaster binodosus*	*Discoaster multiradiatus*	*Zygodiscus plectopons*	*Lophodolithus nascens*	*Zygrhablithus bijugatus*	*Tribrachiatus contortus*	*Tribrachiatus bramlettei*	*Calcidiscus protoannulus*	*Heliolithus riedelii*	*Chiasmolithus solitus*	*Discoaster nobilis*	*Tribrachiatus orthostylus*	*Sphenolithus radians*
NP12	20X-1, 100–101						F	F		R	R					A							F	
	20X-3, 100–101						R	R			R					A							F	R
	20X, CC						F	C		R	F					A					R		R	C
	21X-1, 100–101						F	C		R	R	R				A							F	F
	21X, CC	R					C	C		R					R	A							R	R
	22X-1, 101–102						F	C			R	R			R	A			F		R		R	R
	22X-3, 100–102																							
	22X-5, 100–102						F	C			F					C							R	R
	22X-6, 100–101	R					C	C			R	R				C							F	
	22X, CC	R		R			C	C		R	R	F				A							C	R
NP11	23X-1, 100–101	F					F	F		R	R				R	A			R			R	R	R
	23X-3, 95–96	R	V	R			F	F		R	F			R	C	A						R		R
	23X, CC	R		R			C	F		R-F	F	R		F	F	A			R			R	R	F
	24X-1, 100–101	R		R			F	F		R	F			R	F	A			R			R	F	F
	24X, CC	R		R-V			R	C	R		C	R	R			A		V			R	F	F	R
	25X-1, 100–101	R					R	F		R	F	R			R	A						R	R	R
										R														
	25X-3, 100–101	R		R			F	R		R	C		R		R	C			V			F		R
NP10	25X-4, 100–101				V		R	R	R	R	F					C	V					F		
	25X, CC				R		R	R	F	R	F					C	R					F	R	
																				V				
	26X-1, 100–102				R		A	A	F	F	C		V		R	A					F	R		
	26X-3, 100–101	R			R	R	A	R	F	R	F		R		R	A				R	F			
	26X-4, 100–101				R		A	R			F					A								
	26X-5, 100–101				V			R			C	R	C			A	R					R		
	26X, CC				R		A	A	F	F	C		C			C		F						

Figure 6 shows the Cenozoic zonation at Site 763. The entire Paleocene, the lower Eocene, and part of the middle Eocene (Zones NP1–NP14) are missing at this site. In addition, Zones NP17 (middle Eocene), NN6–NN9 (middle to upper Miocene), and NN17 (upper Pliocene) are missing. A range chart of species across the NP25–NN4/NN5 interval is given in Table 5 in order to investigate further the Zone NN3 interval missing in our standard section at Site 762.

Site 764

Two holes were drilled at this site: 764A and 764B (16°33.96'S, 115°27.43'E; 2697 m water depth). Hole 764A was rotary-cored to a depth of 169 mbsf. A thin (41.5-m-thick) Cenozoic sequence unconformably overlies Maestrichtian sediments at this site. The lowermost Cenozoic section (122-764A-5R-3) contains a mixed Eocene-Oligocene assemblage (Fig. 7). Overlying this mixed assemblage is an apparently complete sequence ranging from NP24 (upper Oligocene) to NN4/NN5 (lower to middle Miocene). A major lower-middle Miocene–Quaternary hiatus separates Section 122-764A-1R-7 (NN4/NN5) from Section 122-764A-1R-6 (NN19)

SUMMARY

Two sites located on the central part of the Exmouth Plateau and four sites located on a northern marginal spur, the Wombat Plateau were drilled during Leg 122. Cenozoic sediments containing abundant, diverse, and generally well-preserved nannofossils were recovered at all sites. Each site was amenable to detailed zonation using Martini's (1971) tropical-temperate calcareous nannofossil zonation. Species assemblages suggest generally temperate-tropical conditions throughout the Cenozoic.

Minor hiatuses occur throughout the Cenozoic section. Site 762, however, contains an almost complete Cenozoic section, missing only short intervals in the Miocene. This site may prove to be a useful biostratigraphic and biomagnetochronologic reference section for the eastern Indian Ocean.

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Table 4 (continued).

Reticulofenestra dictyoda	*Pontosphaera* spp.	*Pontosphaera* sp. A.	*Toweius gammation*	*Cruciplacolithus cribellum*	*Transversopontis duocavus*	*Transversopontis pulcheroides*	*Campylosphaera eodela*	*Discoaster robustus*	*Ericsonia subdisticha*	*Transversopontis zigzag*	*Transversopontis pulcher*	*Braarudosphaera bigelowii*	*Transversopontis fimbriatus*	*Transversopontis obliquipons*	*Chiphragmalithus calathus*	*Ericsonia formosa*	*Neococcolithes dubius*	*Discoaster delicatus*	*Rhabdosphaera perlongus*	*Discoaster lodoensis*	*Discoaster germanicus*	*Chiasmolithus grandis*	*Clathrolithus ellipticus*	*Discoasteroides kuepperi*	*Discoaster deflandrei*	*Coronocyclus nitescens*	*Campylosphaera dela*	*Chiasmolithus expansus*	*Sphenolithus moriformis*	*Discoaster wemmelensis*	*Micrantholithus pinguis*
																F				C				R				R			
F																F				C		R	R	R						R	
F												C								C				R		R	R	R			V
R																F				C	R	F		F		R	R				
F	R						V									F				F		R		R		R	F				
C																F				F		F		R			R		R		
C																F				F	R	R	R	R	R						
C															R	F				R											
C	R						R		R		R	F		R		F				C		R									
C			R		R		R				R	R		R	R	V			R												
C	F			R	R		R		R	R	R	R	R	R		V		V	R								R				
F		R					R							R	R	R	R										R				
C		R		R	R	R	R	V			R					R			R												
A		R			V																										
F		R	V	R			R																								
F		R					R							V																	
		R																													
		R																													
		R					R																								
	R	R																													
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APPENDIX

Cenozoic Calcareous Nannofossils in Exmouth Plateau Sediments

Listed in alphabetical order of species epithets:

Scyphosphaera abelei Rade (1975)
Sphenolithus abies Deflandre in Deflandre and Fert (1954)
Chiphragmalithus acanthodes Bramlette and Sullivan (1961)
Ceratolithus acutus Gartner and Bukry (1974)
Discoaster adamanteus Bramlette and Wilcoxon (1967)
Chiasmolithus altus Bukry and Percival (1971)
Scyphosphaera amphora Deflandre (1942)
Scyphosphaera ampla Kamptner (1955)
Amaurolithus amplificus (Bukry and Percival) Gartner and Bukry (1975)
Markalius apertus Perch-Nielsen (1979)
Scyphosphaera apsteinii dilatata Gaarder (1970)
Scyphosphaera apsteinii Lohmann (1902)
Scyphosphaera aranta Kamptner (1967)
Ceratolithus armatus Müller (1974)
Markalius astroporus (Stradner) Hay and Mohler (1967)
Discoaster asymmetricus Gartner (1969)
Discoaster barbadiensis Tan (1927)
Sphenolithus belemnos Bramlette and Wilcoxon (1967)
Discoaster bellus Bukry and Percival (1971)
Chiasmolithus bidens (Bramlette and Sullivan) Hay and Mohler (1967)
Braarudosphaera bigelowii (Gran and Braarud) Deflandre (1947)
Zygrahablithus bijugatus (Deflandre) Deflandre (1959)
Fasciculithus billii Perch-Nielsen (1971)
Discoaster binodosus Martini (1958)
Dictyococcites bisectus (Hay, Mohler and Wade) Bukry and Percival (1971)
Prinsius bisulcus (Stradner) Hay and Mohler (1967)
Amaurolithus bizzarus (Bukry) Gartner and Bukry (1975)
Lapideacassis blackii Perch-Nielsen in Perch-Nielsen and Franz (1977)
Discoaster blackstockae Bukry (1973)
Discoaster braarudii Bukry (1971)
Discoaster bramlettei (Bukry and Percival) Romein (1979)
Tribrachiatus bramlettei (Bronnimann and Stradner) Proto Decima et al. (1975)
Zygodiscus bramlettei Perch-Nielsen (1981)
Discoaster brouweri Tan 1927 emend. Bramlette and Riedel (1954)
Chiphragmalithus calathus Bramlette and Sullivan (1961)
Discoaster calcaris Gartner (1967)
Dictyococcites callidus Perch-Nielsen (1971)
Catinaster calyculus Martini and Bramlette (1963)
Scyphosphaera campanula Deflandre (1942)
Scyphosphaera canescens Kamptner (1955)
Sphenolithus capricornutus Bukry and Percival (1971)
Gephyrocapsa caribbeanica Boudreaux and Hay (1969)
Triquetrorhabdulus carinatus Martini (1965)
Helicosphaera carteri (Wallich) Kamptner (1954)
Ericsonia cava (Hay and Mohler) Perch-Nielsen (1969)
Discoaster challengeri Bramlette and Riedel (1954)
Triquetrorhabdulus challengeri Perch-Nielsen (1977)
Neochiastozygus chiastus (Bramlette and Sullivan) Perch-Nielsen (1971)
Sphenolithus ciperoensis Bramlette and Wilcoxon (1967)
Rhabdosphaera claviger in Murray and Blackman (1898)

Table 4 (continued).

Zone	Core, section, interval (cm)	*Thoracosphaera* sp. A.	*Thoracosphaera operculata*	*Thoracosphaera saxea*	*Biantholithus sparsus*	*Placozygus sigmoides*	*Cruciplacolithus tenuis*	*Ericsonia subpertusa*	*Discoaster bramlettei/Z. herlynii*	*Neochiastozygus chiastus*	*Ericsonia cava*	*Prinsius bisulcus*	*Chiasmolithus bidens*	*Bomolithus elegans*	*Ellipsolithus distichus*	*Chiasmolithus consuetus*	*Discoaster mohleri*	*Pontosphaera* sp. A.	*Zygodiscus plectopons*	*Coccolithus pelagicus*	*Heliolithus riedelii*	*Neococcolithes protenus*	*Fasciculithus involutus*	*Neochiastozygus junctus*	*Discoaster salisburgensis*	*Semihololithus kerabyi*	*Tribrachiatus contortus*	*Lophodolithus nascens*	*Discoaster binodosus*	*Discoaster multiradiatus*	*Zygrhablithus bijugatus*	*Sphenolithus conicus*	*Tribrachiatus bramlettei*	*Discoaster bramlettei*	*Toweius eminens*	*Fasciculithus tympaniformis*	*Ericsonia robusta*	*Campylosphaera eodela*	*Calcidiscus protoannulus*
NP10	27X-1, 99–100			R				R	R	F	A		F		R	R		R	R	A		R			C			R	R	C	C	R	R			R		R	
	27X-2, 100–101			R				R	R		A		F			R	R			C					C					C	A								
	27X-3, 99–100			R		R		R	R		A		F			R		R		C			F		C		R	R		C	A					F		R	
NP9	27X-4, 100–101			R					R		C		F			R	R			F					C					C	A					R			
	27X, CC	R	F	R				R	R		C		F		R	F	R			F					C	R				C	A				V	R		R	V
	28X-1, 100–101			R	V								F	R		R	R			F			R	R						C	C				C	A			
	28X, CC	R					R						F	R		F	R	R		C			F							C	C	R		R	C	A			
NP7/8	29X-1, 100–101			R				F					R	R		R	R	R		F	R		C								R			R	A	A	R		
	29X-2, 100–101							F					R	R		R	R			R			F												A	A			
	29X-3, 100–101						R	F					F	R	F	F	F			R			F											R	A	A	R		
	762C-29X, CC						R	F				F	C	R	R	C	F	R		F															A	A			

Table 4 (continued).

Zone	Core, section, interval (cm)	*Markalius astroporus*	*Thoracosphaera operculata*	*Thoracosphaera saxea*	*Thoracosphaera* sp. A.	*Biantholithus sparsus*	*Placozygus sigmoides*	*Cruciplacolithus primus*	Small *Prinsius* spp.	*Cruciplacolithus tenuis*	*Ericsonia subpertusa*	*Chiasmolithus danicus*	*Zygodiscus bramlettei/Z. herlynii*	*Neochiastozygus* spp.	*Ericsonia cava*	*Prinsius bisulcus*	*Chiasmolithus bidens*	*Fasciculithus ulii*	*Fasciculithus pileatus*	*Bomolithus elegans*	*Markalius apertus*	*Coccolithus pelagicus*	*Fasciculithus tympaniformis*	*Heliolithus kleinpellii*	*Toweius pertusus*	*Ellipsolithus distichus*	*Neochiastozygus perfectus*	*Chiasmolithus consuetus*	*Discoaster mohleri*	*Pontosphaera* sp. A	*Zygodiscus plectopons*	*Ericsonia robusta*	*Fasciculithus involutus*	*Fasciculithus billii*	*Toweius eminens*
NP7/8	30X-1, 100–101						R				R				R		F					R	C					F	C						C
	30X-3, 100–101			R			R							F			F			R		F	A					F	C	R					F
	30X, CC				R				R	R	R		R			R	R			R		F	A	V	R			R	C	R	R	R R			C
NP6	31X-1, 100–101			R							F						F					R	A	C				R							F
	31X-3, 100–101			R			R			R	F			F			R			R		R	C	F		V									F
	31X-5, 100–101			R			R				R						R					R	C	F											F
	31X, CC			R	R						F		R	R		R	R					F	C	F	R			F				R			F
	32X-1, 97–98			R					R		R		R			R						F	C	F				R							R
	32X-2, 103–104			F					R	R	F				R							F	C	F	F	V		R							R
	32X, CC			R			R		C	R	F		R				R					F	C	R	F								R		R
NP5	33X-1, 109–110			R			R		C	R	F		R	R		R	R			R		F	F		R	V		R							V
	33X-2, 109–110			R					C	R	F		R			R	R					F	F		R										R
	33X-3, 109–110		R	R					C	F	F		R	R	R	R	F					F	C		R		R	R							
	33X-4, 107–108			R					R	F	F		R			R	F					F	C		R			R							
	33X-5, 95–96		R	R					R		F		R		R	F	F		V	R		F	C		R								R		
	33X, CC			R			R		F	F	F				R	F	F		R			R	A		R										
	34X-1, 100–101								C	F	F			R		R	R		R			R	C		R	V									
	34X-2, 100–101			R			R		C	F	R				R	R	R		R			R	A												
	34X-3, 100–101			R			R		C	F					R	C	R		R			F	A												
	34X-5, 100–101								C	F	F		R			C	R		F	R		R	C												
	34X, CC		R	F	F		R		C	F	R		R	R		F	F		C	R	V	R	R												
	35X-1, 99–100			F			R		C	F	R		R			F	R		F	R		F	R												
NP4	35X-2, 12–14	R		F			R		C	F	R	R	R		F	F	F		C	R		R											R		
	35X-2, 100–101		R	R			R		C	F	F	R		R	F	F	R		C	R															
	35X, CC	R		F		R			F	F	F	R	R			F	R		R			R													
	36X-1, 6–7			R					C	F	C	R	R		R	F	R	V				R													
NP3/4	762C-36X, CC	V	R					R	C	C	F	R	R			C						R													

Table 4 (continued).

Zone	Core, section, interval (cm)	*Markalius astroporus*	*Thoracosphaera operculata*	*Thoracosphaera saxea*	*Thoracosphaera* sp. A.	*Biantholithus sparsus*	*Placozygus sigmoides*	*Cruciplacolithus primus*	*Cruciplacolithus edwardsii*	*Cruciplacolithus latipons*	*Cruciplacolithus tenuis*	*Ericsonia subpertusa*	*Chiasmolithus danicus*	*Zygodiscus bramlettei/Z. herlynii*	Small *Prinsius* spp.	*Neochiastozygus* spp.	*Ericsonia cava*	*Prinsius bisulcus*	*Lapideacassis blackii*
	37X-1, 99–100		R	F				R			F	F		F	C	R	R	F	
	37X-3, 99–100		R	R							R	R	R	C	C			R	
	37X, CC		F	F			R	R			R	F	R	R	C	F	R	F	
	38X-1, 100–101		R	R			R				F	R	F	F	C	R		R	
	38X-3, 100–101		R	R								R	F	F	A				
	38X-5, 100–101		R	F				R	R		R	F	C	F	C	R			
NP3/4	38X, CC	R	R	F			R	R		R	R		F		C			R	
	39X-1, 79–81		R	C			R	R			F	R	F	R	C				
	39X-3, 79–81		F	C			R				F		F	F	C				
	39X-5, 79–81	R	C	A			R	R	F		F		R	F	C				
	39X, CC	R	F	C			F	R	R		R	R	R	R	C			R	
	40X-1, 79–81		F	C	F		F	R	F		V		R	R	C				
	40X-2, 79–81	R	C	C			R	R	R		V		V	R	C				
----------	40X-3, 79–81	R	C	C	R	R	R	R	R		R			V	A				
	40X-5, 79–81	R	C	C	F	R	F	R	F		V	R		R	C			R	
	40X, CC	R	C	C	R		F	R	F		V	R		R	C			R	V
	41X-1, 80–82	R	F	F			R	R	F			R		R	A			V	
	41X-2, 100–101	R	F	R		R		R	F			R		R	C				
	41X-3, 101–102		F	R				F	F		V				C				
NP2	41X-4, 81–82	R	F	R			R	F	F						C				
	41X-5, 81–82	R	R	R			R	F	C						C				
	41X-CC	R	R				F	F	F		R				C				
	42X-1, 79–81	R	R			F		C	F						C				
	42X-3, 79–81	R	R	R		R		C	R						R				
	42X-4, 79–80	R	R		R		F	C	R										
	42X-5, 7–8	R	F	R	R	R	F	C	R										
NP1	42X-6, 91–92	F	F	C	R	R	C												
	762C-42X, CC	F	R	F	R	R	R												

Table 5. Calcareous nannofossils in Hole 763A.

Zone	Core, section, interval (cm)	*Dictyococcites bisectus*	*Cyclicargolithus floridanus*	*Sphenolithus heteromorphus*	*Coccolithus pelagicus*	*Coronocyclus nitescens*	*Pontosphaera* sp. B.	*Sphenolithus moriformis*	*Umbilicosphaera sibogae*	*Thoracosphaera saxea*	*Helicosphaera carteri*	*Scyphosphaera* spp.	*Calcidiscus leptoporus*	*Discoaster druggii*	*Discoaster adamanteus*	*Thoracosphaera deflandrei*	*Triquetrorhabdulus milowii*	*Reticulofenestra pseudoumbilica*	*Braarudosphaera bigelowii*	*Micrantholithus pinguis*	*Hayaster perplexus*	*Coccolithus eopelagicus*	*Triquetrorhabdulus carinatus*	*Helicosphaera perch-nielseniae*	*Sphenolithus conicus*	*Sphenolithus dissimilus*	*Sphenolithus belemnos*	*Coccolithus radiatus*	*Helicosphaera intermedia*	*Helicosphaera euphratis*	*Helicosphaera obliqua*	*Sphenolithus predistentus*	*Zygrhablithus bijugatus*	*Triquetrorhabdulus challengeri*	*Sphenolithus ciperoensis*	*Sphenolithus grandis*
	122-763A-																																			
	16H-3, 88–89		C	F	R	F	R	F	R	F	F	R	R		R	C	V	R	R																	
NN4/5	16H-4, 99–100		C	C	R	F		F	R	R						C		V																		
	16H-5, 99–100		C	F		R		C	R				R			C																				
	16H-CC		A	F	R	F	R	C	R	F	F	R	R			C			C	R	R	R	V													
	17H-2, 74–76	V	A	V	R	R	R	F	R		F				R	C			C	R	R			R	R	R	R	R								
NN3	17H-3, 99–100		C		R	R		F								C							V			R	R									
	17H-4, 34–35		C		R	F		F					R		R	C			R		R	R					R		R				V			
	17H-5, 99–100	R	C		R	F		C	R	R			R	R	R	C			R		R	R	R													
	17H-6, 99–100		A		R	F		F							R	C			R			R				F							R	V		
NN1/2	17H-CC		A		R	F	R	R							R	C	R		R			R	F		R		R		R		R	V	R	R		
	18H-1, 100–101	V	A		R	R	R	F		R					R	C					R	F	R							R			R			
	18H-2, 99–101	R	A		R	R	R	F							R	C			R			R	C													F
NP25	18H-4, 99–101	C	A		R	F		C								C			R				F										C		R	

Catinaster coalitus Martini and Bramlette (1963)
Scyphosphaera cohenii Boudreaux and Hay (1969)
Helicosphaera compacta Bramlette and Wilcoxon (1967)
Heliorthus concinnus (Martini) Hay and Mohler (1967)
Neochiastozygus concinnus (Martini) Perch-Nielsen (1971)
Scyphosphaera conica Kamptner (1955)
Sphenolithus conicus Bukry (1971)
Chiasmolithus consuetus (Bramlette and Sullivan) Hay and Mohler (1967)
Tribrachiatus contortus (Stradner) Bukry (1972)
Cruciplacolithus cribellum (Bramlette and Sullivan) Romein (1979)
Nannotetrina cristata (Martini) Perch-Nielsen (1971)
Ceratolithus cristatus Kamptner (1950)
Scyphosphaera cylindrica Kamptner (1955)
Chiasmolithus danicus (Brotzen) Hay and Mohler (1967)
Dictyococcites daviesii (Haq) Perch-Nielsen (1971)
Discoaster decorus (Bukry) Bukry (1973)
Discoaster deflandrei Bramlette and Riedel (1954)
Scyphosphaera deflandrei Müller (1974)
Thoracosphaera deflandrei Kamptner (1956)
Amaurolithus delicatus Gartner and Bukry (1975)
Campylosphaera dela (Bramlette and Sullivan) Hay and Mohler (1967)
Discoaster delicatus Bramlette and Sullivan (1961)
Reticulofenestra dictyoda (Deflandre and Fert) Stradner in Stradner and Edwards (1968)
Pontosphaera discopora Schiller (1925)
Braarudosphaera discula Bramlette and Riedel (1954)
Sphenolithus dissimilus Bukry and Percival (1971)
Sphenolithus distentus (Martini) Bramlette and Wilcoxon (1967)
Ellipsolithus distichus (Bramlette and Sullivan) Sullivan (1964)
Discoaster distinctus Martini (1958)
Discoaster druggii Bramlette and Wilcoxon (1967)
Neococcolithes dubius (Deflandre) Black (1967)
Transversopontis duocavus (Bramlette and Sullivan) Locker (1973)
Cruciplacolithus edwardsii Romein (1979)
Bomolithus elegans Roth (1973)
Clathrolithus ellipticus Deflandre in Deflandre and Fert (1954)
Toweius eminens (Bramlette and Sullivan) Perch-Nielsen (1971)
Pontosphaera enormis (Locker) Perch-Nielsen (1984)
Campylosphaera eodela Bukry and Percival (1971)
Coccolithus eopelagicus (Bramlette and Riedel) Bramlette and Sullivan in Bramlette and Wilcoxon (1967)
Helicosphaera euphratis Haq (1966)
Discoaster exilis Martini and Bramlette (1963)
Scyphosphaera expansa Bukry and Percival (1971)
Chiasmolithus expansus (Bramlette and Sullivan) Gartner (1970)
Ericsonia fenestrata (Deflandre and Fert) Stradner in Stradner and Edwards (1968)
Transversopontis fimbriatus (Bramlette and Sullivan) Locker (1968)
Cyclicargolithus floridanus (Roth and Hay) Bukry (1971)
Ericsonia formosa (Kamptner) Haq (1971)
Discoaster formosus Martini and Worsely (1971)
Scapholithus fossilis Deflandre in Delfandre and Fert (1954)
Nannotetrina fulgens (Stradner) Achutan and Stradner (1969)
Sphenolithus furcatolithoides Locker (1967)
Toweius gammation (Bramlette and Sullivan) Romein (1979)
Discoaster gemmeus Stradner (1961)
Corannulus germanicus Stradner (1962)
Discoaster germanicus Martini (1958)
Chiasmolithus gigas (Bramlette and Sullivan) Radomski (1968)
Scyphosphaera gladstonensis Rade (1975)
Scyphosphaera globulata Bukry and Percival (1971)
Scyphosphaera globulosa Kamptner (1955)
Chiasmolithus grandis (Bramlette and Riedel) Gartner (1970)
Sphenolithus grandis Haq and Berggren (1978)
Helicosphaera granulata Bukry and Percival (1971)
Discoaster hamatus Martini and Bramlette (1963)
Reticulofenestra haqii Backman (1978)
Fasciculithus hayi Haq (1971)
Thoracosphaera heimi (Lohmann) Kamptner (1920)
Zygodiscus herlynii Sullivan (1964)
Sphenolithus heteromorphus Deflandre (1953)
Emiliania huxleyi (Lohmann) Hay and Mohler in Hay et al. (1967)
Rhabdosphaera inflata Bramlette and Sullivan (1961)
Discoaster intercalaris Bukry (1971)
Sphenolithus intercalaris Martini (1976)
Helicosphaera intermedia Martini (1965)
Scyphosphaera intermedia Deflandre (1942)
Markalius inversus (Deflandre) Bramlette and Martini (1964)
Triquetrorhabdulus inversus Bukry and Bramlette (1969)
Fasciculithus involutus Bramlette and Sullivan (1961)
Peritrachelina joidesa Bukry and Bramlette (1968)
Neochiastozygus junctus (Bramlette and Sullivan) Perch-Nielsen (1971)
Scyphosphaera kamptneri Müller (1974)
Semihololithus kerabyi Perch-Nielsen (1971)
Heliolithus kleinpelli Sullivan (1964)
Discoasteroides kuepperi (Stradner) Bramlette and Sullivan (1961)
Discoaster kugleri Martini and Bramlette (1963)
Pseudoemiliania lacunosa (Kamptner) Gartner (1969)
Scyphosphaera lagena Kamptner (1955)
Cruciplacolithus latipons Romein (1970)
Calcidiscus leptoporus (Murray and Blackman) Loeblich and Tappan (1978)
Discoaster lodoensis Bramlette and Riedel (1961)
Rhabdosphaera longistylis Schiller (1925)
Helicosphaera lophota Bramlette and Sullivan (1961)
Cyclococcolithus luminis Sullivan (1965)
Ellipsolithus macellus (Bramlette and Sullivan) Sullivan (1964)
Calcidiscus macintyrei (Bukry and Bramlette) Loeblich and Tappan (1978)
Fasciculithus magnicordis Romein (1979)
Prinsius martinii (Perch-Nielsen) Haq (1971)
Triquetrorhabdulus milowii Bukry (1971)
Reticulofenestra minuta Roth (1970)
Reticulofenestra minutula (Gartner) Haq and Berggren (1978)
Lanternithus minutus Stradner (1962)
Discoaster mohleri Bukry and Percival (1971)
Sphenolithus moriformis (Bronnimann and Stradner) Bramlette and Wilcoxon (1967)
Pontosphaera multipora (Kamptner) Roth (1970)
Discoaster multiradiatus Bramlette and Riedel (1954)
Lophodolithus nascens Bramlette and Sullivan (1961)
Sphenolithus neoabies Bukry and Bramlette (1969)
Discoaster neohamatus Bukry and Bramlette (1969)
Discoaster neorectus Bukry (1971)
Coronocyclus nitescens (Kamptner) Bramlette and Wilcoxon (1967)
Discoaster nobilis Martini (1961)
Discoaster nodifer (Bramlette and Riedel) Bukry (1973)
Chiasmolithus oamaruensis (Deflandre) Hay, Mohler and Wade (1966)
Helicosphaera obliqua Bramlette and Wilcoxon (1967)
Transversopontis obliquipons (Deflandre) Hay, Mohler and Wade (1966)
Gephyrocapsa oceanica Kamptner (1943)
Thoracosphaera operculata Bramlette and Martini (1964)
Scyphosphaera oremesa Kamptner (1967)
Tribrachiatus orthostylus Shamrai (1963)
Scyphosphaera pacifica Rade (1975)
Coccolithus pelagicus (Wallich) Schiller (1930)
Scyphosphaera penna Kamptner (1955)
Discoaster pentaradiatus Tan 1927 emend. Bramlette and Riedel (1954)
Helicosphaera perch-nielseniae Haq (1971)
Neochiastozygus perfectus Perch-Nielsen (1971)
Rhabdosphaera perlongus (Deflandre) in Grasse (1952)
Hayaster perplexus (Bramlette and Riedel) Bukry (1973)
Toweius pertusus (Sullivan) Romein (1979)
Fasciculithus pileatus Bukry (1973)
Micrantholithus pinguis Bramlette and Sullivan (1961)
Scyphosphaera piriformis Kamptner (1955)
Pontosphaera plana (Bramlette and Sullivan) Haq (1971)
Zygodiscus plectopons Bramlette and Sullivan (1961)
Scyphosphaera porosa Kamptner (1967)
Sphenolithus predistentus Bramlette and Wilcoxon (1967)
Amaurolithus primus (Bukry and Percival) Gartner and Bukry (1975)
Cruciplacolithus primus Perch-Nielsen (1977)

Rhabdosphaera procera Martini (1969)
Scyphosphaera procera Kamptner (1955)
Thoracosphaera prolata Bukry and Bramlette (1969)
Neococcolithes protenus (Bramlette and Sullivan) Black (1967)
Calcidiscus protoannulus (Gartner) Loeblich and Tappan (1978)
Sphenolithus pseudoradians Bramlette and Wilcoxon (1967)
Reticulofenestra pseudoumbilica (Gartner) Gartner (1969)
Transversopontis pulcher (Deflandre) Hay, Mohler and Wade (1966)
Transversopontis pulcheroides (Sullivan) Baldi-Beke (1971)
Scyphosphaera pulcherrima Deflandre (1942)
Pontosphaera punctosa (Bramlette and Sullivan) Perch-Nielsen (1984)
Discoaster quinqueramus Gartner (1969)
Sphenolithus radians Deflandre (1952)
Coccolithus radiatus Kamptner (1955)
Scyphosphaera recta (Deflandre) Kamptner (1955)
Scyphosphaera recurvata Deflandre (1942)
Isthmolithus recurvus Deflandre in Deflandre and Fert (1954)
Helicosphaera reticulata Bramlette and Wilcoxon (1967)
Reticulofenestra reticulata (Gartner and Smith) Roth and Thierstein (1967)
Scapholithus rhombiformis Hay and Mohler (1967)
Heliolithus riedelii Bramlette and Sullivan (1961)
Ericsonia robusta (Bramlette and Sullivan) Perch-Nielsen (1977)
Discoaster robustus Haq (1969)
Ceratolithus rugosus Bukry and Bramlette (1968)
Triquetrorhabdulus rugosus Bramlette and Wilcoxon (1967)
Discoaster saipanensis Bramlette and Riedel (1954)
Discoaster salisburgensis Stradner (1961)
Thoracosphaera saxea Stradner (1961)
Discolithina segmenta Bukry and Percival (1971)
Bramletteius serraculoides Gartner (1969)
Umbilicosphaera sibogae (Weber-van Bosse) Gaarder (1970)
Placozygus sigmoides (Bramlette and Sullivan) Romein (1979)
Discoaster signus Bukry (1971)
Hayella situliformis Gartner (1969)
Chiasmolithus solitus (Bramlette and Sullivan) Locker (1968)
Biantholithus sparsus Bramlette and Martini (1964)
Sphenolithus spiniger Bukry (1971)
Blackites spinosus (Deflandre and Fert) Hay and Towe (1962)
Cruciplacolithus staurion (Bramlette and Sullivan) Gartner (1971)
Discoaster strictus Stradner (1961)
Ericsonia subdisticha (Roth and Hay) Roth in Baumann and Roth (1969)
Discoaster sublodoensis Bramlette and Sullivan (1961)
Ericsonia subpertusa Hay and Mohler (1967)
Discoaster surculus Martini and Bramlette (1963)
Discoaster tamalis Kamptner (1967)
Discoaster tanii Bramlette and Riedel (1954)
Ceratolithus telesmus Norris (1965)
Blackites tenuis (Bramlette and Sullivan) Bybell (1975)
Cruciplacolithus tenuis (Stradner) Hay and Mohler in Hay et al. (1967)
Amaurolithus tricorniculatus (Gartner) Gartner and Bukry (1975)
Discosphaera tubifer (Murray and Blackman) Ostenfeld (1900)
Scyphosphaera tubifera Kamptner (1955)
Scyphosphaera turris Kamptner (1955)
Fasciculithus tympaniformis Hay and Mohler in Hay et al. (1967)
Fasciculithus ulii Perch-Nielsen (1971)
Reticulofenestra umbilica (Levin) Martini and Ritzkowski (1968)
Discoaster variabilis Martini and Bramlette (1963)
Scyphosphaera ventriosa Martini (1968)
Pontosphaera versa (Bramlette and Sullivan) Sherwood (1974)
Rhabdosphaera vitreus Deflandre in Deflandre and Fert (1954)
Helicosphaera wallichii (Lohmann) Boudreaux and Hay (1969)
Discoaster wemmelensis Achutan and Stradner (1969)
Helicosphaera wilcoxonii Gartner (1971)
Transversopontis zigzag Roth and Hay in Hay et al. (1967)

HOLE 760A

	CORE-SECTION	NANNO ZONE	SERIES
1H	1H-1 TO 1H-4	NN 20-21	PLEISTOCENE
1H, 2H	1H-5 TO 2H-6	NN 19	
2H	2H-7	NN 16	U. PLIOCENE
	2H-CC	NN 11	U. MIOCENE
3H	3H-1 TO 3H-3	NN 16	U. PLIOCENE
	3H-4 TO 3H-5	NN 11	U. MIOCENE
	3H-6	NN 10	
	3H-7 TO 3H-CC	NN 9	
4H	4H-1 TO 4H-3	NN 8	
	4H-4 TO 4H-5	NN 7	M. MIOCENE
4H, 5H	4H-6 TO 5H-1	NN 6	
5H	5H-2 TO 5H-6	NN 5	
5H, 6H	5H-CC TO 6H-1	NN 3	L. MIOCENE
6H	6H-2 TO 6H-CC	NN 2	
7H	7H-1	NN 1	
	7H-2 TO 7H-5	NP 25	U. OLIGOCENE
7H, 8H	7H-6 TO 8H-1	NP 24	
8H	8H-2 TO 8H-4	NP 23	L. OLIGOCENE
8H, 9H	8H-4 TO 9H-1	NP 20	U. EOCENE
9H	9H-2 TO 9H-4	???	L.-M. EOCENE
	9H-5 TO 9H-6	NP 10-11 +NC?	L. EOCENE+ CRETACEOUS

Figure 2. Calcareous nannofossil zonation (Martini, 1971) of Hole 760A, Wombat Plateau.

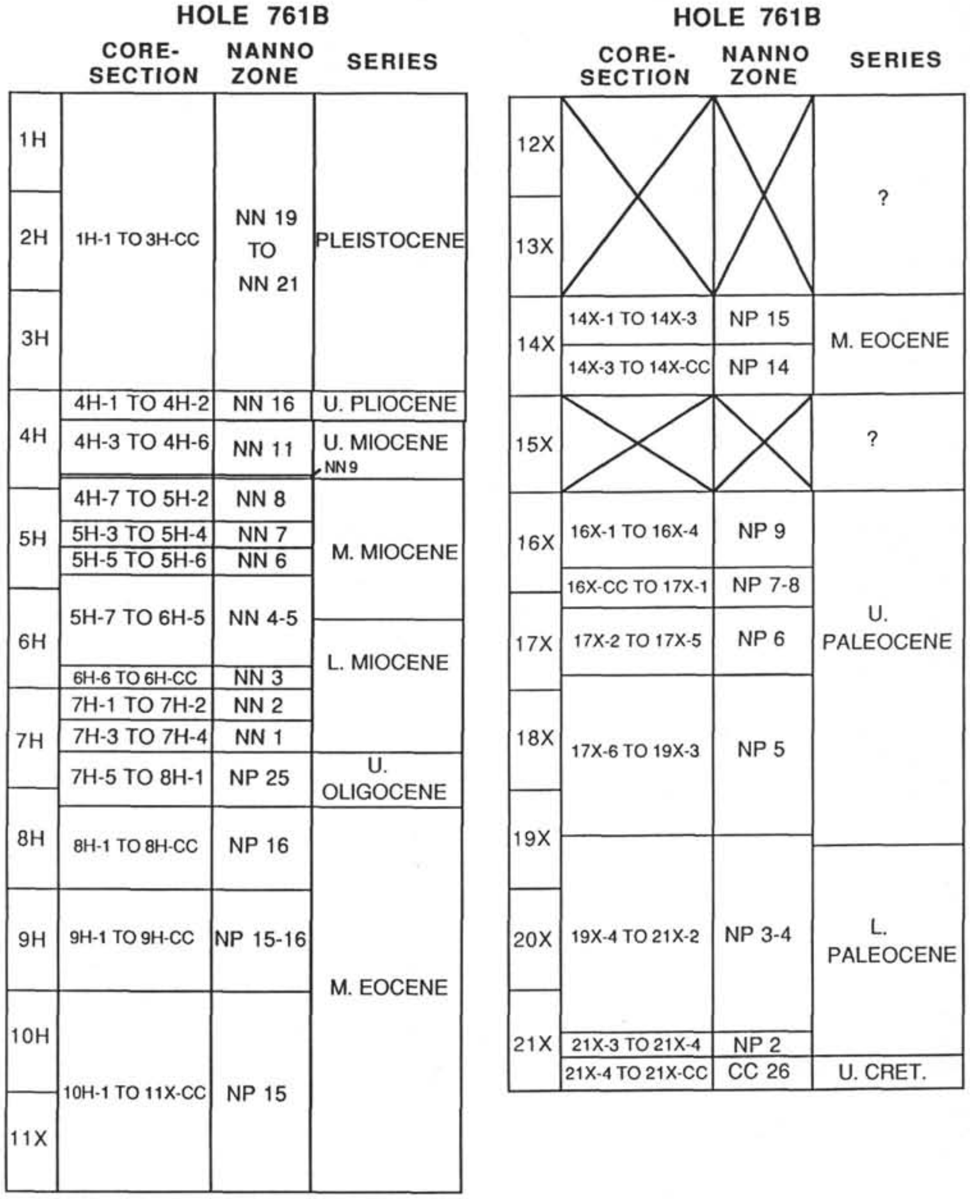

Figure 3. Calcareous nannofossil zonation (Martini, 1971) of Hole 761B, Wombat Plateau.

HOLE 762B

CORE	CORE-SECTION	NANNO ZONE	SERIES
1H	1H-CC	NN 20-21	PLEISTOCENE
2H, 3H, 4H	2H-1 TO 4H-3	NN 19	
	4H-4 TO 5H-2	NN 17-18	U. PLIOCENE
5H, 6H, 7H	5H-3 TO 8H-1	NN 16	
8H	8H-3 TO 8H-CC	NN 14-15	L. PLIOCENE
9H, 10H	9H-1 TO 11H-2	NN 13	
11H	11H-3 TO 11H-CC	NN 12	
12H	12H-1 TO 13H-2	NN 11	U. MIOCENE
13H	13H-3 TO 13H-CC	NN 9	
14H	14H-1 TO 14H-5	NN 6-7	M. MIOCENE
	14H-6 TO 15H-4	NN 4-5	
15H, 16H	15H-5 TO 16H-5	NN 1-2	L. MIOCENE
17H	16H-6 TO 17H-4	NP 24-25	U. OLIGOCENE
	17H-5 TO 18H-4	NP 23	L. OLIGOCENE
18H, 19H	18H-5 TO 19H-5	NP 22	
	19H-5 TO 19H-CC	NP 21	

HOLE 762C

CORE	CORE-SECTION	NANNO ZONE	SERIES
2X, 3X, 4X	2X-2 TO 5X-1	NP 21	L. OLIGOCENE
5X, 6X	5X-2 TO 7X-3	NP 19-20	U. EOCENE
7X, 8X, 9X	7X-4 TO 9X-CC	NP 18	
10X, 11X, 12X	10X-1 TO 12X-5	NP 17	M. EOCENE
13X	12X-6 TO 13X-CC	NP 16	
14X, 15X, 16X	14X-1 TO 16X-3	NP 15	
17X, 18X	16X-CC TO 18X-5	NP 14	
	18X-6 TO 19X-2	NP 13	L. EOCENE
19X, 20X, 21X, 22X	19X-3 TO 22X-CC	NP 12	

HOLE 762C

CORE	CORE-SECTION	NANNO ZONE	SERIES
23X, 24X	23X-1 TO 25X-3	NP 11	L. EOCENE
25X, 26X	25X-4 TO 27X-3	NP 10	
27X, 28X	27X-4 TO 28X-CC	NP 9	U. PALEOCENE
29X, 30X	29X-1 TO 30X-CC	NP 7-8	
31X, 32X	31X-1 TO 32X-CC	NP 6	
33X, 34X	33X-1 TO 35X-1	NP 5	
35X	35X-2 TO 36X-1	NP 4	L. PALEOCENE
36X, 37X, 38X, 39X	36X-CC TO 40X-2	NP 3-4	
40X, 41X, 42X	40X-3 TO 42X-5	NP 2	
	42X-6 TO 43X-1	NP 1	
43X	43X-1,31cm -	CC 26	MAEST.

Figure 4. Calcareous nannofossil zonation (Martini, 1971) of Holes 762B and 762C, central Exmouth Plateau.

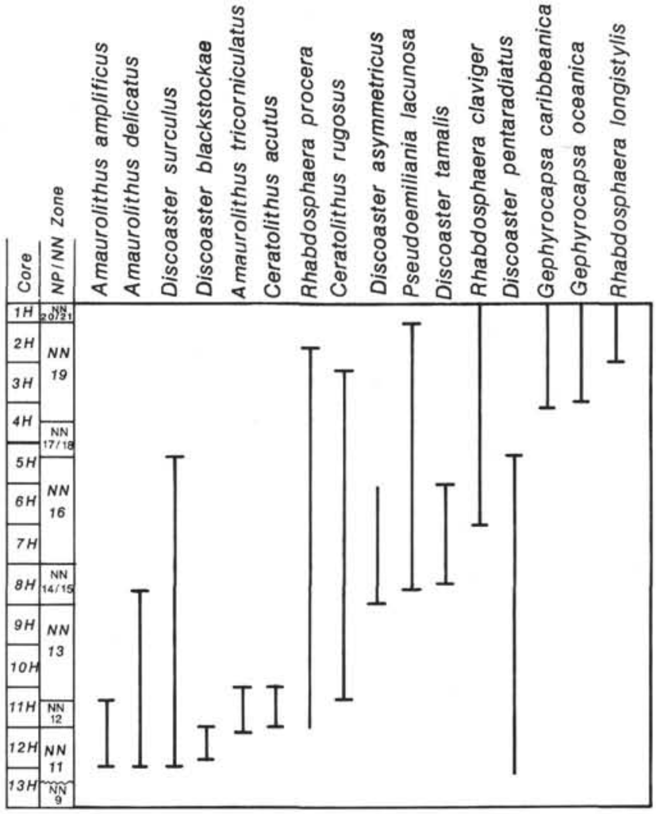

Figure 5. First occurrences (FO) and last occurrences (LO) of biochronologically important Cenozoic calcareous nannofossil species at Site 762 plotted against core position and against Martini's (1971) nannofossil zonation. Lack of a horizontal line at the end of a vertical range bar indicates that the precise FO/LO of that species is less confidently documented.

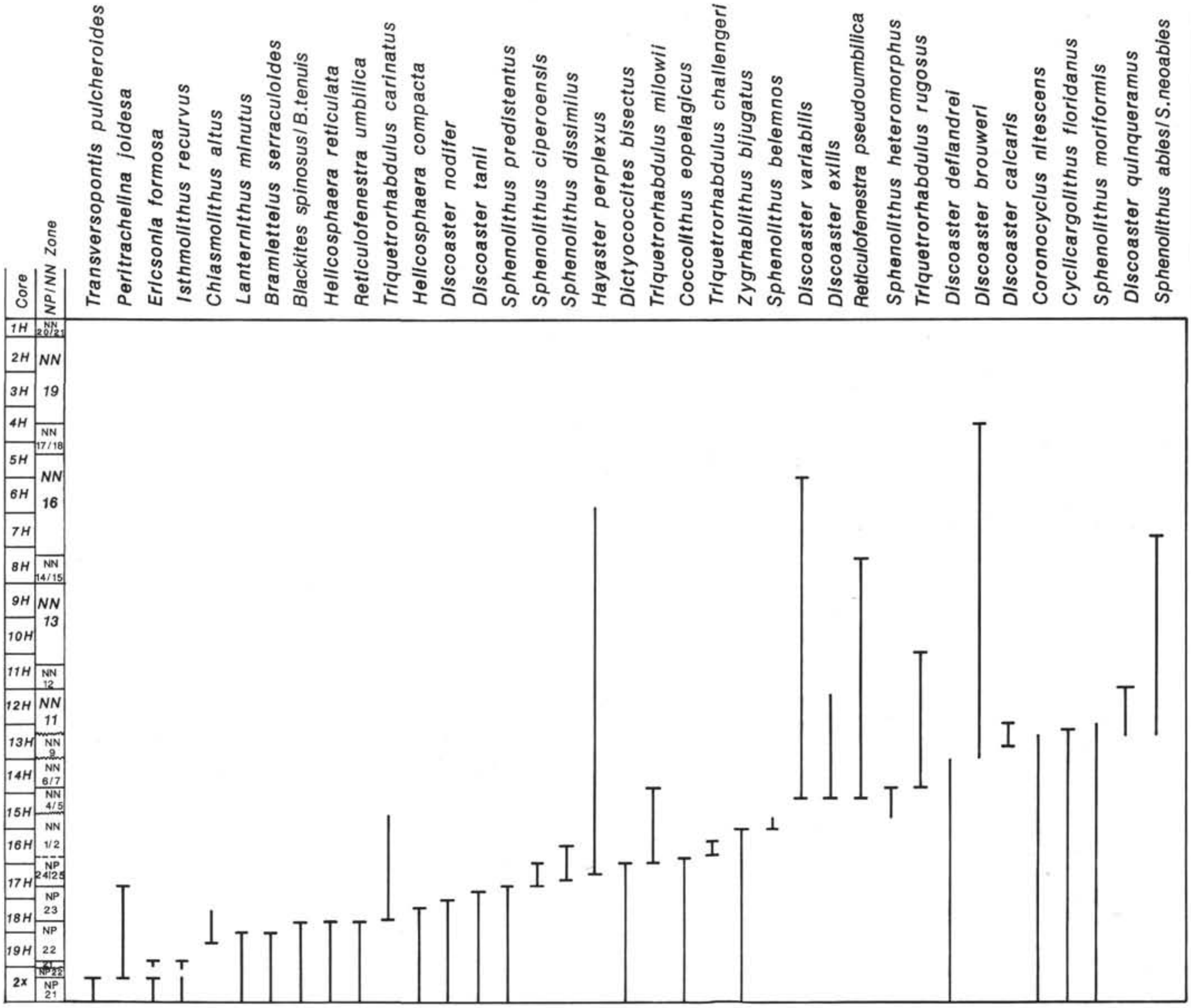

Figure 5 (continued).

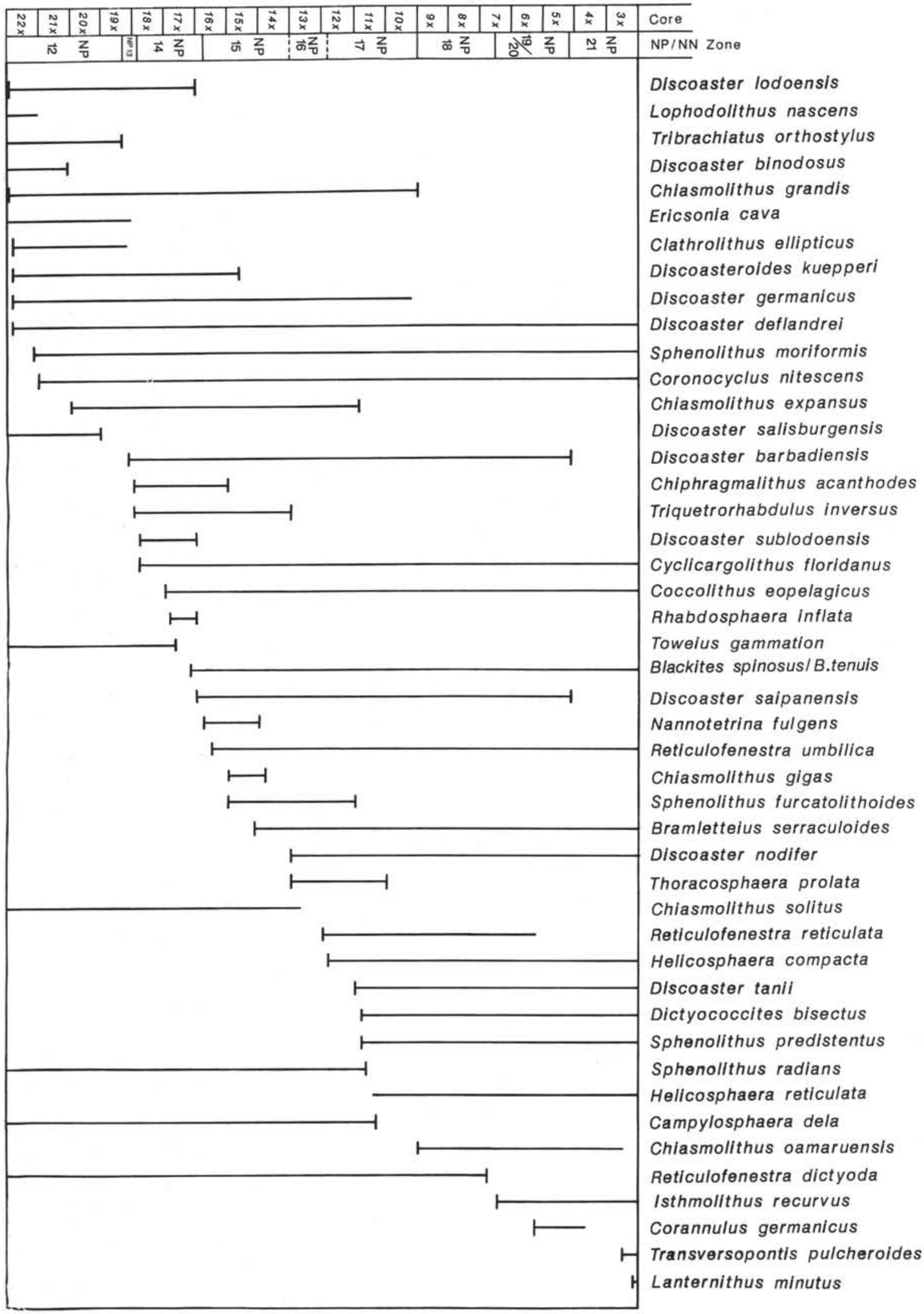

Figure 5 (continued).

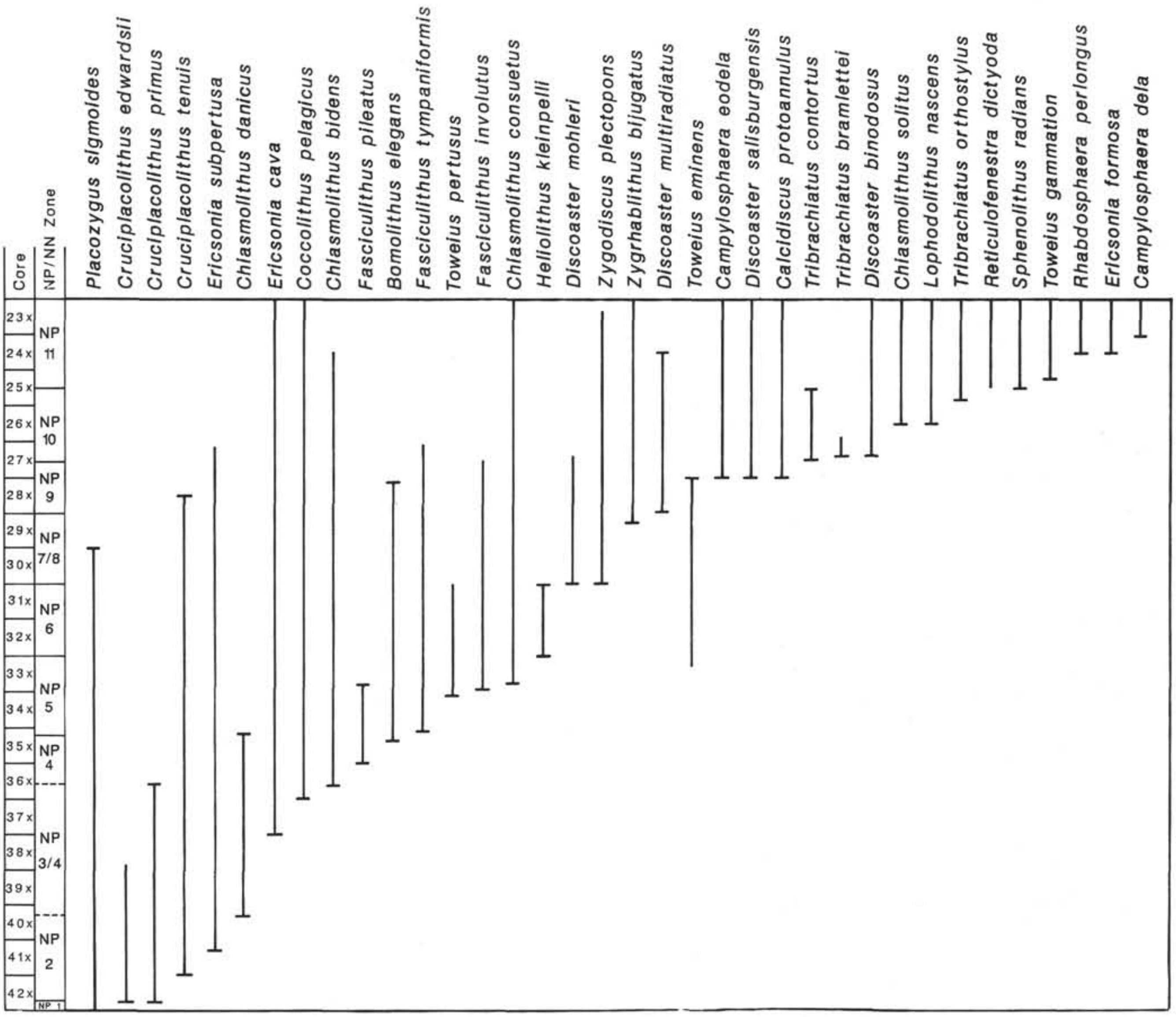

Figure 5 (continued).

HOLE 763A

	CORE-SECTION	NANNO ZONE	SERIES
IH	1H-CC TO 2H-3	NN 20-21	PLEISTOCENE
2H 3H 4H	2H-3 TO 5H-1	NN 19	
5H	5H-2 TO 5H-CC	NN 18	U. PLIOCENE
6H 7H 8H	6H-1 TO 8H-CC	NN 16	
9H	9H-1 TO 9H-5	NN 14-15	L. PLIOCENE
	9H-6 TO 9H-CC	NN 13	
10H 11H	10H-1 TO 11H-CC	NN 12	
12H 13H 14H	12H-1 TO 14H-CC	NN 11	U. MIOCENE
15H	15H-1 TO 16H-3	NN 10	
16H	16H-3 TO 17H-1	NN 4-5	M. MIOCENE
17H	17H-2 TO 17H-4	NN 3	L. MIOCENE
	17H-5 TO 18H-2	NN 1-2	
18H	18H-4 TO18H-CC	NP 25	U. OLIGOCENE
19H	19H-2 TO 19H-4	NP 24	
	19H-6 TO 20H-2	NP 23	L. OLIGOCENE
20H	20H-6	NP 22	
21H	20H-CC TO 2X-1	NP 21	L. OLIGOCENE - U. EOCENE

HOLE 763B

	CORE-SECTION	NANNO ZONE	SERIES/STAGE
2X	2X-1	NP21	U. EOCENE
3X	2X-2 TO 3X-CC	NP 20	
4X	4X-1 TO 4X-CC	NP 19-20	
5X	5X-1 TO 5X-CC	NP 18	
6X	6X-1 TO 6X-5	NP15-16	M. EOCENE
7X	6X-CC TO 7X-CC	NP 15	
8X	8X-1 TO 10X-CC		U. CAMPANIAN

Figure 6. Calcareous nannofossil zonation (Martini, 1971) of Holes 763A and 763B, Wombat Plateau.

HOLE 764A

	CORE-SECTION	NANNO ZONE	SERIES
1R	1R-1	NN 20-21	PLEISTOCENE
	1R-2 TO 1R-6	NN 19	
2R	1R-7 TO 2R-CC	NN 4-5	M. MIOCENE
3R	3R-1 TO 3R-3	NN 3	L. MIOCENE
	3R-4	NN1-2	
	3R-5 TO 3R-CC	NP 25	U. OLIGOCENE
4R	4R-CC	NP 24	
5R	5R-3,10cm	mixed Olig-Eoc	OLIGO. TO EOCENE
	5R-3, 55cm	CC 25	U. MAEST.

Figure 7. Calcareous nannofossil zonation (Martini, 1971) of Hole 764A, Wombat Plateau.

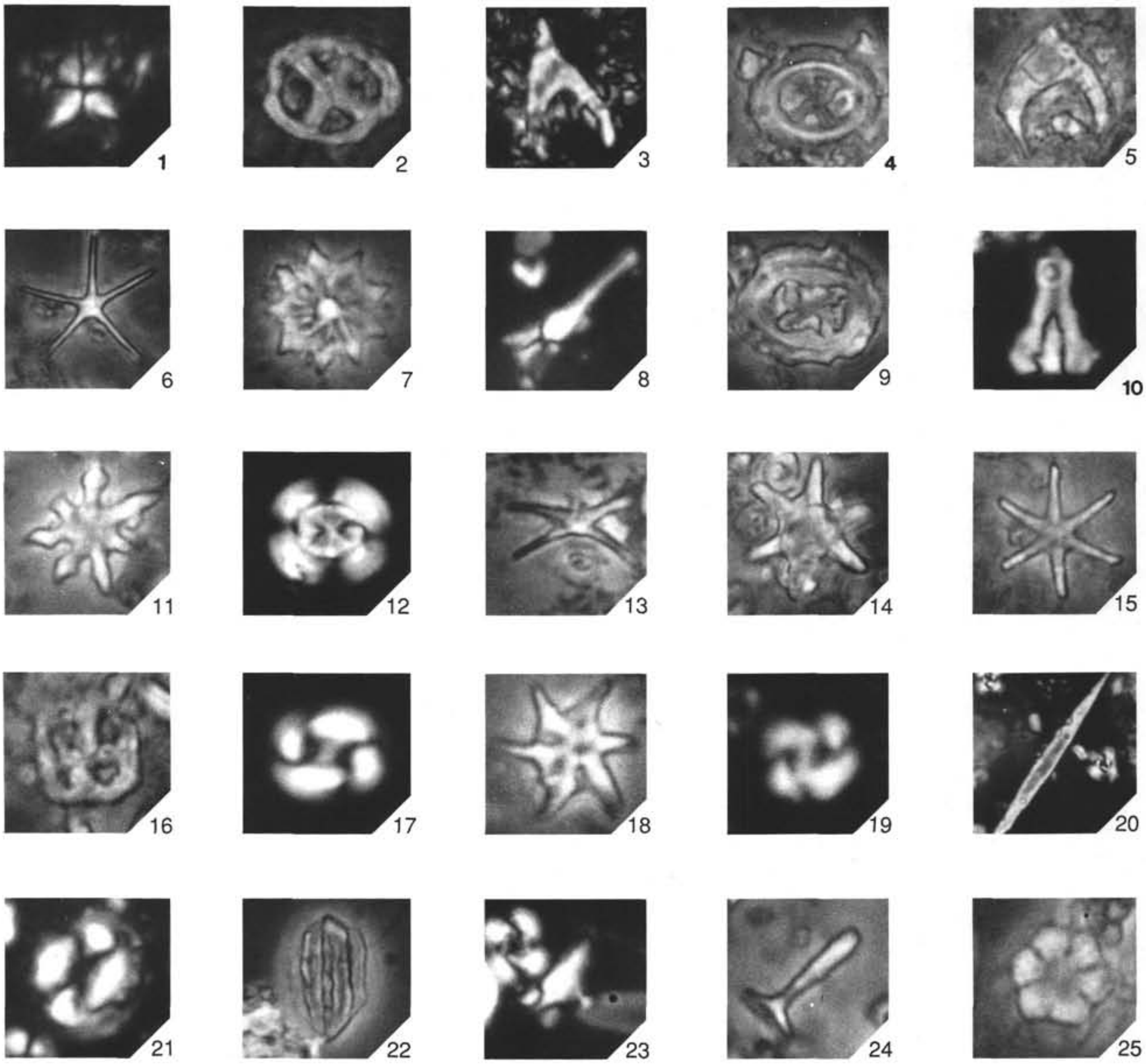

Plate 1. Cenozoic calcareous nannofossils. XN = cross-polarized light; PC = phase contrast. Magnifications approximate. **1.** *Sphenolithus abies*, XN, ×1500. Sample 122-762B-9H-5, 100–101 cm. **2.** *Chiphragmalithus acanthodes*, PC, ×1800. Sample 122-762C-18X-1, 100–101 cm. **3.** *Ceratolithus acutus*, XN, ×2000. Sample 122-762B-1H-CC. **4.** *Chiasmolithus altus* s.l., PC, ×1900. Sample 122-762B-19H-1, 100–101 cm. **5.** *Amaurolithus amplificus*, PC, ×2000. Sample 122-762B-12H-CC. **6.** *Discoaster asymmetricus*, PC, ×1600. Sample 122-762B-7H-3, 100–101 cm. **7.** *Discoaster barbadiensis*, PC, ×1600. Sample 122-762C-7X-CC. **8.** *Sphenolithus belemnos*, XN, ×2000. Sample 122-762B-15H-6, 88–90 cm. **9.** *Chiasmolithus bidens*, PC, ×1700. Sample 122-762C-27X-1, 99–100 cm. **10.** *Zygrahablithus bijugatus*, XN, ×1600, Sample 122-762C-2X-3, 100–101 cm. **11.** *Discoaster binodosus*, PC, ×1800, Sample 122-762C-22X-CC. **12.** *Dictyococcites bisectus*, XN, ×1600. Sample 122-762C-7X-CC. **13.** *Discoaster blackstockae*, PC, ×1200. Sample 122-762B-12H-1, 125–127 cm. **14.** *Tribrachiatus bramlettei*, PC, ×1800. Sample 122-762C-27X-1, 99–100 cm. **15.** *Discoaster brouweri*, PC, ×1300. Sample 122-762B-8H-1, 100–101 cm. **16.** *Chiphragmalithus calathus*, PC, ×1800. Sample 122-762C-22X-CC. **17.** *Dictyococcites callidus* s.l., XN, ×1500. Sample 122-762C-3X-3, 100–101 cm. **18.** *Catinaster calyculus*, PC, ×2900. Sample 122-762B-13H-3, 100–101 cm. **19.** *Gephyrocapsa caribbeanica*, XN, ×2200. Sample 122-762B-1H-1, 100–112 cm. **20.** *Triquetrorhabdulus carinatus*, XN, ×900. Sample 122-762C-17H-1, 100–102 cm. **21.** *Ericsonia cava*, XN ×1400. Sample 122-762C-35X-2 100–101 cm. **22.** *Triquetrorhabdulus challengeri*, PC, ×1000. Sample 122-763A-17H-CC. **23.** *Sphenolithus ciperoensis*, XN, ×2400. Sample 122-762B-17H-3, 100–102 cm. **24.** *Rhabdosphaera claviger*, PC, ×2000. Sample 122-762B-1H-1, 100–112 cm. **25.** *Catinaster coalitus*, PC, ×2000, Sample 122-762B-13H-CC.

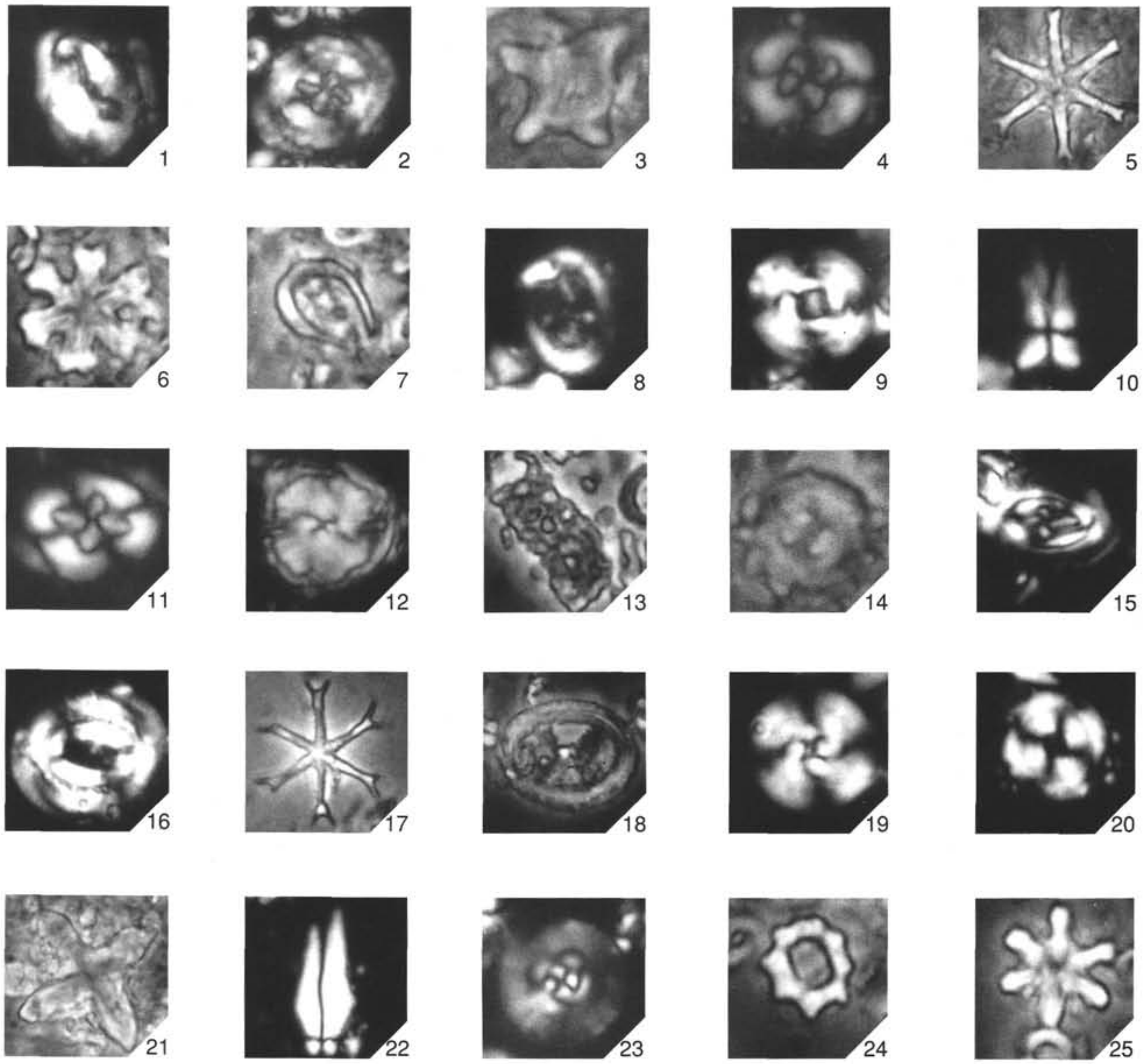

Plate 2. Cenozoic calcareous nannofossils. XN = cross-polarized light; PC = phase contrast. Magnifications approximate. **1.** *Helicosphaera compacta,* XN, ×1600. Sample 122-762C-7X-CC. **2.** *Chiasmolithus consuetus,* XN, ×1200. Sample 122-762C-29X-CC. **3.** *Tribrachiatus contortus,* PC, ×1400. Sample 122-762C-27X-3, 99–100 cm. **4.** *Chiasmolithus danicus,* XN, ×2000. Sample 122-762C-38X-5, 100–101 cm. **5.** *Discoaster decorus,* PC, ×1400. Sample 122-762B-8H-1, 100–101 cm. **6.** *Discoaster deflandrei,* PC, ×1400. Sample 122-762C-4X-CC. **7.** *Amaurolithus delicatus,* PC, ×1800. Sample 122-762B-12H-CC. **8.** *Campylosphaera dela,* XN, ×1800. Sample 122-762C-19X-1, 100–101 cm. **9.** *Reticulofenestra dictyoda,* XN, ×1500. Sample 122-762C-14X-3, 100–101 cm. **10.** *Sphenolithus dissimilus,* XN, ×1500. Sample 122-762B-16H-3, 100–101 cm. **11.** *Cruciplacolithus edwardsii,* XN, ×1800. Sample 122-762C-40X-CC. **12.** *Bomolithus elegans,* XN, ×1800. Sample 122-762C-34X-CC. **13.** *Clathrolithus ellipticus,* PC, ×1000. Sample 122-762C-22X-5, 100–102 cm. **14.** *Toweius eminens,* PC, ×2200. Sample 122-762C-30X-1, 100–101 cm. **15.** *Campylosphaera eodela,* XN, ×2400. Sample 122-762C-27X-1, 99–100 cm. **16.** *Coccolithus eopelagicus,* XN, ×900. Sample 122-762C-7X-CC. **17.** *Discoaster exilis,* PC ×1250. Sample 122-762B-13H-3 100–101 cm. **18.** *Chiasmolithus expansus,* PC, ×1000, Sample 122-762C-18X-5, 100–101 cm. **19.** *Cyclicargolithus floridanus,* XN, ×1300. Sample 122-762C-18X-5, 100–101 cm. **20.** *Ericsonia formosa,* XN, ×1400. Sample 122-762C-7X-CC. **21.** *Nannotetrina fulgens,* PC, ×1450. Sample 122-762C-16X-3, 99–100 cm. **22.** *Sphenolithus furcatolithoides,* XN, ×2000. Sample 122-762C-14X-5, 100–101 cm. **23.** *Toweius gammation,* XN, ×1800. Sample 122-762C-18X-5, 100–101 cm. **24.** *Corannulus germanicus,* PC, ×2100. Sample 122-762B-18H-CC. **25.** *Discoaster germanicus,* PC, ×1800. Sample 122-762C-22X-5, 100–102 cm.

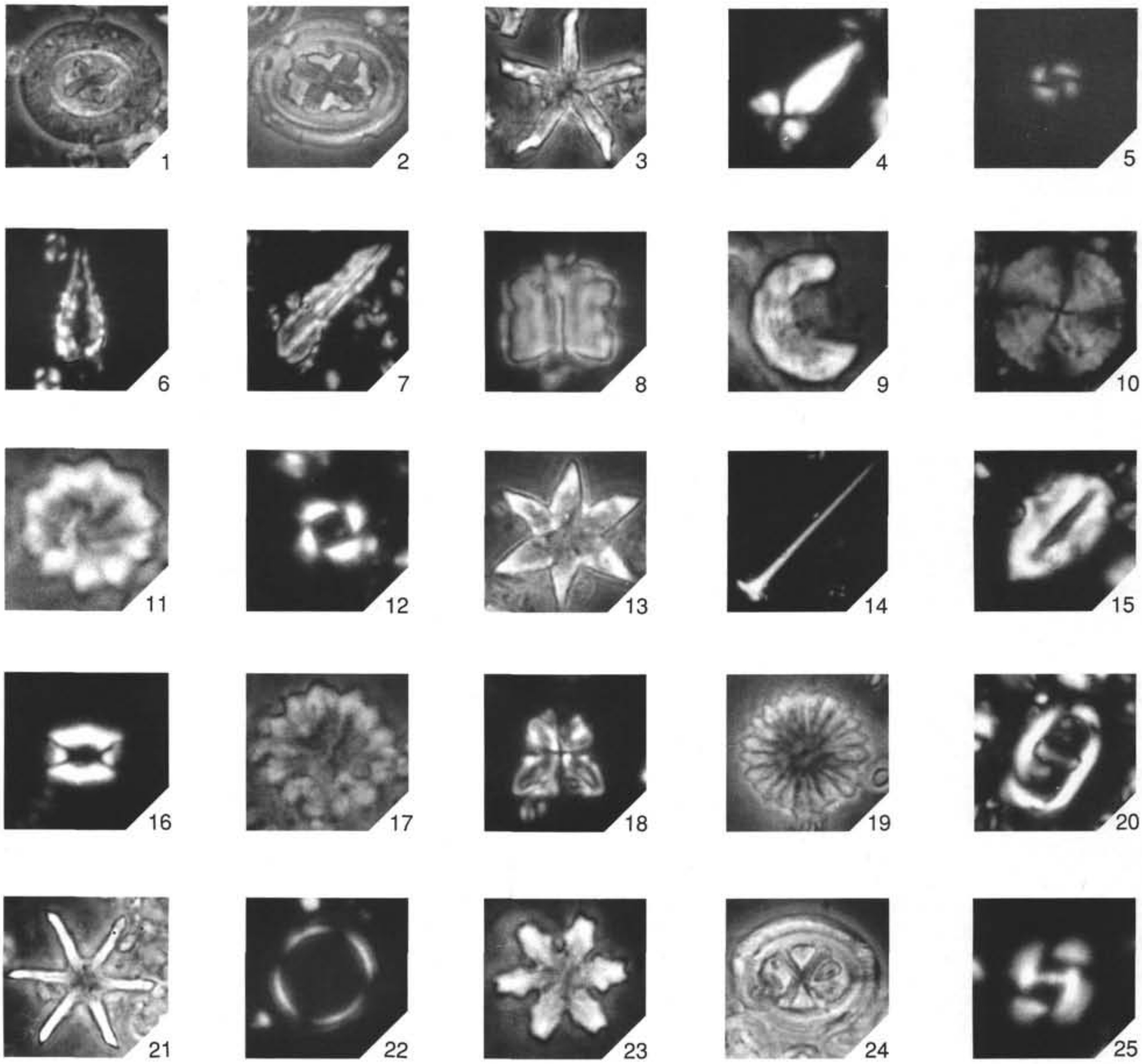

Plate 3. Cenozoic calcareous nannofossils. XN = cross-polarized light; PC = phase contrast. Magnifications approximate. **1.** *Chiasmolithus gigas*, PC, ×1000. Sample 122-762C-14X-CC. **2.** *Chiasmolithus grandis*, PC, ×1100. Sample 122-762C-11X-3, 99–100 cm. **3.** *Discoaster hamatus*, PC, ×1100. Sample 122-762B-13H-3, 100–101 cm. **4.** *Sphenolithus heteromorphus*, XN, ×1600. Sample 122-762B-15H-1, 88–90 cm. **5.** *Emiliania huxleyi*, XN, ×1900. Sample 122-762B-1H-1, 110–112 cm. **6.** *Rhabdosphaera inflata*, XN, ×1200. Sample 122-762C-17X-5, 99–100 cm. **7.** *Triquetrorhabdulus inversus*, XN, ×1100. Sample 122-762C-14X-3, 100–101 cm. **8.** *Fasciculithus involutus*, XN, ×1100. Sample 122-762C-29X-1, 100–101 cm. **9.** *Peritrachelina joidesa*, PC, ×2100. Sample 122-762B-18H-CC. **10.** *Heliolithus kleinpelli*, XN, ×900. Sample 122-762C-31X-1, 100–101 cm. **11.** *Discoasteroides kuepperi*, PC, ×2100. Sample 122-762C-18X-5, 100–101 cm. **12.** *Pseudoemiliania lacunosa*, XN, ×2000. Sample 122-762B-3H-1, 99–100 cm. **13.** *Discoaster lodoensis*, PC, ×1800. Sample 122-762C-18X-CC. **14.** *Rhabdosphaera longistylus*, XN, ×850. Sample 122-762B-5H-5, 100–101 cm. **15.** *Triquetrorhabdulus milowii*, XN, ×1600. Sample 122-762B-16H-5, 100–101 cm. **16.** *Lanternithus minutus*, XN, ×1800. Sample 122-762C-2X-3, 100–101 cm. **17.** *Discoaster mohleri*, PC, ×1500. Sample 122-762C-30X-1, 100–101 cm. **18.** *Sphenolithus moriformis*, XN, ×1400. Sample 122-762C-17H-1, 100–102 cm. **19.** *Discoaster multiradiatus*, PC, ×1300. Sample 122-762C-27X-1, 99–100 cm. **20.** *Lophodolithus nascens*, XN, ×1800. Sample 122-762C-23X-CC. **21.** *Discoaster neohamatus*, PC, ×1400. Sample 122-762B-13H-3, 100–101 cm. **22.** *Coronocyclus nitescens*, XN, ×1800. Sample 122-762C-18X-5, 100–102 cm. **23.** *Discoaster nodifer*, PC, ×1350. Sample 122-762C-4X-CC. **24.** *Chiasmolithus oamaruensis*, PC, ×1300. Sample 122-762C-7X-CC. **25.** *Gephyrocapsa oceanica*, XN, ×2200. Sample 122-762B-1H-1, 110–112 cm.

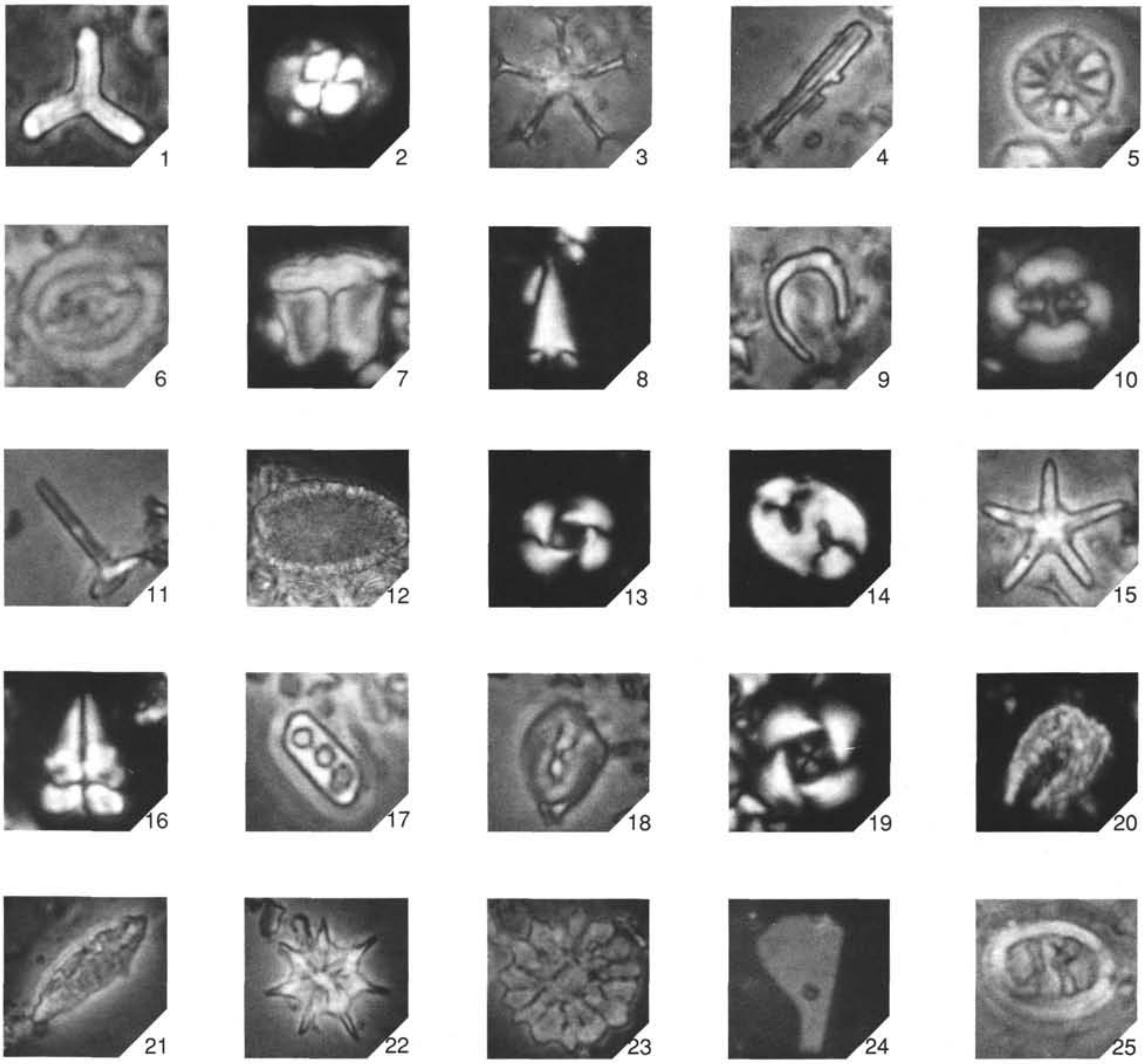

Plate 4. Cenozoic calcareous nannofossils. XN = cross-polarized light; PC = phase contrast. Magnifications approximate. **1.** *Tribrachiatus orthostylus*, PC, ×1500. Sample 122-762C-22X-CC. **2.** *Coccolithus pelagicus*, XN, ×1600. Sample 122-762C-3X-3, 100–101 cm. **3.** *Discoaster pentaradiatus*, PC, ×1800. Sample 122-762B-8H-1, 100–101 cm. **4.** *Rhabdosphaera perlongus*, PC, ×1500. Sample 122-762C-23X-3, 95–96 cm. **5.** *Hayaster perplexus*, PC, ×1300. Sample 122-762B-16H-5, 100–101 cm. **6.** *Toweius pertusus*, PC, ×2300. Sample 122-762C-36X-1, 6–7 cm. **7.** *Fasciculithus pileatus*, XN, ×1750. Sample 122-762C-34X,-CC. **8.** *Sphenolithus predistentus*, XN, ×2200. Sample 122-762B-18H-CC. **9.** *Amaurolithus primus*, PC, ×2000. Sample 122-762B-12H-CC. **10.** *Cruciplacolithus primus*, XN, ×2000. Sample 122-762C-42X-5, 7–8 cm. **11.** *Rhabdosphaera procera*, PC, ×1900. Sample 122-762B-7H-3, 100–101 cm. **12.** *Thoracosphaera prolata*, PC, ×800. Sample 122-762C-13X-CC. **13.** *Reticulofenestra pseudoumbilica*, XN, ×1800. Sample 122-762B-13H-3, 100–101 cm. **14.** *Transversopontis pulcheroides*, XN, ×1450. Sample 122-762C-3X-3, 100–101 cm. **15.** *Discoaster quinqueramus*, PC, ×1200. Sample 122-762B-12H-CC. **16.** *Sphenolithus radians*, XN, ×1500. Sample 122-762C-20X-CC. **17.** *Isthmolithus recurvus*, PC, ×1900. Sample 122-762C-4X-1, 100–101 cm. **18.** *Helicosphaera reticulata*, PC, ×1500. Sample 122-762B-19H-1, 100–101 cm. **19.** *Reticulofenestra reticulata*, XN, ×2000. Sample 122-762C-7X-CC. **20.** *Ceratolithus rugosus*, XN, ×1200. Sample 122-762B-9H-5, 100–101 cm. **21.** *Triquetrorhabdulus rugosus*, PC, ×1900. Sample 122-762B-13H-3, 100–101 cm. **22.** *Discoaster saipanensis*, PC, ×1400. Sample 122-762C-7X-CC. **23.** *Discoaster salisburgensis*, PC, ×1250. Sample 122-762C-27X-3, 99–100 cm. **24.** *Bramletteius serraculoides*, XN, ×1500. Sample 122-762C-17H-1, 100–102 cm. **25.** *Chiasmolithus solitus*, PC, ×1800. Sample 122-762C-14X-3, 100–101 cm.

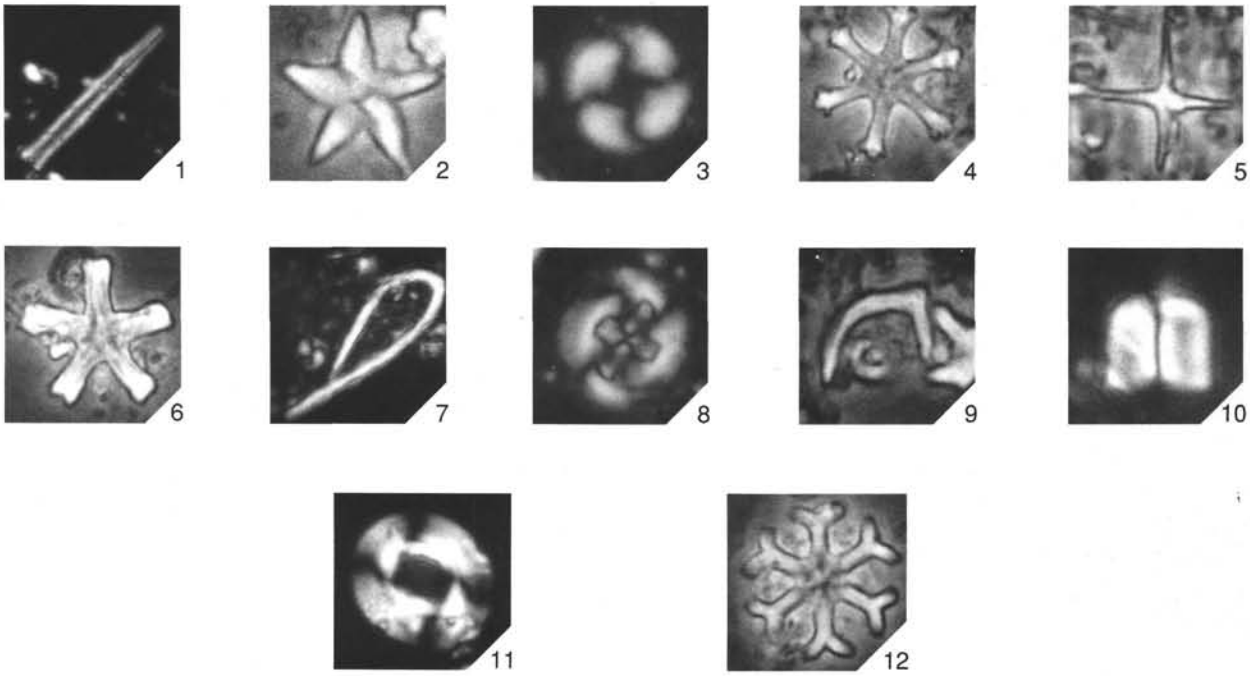

Plate 5. Cenozoic calcareous nannofossils. XN = cross-polarized light; PC = phase contrast. Magnifications approximate. **1.** *Blackites spinosus,* XN, ×1900. Sample 122-762C-2X-3, 100–101 cm. **2.** *Discoaster sublodoensis,* PC, ×1500. Sample 122-762C-18X-1, 100–101 cm. **3.** *Ericsonia subpertusa,* XN, ×1600. Sample 122-762C-36X-1, 6–7 cm. **4.** *Discoaster surculus,* PC, ×1100. Sample 122-762B-11H-CC. **5.** *Discoaster tamalis,* PC, ×1900. Sample 122-762B-7H-3, 100–101 cm. **6.** *Discoaster tanii,* PC, ×1650. Sample 122-762C-7X-CC. **7.** *Ceratolithus telesmus,* XN, ×850. Sample 122-762B-1H-1, 110–112 cm. **8.** *Cruciplacolithus tenuis,* XN, ×1500. Sample 122-762C-39X-5, 79–81 cm. **9.** *Amaurolithus tricorniculatus,* PC, ×2000. Sample 122-762B-12H-1, 125–127 cm. **10.** *Fasciculithus tympaniformis,* XN, ×2000. Sample 122-762C-31X-1, 100–101 cm. **11.** *Reticulofenestra umbilica,* XN, ×1400. Sample 122-762C-7X-CC. **12.** *Discoaster variabilis,* s.l., PC, ×1200. Sample 122-762B-11H-CC.