

19. DIATOMS IN DSDP LEG 41 SITES

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ABSTRACT

Marine planktonic diatom frustules are found with varying abundance and preservation in Cenozoic sediments of Sites 366 and 369. Displaced fresh-water diatoms and phytoliths are observed at Site 366 in Core 2, Hole 366A in Cores 1 and 2, and at Hole 369A with rare abundance in Cores 1 through 30. No biostratigraphic investigation nor detailed taxonomy were made.

INTRODUCTION

Leg 41 of the Deep Sea Drilling Project, from Abidjan to Malaga drilled five sites, Sites 366 through 370, on the eastern north Atlantic margin (Figure 1). Light microscope techniques were used exclusively to study opal phytoplankton, fresh-water diatoms, and phytoliths. Sample preparation followed the method of Schrader and Fenner (1976) for semiquantitative study. Diatom zonation partly used here is that of Schrader and Burckle (in press). No detailed biostratigraphic investigation was made for the Paleogene interval at Sites 366 and 369 because most of the assemblages are poorly preserved. No detailed taxonomic investigation was done on Leg 41 samples so some species were grouped and listed in Tables 1 and 2 as spp. All other species are described in Schrader (1974), Kolbe (1954), Burckle (1972), Hustedt (1930-1959), and Simonsen (1974).

Samples barren in diatoms are marked on the summary figures with an arrow and are tabulated.

The aim of this investigation is to present information of the diatom content in order to facilitate subsequent detailed diatom studies on Leg 41 sediments, especially for the Oligocene to Eocene interval.

RESULTS

Site 366

This continuously cored sedimentary sequence ranges in age from Holocene to Maestrichtian and contains marine planktic diatoms. Their abundance ranges from trace to abundant and their preservation varies from poor to good in the Pleistocene and early Miocene through late Eocene interval. Detailed information is shown in Figure 2. Samples studied but barren are listed in Figure 2 (arrows).

Displaced fresh-water diatoms and phytoliths are common in the Pleistocene and rare in the early Miocene (Figure 2, triangles).

Selected ranges of important species are documented in Figure 3.

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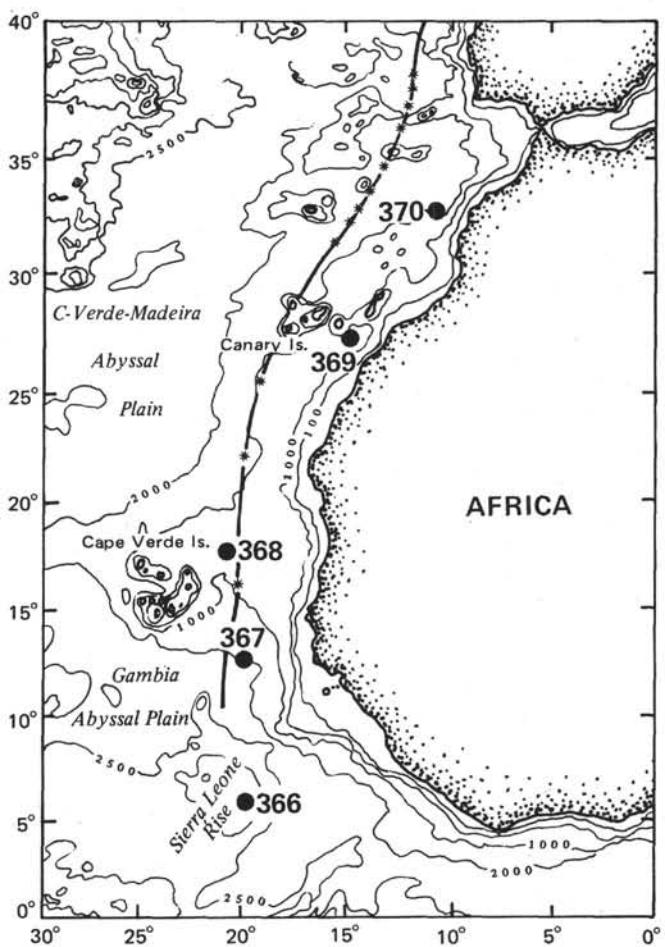


Figure 1. Localities of DSDP Leg 41 drill sites.

Site 367

All 126 samples from Cores 1-37 (except Cores 7, 8, and 11) obtained from the Cape Verde Basin site were barren in opal phytoplankton remains (Figure 4).

Site 368

All 244 samples from Cores 2-63 (except Cores 48, 60, and 61) of the mostly terrigenous sediment section at the Cape Verde Rise site were barren in opal phytoplankton remains.

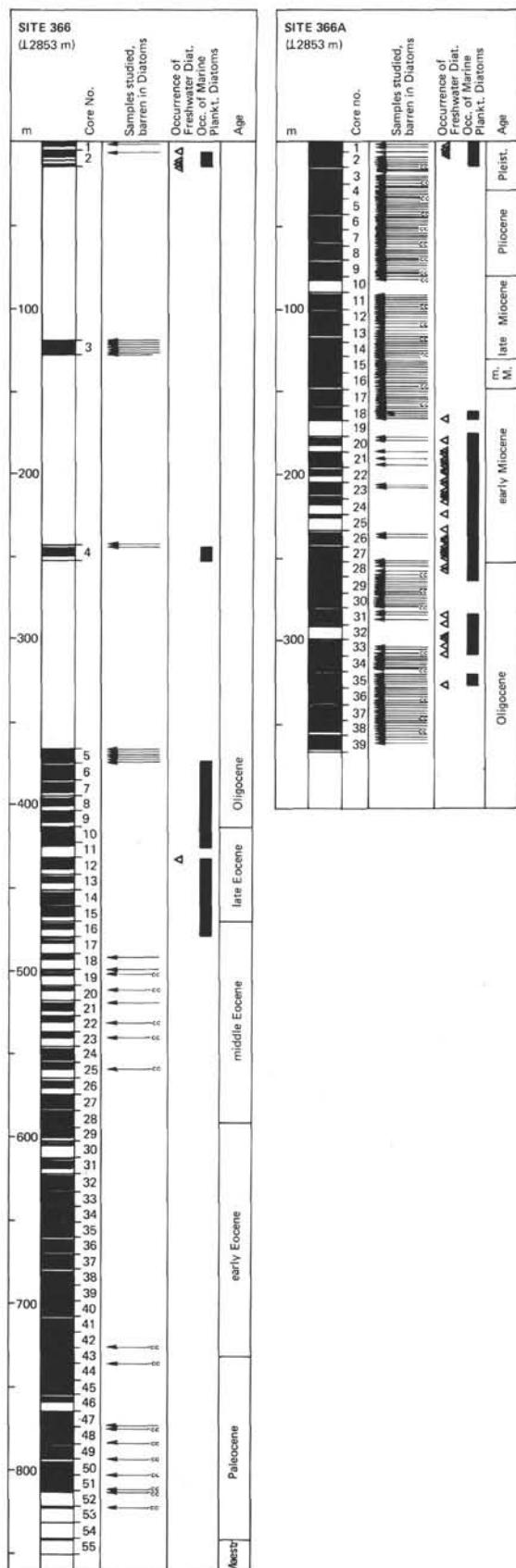


Figure 2. Site 366 summary figure. Ages are taken from the site reports (this volume). Arrow indicate samples barren in opal phytoplankton.

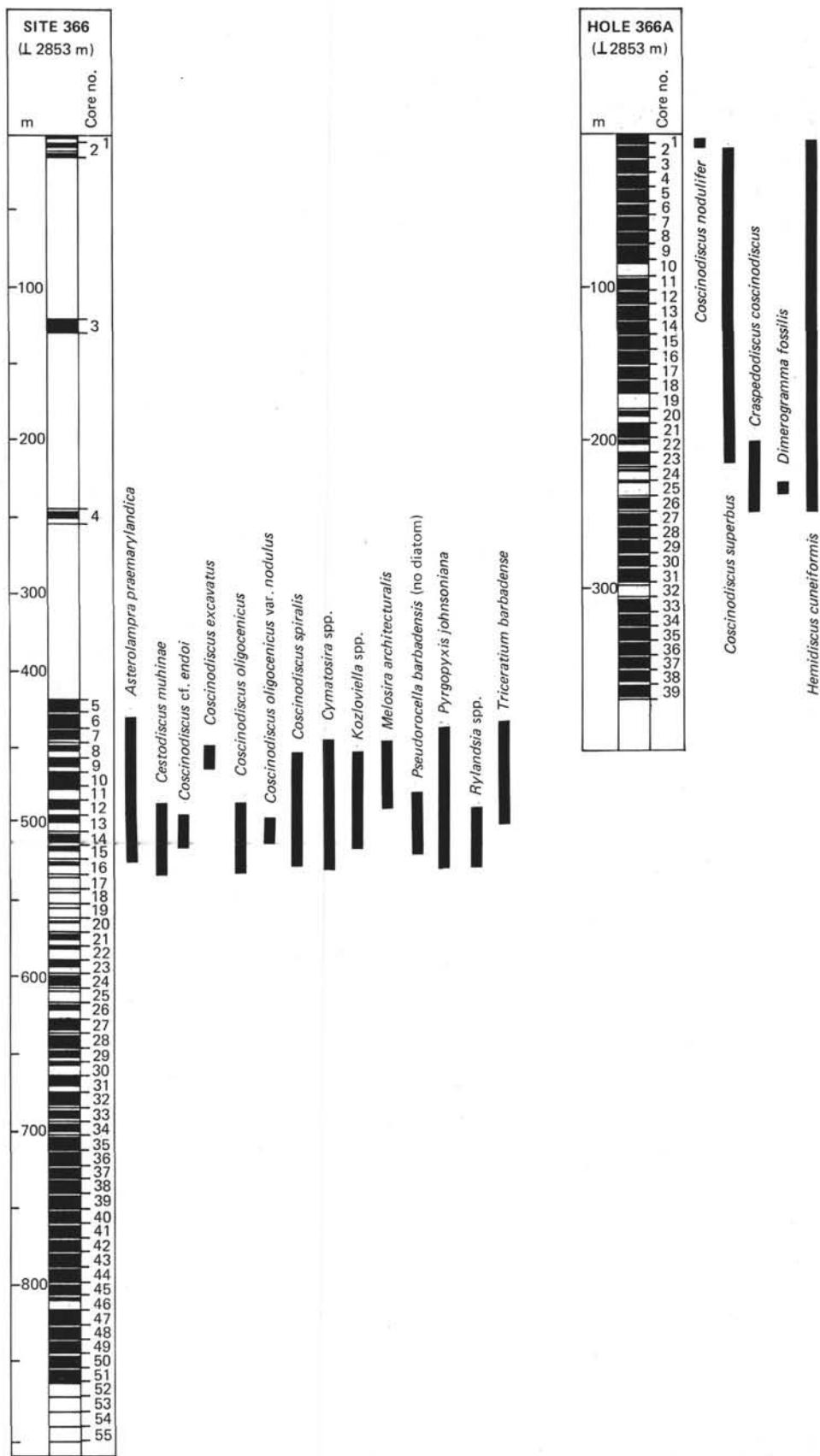


Figure 3. Occurrence of selected diatoms at Site 366 and Hole 366A (range chart).

TABLE 1
Holes 336/336A

Sample (Interval in cm)	Abundance Marine Plankt. Diatoms Preservation Marine Plankt. Diatoms Abundance Freshwater Diatoms Abundance Phytoliths Abundance Sponge Spicules Abundance Radiolaria Abundance Silicoflagellates	<i>Actinocyclus ellipticus</i> <i>Actinopychus undulatus</i> <i>Asterolampra decora</i> <i>Asterolampra grevillei</i> <i>Asterolampra praemarylandica</i>	<i>Asteromphalus robustus</i> <i>Cestodiscus multinae</i> <i>Cestodiscus aff. pulchellus</i> (Jouss, 1974) <i>Chaetoceros bristles</i> <i>Chaetoceros spores</i>	<i>Coseinodiscus crenulatus</i> <i>Coseinodiscus endoi</i> <i>Coseinodiscus excavatus</i> <i>Coseinodiscus lewisiensis</i> <i>Coseinodiscus marginatus</i> <i>Coseinodiscus nodulifer</i> <i>Coseinodiscus oligocenicus</i> var. <i>nodulus</i> <i>Coseinodiscus spiralis</i> <i>Coseinodiscus superbis</i> <i>Coseinodiscus symbolophorus</i> group <i>Coscinodiscua retusissimus</i> <i>Coscinodiscus A</i> <i>Coscinodiscus B</i> <i>Craspedodiscus coscinodiscus</i>	<i>Cussia paleacea</i> <i>Cymatosira</i> spp. <i>Dimerogramma fossilis</i> <i>Diploneis</i> spp. (benthic) <i>Ethmodiscus rex</i>
Hole 366					
2-2, 57-58	R M F F R R R				F
2-5, 59-60	R M F F R R R				
2-6, 50-51	F M F F R C F				
2, CC	F M F F R C F				
4-3, 63-64	F P B B R A B				
4, CC	F P B B R A B				
5, CC	C P B B R A B				
6-1, 40-41	C P B B R A R				
6-2, 66-67	F P B B R A R	R			
6-3, 30-31	F P B B R A R	R			
6-4, 75-76	C P B B R A R	R			R
6-5, 81-82	C P B B R A R	R			R
6-6, 56-57	F P B B R A R	R			R
6, CC	C P B B R A R	R			R
7-1, 127-128	F P B B R A R	R			R
7-2, 83-84	R P B B R A R				
7-3, 66-67	C P/MB B R A R	R			
7-4, 57-58	C P/MB B R A R	R			
7-5, 34-35	C P/MB B R A R				
7, CC	C P/MB B R A R				
8-2, 107-108	C M B B R A R	R R			
8-3, 84-85	A M B B R C R	R R	F R		
8-4, 41-43	A M B B R C R	R R	F R		
8, CC	A M B B R C R	R R	F R		
9-1, 65-67	C M B B B R R				
9-2, 68-69	C P B B R C R			R F	
9-3, 43-44	C P B B R C R			R F	
9-4, 45-47	C P B B R C R			R F	
9, CC	F P B B R A R		R	R F	
10-1, 46-47	F P B B R A B		R F	R F	
10-3, 65-66	A M B B R C R	R	F		
10-4, 43-44	A M B B R C R	R	F		
10-5, 40-41	A M B B R F R	R	F		
10-6, 32-33	A M B B R F R	R	F		
10, CC	A M B B R F R	R	F R	R	
12-1, 73-74	A M R B R F R	R	R R	R	
12-2, 47-48	A M B B R C R	R	C F	R	
12-3, 73-74	A M B B R C R	R	R C F	R	
12-4, 63-64	A M B B R C R	R	R C F	R	
12, CC	A M B B R C R	R	R F F F	R	
13-1, 149-150	A M B B R C R	R	R C R	R R	
13-2, 73-74	C M B B R C R	R	R C R	R R	
13-3, 85-86	A P B B F C R	R	R F F	R R	
13, CC	A M B B R A R	R	R F F	R R	
14-1, 103-104	A M B B R A R	R	R F	R R	
14-2, 52-53	A M B B R C R		F R R R	R R	
14-3, 115-116	C P B B R C R		F R R R	R R	
14-4, 51-52	A M B B R C R		F R R R	R R	
14-5, 78-79	A M B B R C R		F R R R	R R	
14, CC	A M B B R C R		R R R R	R R	

TABLE 1 - *Continued*

<i>Grammatophora</i> spp. (benthic)														
<i>Hemiaulus</i> spp.														
<i>Hemidiscus cuneiformis</i>														
<i>Kozloviella</i>														
<i>Loistephania</i> stage of <i>Asteromphalus</i>														
<i>Melosira architectalis</i>														
<i>Melosira granulata</i> (Freshwater Diat.)	R	C	F	F	R	R	R	R	R	R	R	R	R	R
<i>Melosira sulcata</i>														
<i>Melosira C</i>														
<i>Melosira D</i>														
<i>Navicula lyra</i> (benthic)														
<i>Nitzschia marina</i>														
<i>Pseudoenotica dolichus</i>														
<i>Pseudoroccella barbadensis</i> (no Diatom)														
<i>Pterotheca</i> spp.														
<i>Pyrgopyxis gracilis</i>														
<i>Pyrgopyxis johnsoniana</i>														
<i>Raphoneis amphiceros</i>														
<i>Rhizosolenia bergenii</i>														
<i>Rhizosolenia hebetata</i> forma <i>subacuta</i>														
<i>Rhizosolenia styliformis</i>														
<i>Rhizosolenia</i> spp.														
<i>Rhopalodia gibba</i> (benthic)														
<i>Riedelia</i> spp.														
<i>Rutularia</i>														
<i>Scepironites</i> spp.														
<i>Stephanodiscus astraea</i> (Freshw. D.)														
<i>Stephanopyxis turris</i>														
<i>Stephanopyxis</i> spp.														
<i>Synedra joaseana</i>														
<i>Synedra miocenica</i>														
<i>Thalassionema hirosakiensis</i>														
<i>Thalassionema nitzschoides</i>														
<i>Thalassiothrix eccentrica</i>														
<i>Thalassiothrix oestrupii</i>														
<i>Thalassiothrix longissima</i>														
<i>Triceratium barbadense</i>														
<i>Triceratium schulzii</i>														
<i>Trinacia excavata</i>														

TABLE 1 – *Continued*

Sample (Interval in cm)	Abundance Marine Plankt. Diatoms Preservation Marine Plankt. Diatoms Abundance Freshwater Diatoms Abundance Phytoliths Abundance Sponge Spicules Abundance Radiolaria Abundance Silicoflagellates	<i>Actinocyclus ellipticus</i> <i>Actinoptychus undulatus</i> <i>Asterolampra decora</i> <i>Asterolampra praemarylandica</i> <i>Asteromphalus robustus</i> <i>Cestodiscus multinae</i> <i>Cestodiscus aff. pulchellus</i> (Jouse, 1974) <i>Chaetoceros bristles</i> <i>Chaetoceros spores</i> <i>Coscinodiscus crenulatus</i> <i>Coscinodiscus endoi</i> <i>Coscinodiscus excavatus</i> <i>Coscinodiscus lewisanus</i> <i>Coscinodiscus marginatus</i> <i>Coscinodiscus nodulifer</i> <i>Coscinodiscus oligocenicus</i> <i>Coscinodiscus oligocenicus</i> var. <i>nodulus</i> <i>Coscinodiscus spiralis</i> <i>Coscinodiscus superbus</i> <i>Coscinodiscus symbolophorus</i> group <i>Coscinodiscus vetustissimus</i> <i>Coscinodiscus A</i> <i>Coscinodiscus B</i> <i>Craspedodiscus coscinodiscus</i> <i>Cussia paleacea</i> <i>Cymatostira</i> spp. <i>Dimerogramma fossils</i> <i>Diploneis</i> spp. (benthic) <i>Ethmodiscus rex</i>
Hole 366 – <i>Continued</i>		
15-1, 22-23	A M/G B B F C F	
15-1, 53-54	A M B B R A R	
15-2, 49-50	F M B B R A B	
15, CC	A M B B R C R	
16-2, 23-24	C M B B R C R	
16-3, 23-24	C M B B R C R	
16, CC	F P B B R A B	
Hole 366A		
1-3, 76-77	R P C F R B B	
1-4, 48-49	R P C C R F B	
1, CC	R P C C R F R	
2-2, 74-75	R P C F R R R	
18, CC	T P B B R C R	
20-3, 68-69	R P B B R C R	
20, CC	T P B B F C B	
21-2, 65-66	T P B B F C B	
21-4, 68-69	T P B B F C B	
21-6, 48-49	T P B B F C B	
21, CC	R P B B F C B	
22-1, 88-89	T P B B F C B	
22-2, 73-74	T P B B F C B	
22, CC	R P B B F C B	
23-1, 54-55	T P B B F C B	
23-4, 68-69	T P B B F C B	
23-5, 68-69	R P B B F C B	
23-6, 48-49	F P B B F C B	
24-1, 93-94	C P R R F C R	
25-1, 113-114	T P R R R C R	
25, CC	C P R R R F R	
26-1, 69-70	A M R R R A B	
26-4, 81-82	F P R R R C B	
26-5, 58-59	F M R R R C B	
26, CC	F P R R R C B	
27-1, 116-117	F P R R R C B	
27-2, 38-39	R P R R R C B	
27-3, 98-99	T P R R R C B	
27-4, 103-104	T P R R R C B	
27-5, 68-69	T P R R R C B	
27-6, 58-59	T P R R B C B	
27, CC	T P R R R C B	
28-4, 50-51	T P R R R C B	
28-6, 54-55	T P R R R C B	
31-4, 45-46	F P R R R C B	
31, CC	T P R R R C B	
32, CC	R P R R B C B	
33-1, 100-101	T P R R R C B	
33-2, 80-81	R P R R R C B	
33-3, 120-121	F P R R F C B	
33-6, 68-69	T P R R R C B	
35, CC	C M B B R C R	

TABLE 1 - *Continued*

				<i>Grammatophora</i> spp. (benthic)			
				<i>Hemiaulus</i> spp.			
				<i>Hemidiscus caniformis</i>			
				<i>Kozloviella</i>			
				<i>Liostephania</i> stage of <i>Asteromphalus</i>			
				<i>Melosira architectalis</i>			
				<i>Melosira granulata</i> (Freshwater Diat.)			
				<i>Melosira sulcata</i>			
		C C	R	<i>Melosira C</i>			
		C C	R	<i>Melosira D</i>			
		F	R	<i>Nanula lyra</i> (benthic)			
		C	R	<i>Nitzschia marina</i>			
		C	R	<i>Pseudoeunotica doliolus</i>			
		R	R	<i>Pseudorocella barbadensis</i> (no Diatom)			
		R	R	<i>Pterotheca</i> spp.			
		R	R	<i>Pyrgopyxis gracilis</i>			
		R	R	<i>Pyrgopyxis johnsoniana</i>			
		R	R	<i>Raphoneis amphiceros</i>			
		R	R	<i>Rhizosolenia bergenii</i>			
		R	R	<i>Rhizosolenia hebetata</i> forma <i>subacuta</i>			
		R	R	<i>Rhizosolenia styliformis</i>			
		R	R	<i>Rhizosolenia</i> spp.			
		R	R	<i>Rhopalodicta gibba</i> (benthic)			
		R	R	<i>Riedelia</i> spp.			
		R	R	<i>Rutillaria</i>			
		R	R	<i>Rylandsia</i>			
		R	R	<i>Sceptrenea</i> spp.			
		R	R	<i>Stephanodiscus astraeae</i> (Freshw. D.)			
		R	R	<i>Stephanopyxis turris</i>			
		R	R	<i>Stephanopyxis</i> spp.			
		R	R	<i>Synedra焦�ana</i>			
		R	R	<i>Synedra miocenica</i>			
		R	R	<i>Thalassionema hirokaiensis</i>			
		R	R	<i>Thalassionema niteschoides</i>			
		R	R	<i>Thalassiostra eccentrica</i>			
		R	R	<i>Thalassiostra ostruppii</i>			
		R	R	<i>Thalassiothrix longissima</i>			
		R	R	<i>Tricerium barbadense</i>			
		R	R	<i>Tricerium schultzii</i>			
		R	R	<i>Trinacia excavata</i>			
		only fragments, no age diagnostic species					

TABLE 2
Hole 369A

Sample (Interval in cm)	Abundance Marine Plankt. Diatoms Preservation Marine Plankt. Diatoms Abundance Freshwater Diatoms Abundance Phytoliths Abundance Sponge Spicules Abundance Silicoflagellates Abundance Radiolaria <i>Actinocyclus ebrenbergii</i> <i>Actinocyclus ellipticus</i> and varieties <i>Actinocyclus ingens</i> <i>Actinocyclus moronensis</i> <i>Actinopychus undulatus</i> <i>Actinopychus splendens</i> <i>Actinopychus heliopelta</i> <i>Anellos californicus</i> <i>Asterolampra acutiloba</i> <i>Asterolampra graveillei</i> <i>Asterolampra insignis</i> <i>Asterolampra marylandica</i> <i>Asteromphalus arachne</i> <i>Asteromphalus moronensis</i> <i>Bidulphia tuomeyi</i> (benthic) <i>Bogorovia veniamini</i> <i>Bruniopsis mirabilis</i> <i>Chaetoceros</i> spp. (bristles) <i>Chaetoceros</i> spp. (spores) <i>Cestodiscus peplum</i> <i>Cladogramma dubium</i> <i>Cocconeis</i> spp. (benthic) <i>Coscinodiscus crenulatus</i> <i>Coscinodiscus endoi</i> <i>Coscinodiscus excavatus</i> <i>Coscinodiscus lewisianus</i> <i>Coscinodiscus lineatus</i> <i>Coscinodiscus marginatus</i> <i>Coscinodiscus nitidus</i> <i>Coscinodiscus nodulifer</i> <i>Coscinodiscus plicatus</i> group <i>Coscinodiscus praeinitidus</i>								
1, CC	R P R R R B F								
2-1, 71-72 ^a	R P B B B F F								
2-4, 71-72	R P B B F B R								
2-5, 71-72	R P R B F F F								
2-6, 71-72	R P B R F B F								
2, CC	R P B R F B R								
3-4, 71-72	R P R B F B F								
3-5, 61-62	F P B R R B F								
3-6, 71-72	C M B B R R R F								
3, CC	C M R R F R R								
4-1, 71-72	C M B R F R F								
4-2, 90-91	C M B B F R F								
4-3, 71-72	C M B R F C F								
4-4, 71-72	C M B B F F F								
4-5, 71-72	F P B B F F F								
4-6, 71-72	R P B B F B C								
4, CC	R P B B R B C								
5-1, 91-92	F P B R F R F								
5-2, 71-72	R P B B F B F								
5-3, 73-74	R P B R F B C	R							
5-4, 71-72	F P B B F B R								
5-5, 71-72	F M B B F R C								
5-6, 71-72	F M B B F B F								
5, CC ^a	F M B B R R F	R							
9-5, 63-64	R P R B F B F								
9-6, 63-64	C G R B F R F	R	R	R	R F				
9, CC	C M B B F R F	R	R	R	F				
10-1, 113-114	F P B B F R F	R	R	R	R F				
10-2, 73-74	C G R B F F F	R	R	R	C C				
10-3, 73-74	A G B B F F F	F	R	R	C C				
10-4, 73-74	F P B B F F F				R C R				
10-5, 71-72	A M B B F F F	F	R	R	C R				
10-6, 71-72	R P B B F F F				C R				
10, CC	C M B B R F F	R	F	R	R R				
11-1, 67-68	F P B B F R F	R	R	R	R R				
11-2, 62-63	F P R B F R F				R				
11-3, 68-69	A G R B R F F	R	R	R	F F R				
11-4, 72-73	A G B B R F F	R	R	R	F F R				
11-5, 72-73	A G B B R F R R	R	F		R C R				
11-6, 72-73	A G B B R F R R	R	F		C R				
11, CC	A G B B F F R	R	F	R	C F				
12-1, 73-74	A G B B F F F	R	F	R	F F				
12-2, 73-74	A G B B F F F	R	F	R	F F				
12-3, 73-74	A G B B F F F	F	F	R R	C F				
12-6, 73-74	A G B B R F F	F	R R	R	R R				
12, CC	F P R B F R F	R	R	R	F F				
13-1, 73-74	A G B B R R F	R	R	R	C C				
13-2, 73-74	C M B B F F F	R	R	R	C C				
13-3, 73-74	A G B R F R F	R	R	R	C C				
13-4, 73-74	C M B B R R F	R	R	R	R F				

TABLE 2 - *Continued*

Sample (Interval in cm)	Abundance Marine Plankt. Diatoms Preservation Marine Plankt. Diatoms Abundance Freshwater Diatoms Abundance Phytoploliths Abundance Sponge Spicules Abundance Silicoflagellates Abundance Radiolaria	<i>Actinocyclus ehrenbergii</i> <i>Actinocyclus ellipticus</i> and varieties <i>Actinocyclus ingens</i> <i>Actinocyclus moronensis</i> <i>Actinopteryx undulatus</i> <i>Actinopteryx splendens</i> <i>Actinopteryx heliopelta</i> <i>Anellus californicus</i> <i>Asterolampra acutiloba</i> <i>Asterolampra grisevillei</i> <i>Asterolampra insignis</i> <i>Asterolampra marylandica</i> <i>Asteromphalus arachne</i> <i>Asteromphalus moronensis</i> <i>Biadulphia tuomeyi</i> (benthic)	<i>Bogorovia ventimini</i> <i>Bruniopsis mirabilis</i> <i>Chaetoceros</i> spp. (bristles) <i>Chaetoceros</i> spp. (spores) <i>Ceratodiscus perplum</i> <i>Cladogramma dubium</i> <i>Cocconeis</i> spp. (benthic) <i>Coscinodiscus crenulatus</i> <i>Coscinodiscus endoi</i> <i>Coscinodiscus excavatus</i> <i>Coscinodiscus levistianus</i> <i>Coscinodiscus lineatus</i> <i>Coscinodiscus marginatus</i> <i>Coscinodiscus nitidus</i> <i>Coscinodiscus nodulifer</i> <i>Coscinodiscus plicatus</i> group <i>Coscinodiscus praenitidus</i>
13-5, 73-74	C M R B R R F	R	
13-6, 73-74	R P R B R R C	R	
13, CC	F P R B F B F	R	
14-1, 113-114	F P B B F B F	R	
14-2, 73-74	F P B B F B F	R	
14-3, 73-74	F P B B R B R	R	
14-4, 73-74	F P B B F R C	R	
16, CC	C P B R F R F	R	
17-1, 68-69	C P B B F R F	R	
17-2, 68-69	C P B R F F F	R	
17-3, 68-69	R P B B R B R	R	
17-4, 68-69	R P B B F R R	R	
17-5, 78-79	R P B B F R R	R	
17-6, 68-69	R P B B F R R	R	
17, CC	F P B B F B F	R	
18-1, 68-69	C M B R R R F	R	
18-2, 68-69	C M B B F R F	R	
18-3, 68-69	C M B B F R F	R	
18-4, 68-69	C M R R F R F	R	
18-5, 68-69	F M B B F R R	R	
18-6, 68-69	C M B B F R R	F R	
18, CC	F M B B F R F	R	
19-1, 92-93	R P B B R R R	R	
19-2, 68-69	C P B B R R	R	
19-3, 68-69	C M B B R F R	R	
19-4, 68-69	R P B B R B R	R	
19-6, 68-69	F P B B R B F	R R	
19, CC	F P B R R R F	R	
20-1, 78-79	F P B R R R F	R	
20-2, 68-69	F P B B F F R	R	
20-3, 67-68	F P B B R B F	R	
20-3, 68-69	F P B B R R F	R	
20-4, 68-69	R R B R F R F	R	
20-5, 68-69	R P B B F B F	R	
20-6, 68-69	R P B B R B F	R	
20, CC	R P B B F B F	R	
21-2, 68-69	F P B B F R F	R	
21-3, 68-69	C P B B R R F	R	
21-4, 68-69	F P B B R B R	R	
21-5, 68-69	F P B B R R F	R	
21-6, 68-69	R P B B R R R	R	
21, CC	F P B B R R R	R	
22-1, 68-69	R P B B R B R	R	
22-2, 68-69	F P B B R B R	R	
22-3, 68-69	F P B B R B R	R	
22-4, 68-69	F P B B R R F	R	
22-5, 68-69	C M B R C R F	R	
22-6, 67-68	C G B R F R F	R R	
22-6, 68-69	F P B R F R F	R R	
22, CC	A G B R R F C	R F	R

TABLE 2 – Continued

R		R R R R R	R? F R												C	R R R R R	
R																R F	
																R	
R		R R		R					R						F R		
R		R R		R					R	R R					R R		
R		R		R					R	R R					R R		
R		R		R					R	R R					R R		
R		R							R	R R					R R		
R		R							R	R R					R R		
R		R							R	R R					R R		
R		R R							R	R R					R R		
	F	R R							R	R R					R R		
		R R							R	R					R R		
R	F	R F	R		R R	R			R	R R					R R		
				R	R R	R			F	R F					F F R		

TABLE 2 - *Continued*

Sample (Interval in cm)	Abundance Marine Plankt. Diatoms Preservation Marine Plankt. Diatoms Abundance Freshwater Diatoms Abundance Phytopliths Abundance Sponge Spicules Abundance Silicoflagellates Abundance Radiolaria	<i>Actinocyclus ehrenbergii</i> <i>Actinocyclus ellipticus</i> and varieties <i>Actinocyclus ingens</i> <i>Actinocyclus moronensis</i> <i>Actinptychus undulatus</i> <i>Actinptychus splendens</i> <i>Actinptychus heliopelta</i> <i>Anellus californicus</i> <i>Asterolampra acutiloba</i> <i>Asterolampra grevillei</i> <i>Asterolampra insignis</i> <i>Asterolampra marylandica</i> <i>Asteromphalus arachne</i> <i>Asteromphalus moronensis</i> <i>Bidulphia tuomeyi</i> (benthic)	<i>Bogotovia veniamini</i> <i>Bruniopsis mirabilis</i> <i>Chaetoceros</i> spp. (bristles) <i>Chaetoceros</i> spp. (spores) <i>Cestodiscus peplum</i>	<i>Cladogramma dubium</i> <i>Coconeis</i> spp. (benthic) <i>Coscinodiscus crenulatus</i> <i>Coscinodiscus endoi</i> <i>Coscinodiscus excavatus</i>	<i>Coscinodiscus lewisianus</i> <i>Coscinodiscus lineatus</i> <i>Coscinodiscus marginatus</i> <i>Coscinodiscus nitidus</i> <i>Coscinodiscus nodulifer</i>	<i>Coscinodiscus pilatus</i> group <i>Coscinodiscus praeinitius</i>
23-1, 68-69	F M B B F R F					
23-2, 68-69	C M B B F R F					
23-3, 68-69	C M B B F R F	R				
23-4, 68-69	C M P R R B F	R				
23-5, 68-69	C M B B R R F	R				
23-6, 68-69	F M R R R R R	R				
24-2, 68-69	C G R R R R F					
24-3, 68-69	C G R R R R F					
24-4, 68-69	C G P R F R F	R				
24-5, 68-69	C M B B B R R					
24-6, 68-69	C M B B R R R R	R				
24, CC	C M B B F R C	R				
25-3, 68-69	C M B R R R F	R				
25-4, 68-69	C M B B F R F					
25-5, 68-69	R P B B R R B					
25-6, 68-69	F P B B R B F	R				
26-1, 93-94	R P B B R B R					
26-2, 68-69	F M B R R R F					
26-3, 68-69	R P B B R B F					
26-4, 68-69	R P B B R B R					
26-5, 60-61	R P B B F R F					
27-2, 110-111	C M B B R R F	F				
27-3, 68-69	C M B B R R F	F				
27-4, 88-89	C M B B R F F	R				
27-5, 88-89	C P B B R F F	R				
27-6, 68-69	C M B B R R F	R				
27, CC	C P B B F R F					
28-2, 68-69	C M B B F R F	R				
28-3, 79-80	F P B B R R R	R				
28-4, 68-69	C M B B R R R	F				
28-5, 79-80	C M B R F R R	R				
28, CC	C M B B R R F	R				
29-1, 68-69	C M B B R R F	R				
29-2, 68-69	C M R B F R R	R				
29-5, 68-69	C M R R R R F	F				
29-6, 98-99	C M B B R F F	R				
30-2, 78-79	C M R B R F F	R				
30-3, 78-79	R P R B R F F	R				
30-4, 78-79	F P B B R F F	R				
30-5, 78-79	F P B B F R F	R				
32-2, 78-79	C M B B R R F	R				
32-3, 78-79	C M B B R R F	R				
32-4, 88-89	A M B B R F F	R				
32, CC	C M B B R F F	R				
33-2, 78-79	C M B B F F F	R				
33-3, 78-79	C M B B R F F	R				
33-4, 68-69	C M B B R F F	R				
33, CC	C M B R F F F					
34-1, 98-99	F P B B F R F					
34-2, 78-79	C P B B F R F					
34, CC	C P B B F R F					
35-2, 77-78	A M B B F R C					

^aAsh

TABLE 2 - *Continued*

<i>Coscinodiscus rhombicus</i>	R							
<i>Coscinodiscus stellaris-sybthophorus</i> group	R							
<i>Coscinodiscus superbus</i>	R	R						
<i>Coscinodiscus temporei</i>								
<i>Coscinodiscus verustissimus</i>								
<i>Coscinodiscus vigilans</i>								
<i>Coscinodiscus yabei</i>								
<i>Craspedodiscus coscinodiscus</i>								
<i>Cussia lancettula</i>		R						
<i>Cussia mediopunctata</i>		R						
<i>Cussia paleacea</i>		R						
<i>Cussia tatsunokuchensis</i>		R						
<i>Cymatogonria amphyoceras</i>		R						
<i>Cymatosira compacta</i>		R						
<i>Cymatosira belgica</i>		R						
<i>Cymatosira sp. 2</i>		R						
<i>Cymatosira</i> spp.		R						
<i>Denticula hustedi</i>		R						
<i>Denticula lauta</i>		R						
<i>Denticula nicobarica</i>		R						
<i>Denticula punctata</i>		R						
<i>Denticula punctata</i> var. <i>hustedtii</i>		R						
<i>Denticula norwegica</i>		R						
<i>Dimerogramma elegans</i>		R						
<i>Dimerogramma fossilis</i>		R						
<i>Diploneis</i> spp. (benthic)		R						
<i>Ethmodiscus</i> spp.		R						
cf. <i>Eucampia balaustrum</i>		R						
Genus et sp. indet.		R						
<i>Goniothecium decoratum</i>		R						
<i>Goniothecium odontella</i>		R						
<i>Hemiaulus polycystinorum</i>		R						
<i>Hemiaulus</i> spp.		R						
<i>Hemidiscus cuneiformis</i>		R						
<i>Hemidiscus simplicissimus</i>		R						
<i>Hemidiscus karstenii</i>		R						
<i>Hyalodiscus</i> spp. (benthic)		R						
<i>Macrora stella</i>		R						
<i>Mastogloia</i> spp. (benthic)		R						
<i>Mediaria splendida</i>		R						
<i>Melosira architecturalis</i>		R						
<i>Melosira sulcata</i>		R						
<i>Monobrachia simplex</i>		R						

TABLE 2 - *Continued*

Sample (Interval in cm)	<i>Navicula lyra</i> (benthic) <i>Nitzschia cylindrica</i> <i>Nitzschia fossilis</i> <i>Nitzschia interrupta</i> <i>Nitzschia houseae</i> <i>Nitzschia marina</i> <i>Nitzschia miocenica</i> <i>Nitzschia porteri</i> <i>Nitzschia reinholdii</i> <i>Peponia barbadense</i> <i>Plagiogramma</i> spp. (benthic) <i>Pleurosigma planktonica</i> <i>Pseudodimerogramma elegans</i> <i>Pseudodimerogramma oligocenica</i> <i>Pseudopyxilla americana</i> <i>Pseudopyxilla directa</i> <i>Pseudopyxilla rossica</i> <i>Pseudorutillaria monomenthanaceae</i> <i>Pseudotriceratum chenevieri</i> <i>Pteriptera</i> sp. 1 <i>Pterotheca</i> spp. <i>Pyrgupyxis johnsoniana</i> <i>Rhaphidodiscus marylandicus</i> <i>Rhaphoneis amphiceros</i> <i>Rhaphoneis angustata</i> <i>Rhaphoneis elongata</i> <i>Rhaphoneis margarita-limbata</i> <i>Rhaphoneis</i> sp. 1 <i>Rhizosolenia alata</i> forma indet. <i>Rhizosolenia bergenii</i> <i>Rhizosolenia firma</i> <i>Rhizosolenia hebetata</i> forma <i>hiemalis</i> <i>Rhizosolenia hebetata</i> forma <i>subacuta</i> <i>Rhizosolenia praebergonii</i> <i>Rhizosolenia styliformis</i>
1, CC 2-1, 71-72 ^a 2-4, 71-72 2-5, 71-72 2-6, 71-72	
2, CC 3-4, 71-72 3-5, 61-62 3-6, 71-72 3, CC	R R
4-1, 71-72 4-2, 90-91 4-3, 71-72 4-4, 71-72 4-5, 71-72	R R R R
4-6, 71-72 4, CC 5-1, 91-92 5-2, 71-72 5-3, 73-74	R R R R
5-4, 71-72 5-5, 71-72 5-6, 71-72 5, CC ^a 9-5, 63-64	R R R R
9-6, 63-64 9, CC 10-1, 113-114 10-2, 73-74 10-3, 73-74	R R
10-4, 73-74 10-5, 71-72 10-6, 71-72 10, CC 11-1, 67-68	R R R R
11-2, 62-63 11-3, 68-69 11-4, 72-73 11-5, 72-73 11-6, 72-73	R R R R
11, CC 12-1, 73-74 12-2, 73-74 12-3, 73-74 12-6, 73-74	R R
12, CC 13-1, 73-74 13-2, 73-74 13-3, 73-74 13-4, 73-74	R R R R

TABLE 2 - *Continued*

<i>Riedelia claviger</i>						
<i>Riedelia</i> spp.						
<i>Rouxia obesa</i>						
<i>Roperia tessellata</i>						
<i>Scepironites caducea</i>						
<i>Scepironites humuncia</i>						
<i>Scepironites pesplanus</i>						
<i>Scepironites propinqua</i>						
<i>Scepironites</i> sp. 1						
<i>Scepironites</i> sp. 2						
<i>Scepironites</i> spp.						
<i>Stephanopyxis</i> spp.						
<i>Stephanopyxis turris</i>						
<i>Stictodiscus kittonianus</i>						
<i>Synedra miocenica</i>						
<i>Synedra jouseana</i>						
<i>Thalassionema nitczschoides</i>						
<i>Thalassionema hirosgakienis</i>						
<i>Thalassiosira convexa</i>						
<i>Thalassiosira dubiosa</i>						
<i>Thalassiosira eccentrica</i>						
<i>Thalassiosira miocenica</i>						
<i>Thalassiosira oestrupii</i>						
<i>Thalassiosira</i> cf. <i>plicata</i>						
<i>Thalassiothrix longissima</i>						
<i>Triceratium balearicum</i> (benthic)						
<i>Triceratium barbadensis</i>						
<i>Triceratium schulzii</i>						
<i>Trinacria excavata</i>						
<i>Trinacria pileolus</i>						

TABLE 2 – *Continued*

Sample (Interval in cm)	<i>Navicula lyra</i> (benthic) <i>Nitzschia cylindrica</i> <i>Nitzschia fossili</i> <i>Nitzschia interrupta</i> <i>Nitzschia jouseae</i> <i>Nitzschia marin</i> <i>Nitzschia miocenica</i> <i>Nitzschia porteri</i> <i>Nitzschia reinholdii</i> <i>Peponia barbadense</i> <i>Plagiogramma</i> spp. (benthic) <i>Pleurosigma planktonica</i> <i>Pseudodimerogramma elegans</i> <i>Pseudodimerogramma oligocenica</i> <i>Pseudopyvillia americana</i> <i>Pseudopyxilla directa</i> <i>Pseudopyxilla rossica</i> <i>Pseudorutilaria monomembranaceae</i> <i>Pseudotriera membranaceae</i> <i>Peripatra</i> sp. 1 <i>Pterotheca</i> spp. <i>Pyrgupyxis johnsoniana</i> <i>Rhaphidiodiscus marylandicus</i> <i>Rhaphoneis amphiceros</i> <i>Rhaphoneis angustata</i> <i>Rhaphoneis elongata</i> <i>Rhaphoneis margarita-limbata</i> <i>Rhaphoneis</i> sp. 1 <i>Rhizosolenia alata</i> forma indet. <i>Rhizosolenia bergenii</i> <i>Rhizosolenia firma</i> <i>Rhizosolenia hebetata</i> forma <i>hiemalis</i> <i>Rhizosolenia hebetata</i> forma <i>subacuta</i> <i>Rhizosolenia praebergonii</i> <i>Rhizosolenia styliformis</i>										
13-5, 73-74											R
13-6, 73-74											R
13, CC											R
14-1, 113-114											R
14-2, 73-74											R
14-3, 73-74	R				R						R
14-4, 73-74					R						R
16, CC					R						R
17-1, 68-69	R				R						R
17-2, 68-69					R						R
17-3, 68-69											R
17-4, 68-69											R
17-5, 78-79											R
17-6, 68-69											R
17, CC											R
18-1, 68-69		R		R				R			
18-2, 68-69								R			
18-3, 68-69								R			
18-4, 68-69								R			
18-5, 68-69								R			R
18-6, 68-69	R							R	R	R	R
18, CC								R	R	R	R
19-1, 92-93								R	R	R	
19-2, 68-69								R	R	R	
19-3, 68-69								R	R	R	
19-4, 68-69								R	R	R	R
19-6, 68-69								R	R	R	
19, CC								R	R	R	
20-1, 78-79								R	R	R	
20-2, 68-69								R	R	R	
20-3, 67-68											
20-3, 68-69											
20-4, 68-69											
20-5, 68-69											
20-6, 68-69											
20, CC	R										
21-2, 68-69											
21-3, 68-69											
21-4, 68-69											
21-5, 68-69											
21-6, 68-69											
21, CC											
22-1, 68-69											
22-2, 68-69											
22-3, 68-69											
22-4, 68-69	R										
22-5, 68-69	R										
22-6, 67-68	R										
22-6, 68-69	R										
22, CC											

TABLE 2 - *Continued*

<i>Riedelia claviger</i>						
<i>Riedelia</i> spp.						
<i>Rouxia obesa</i>						
<i>Roperia tessellata</i>						
<i>Sceptrotrinis caducea</i>						
<i>Sceptrotrinis humuncia</i>						
<i>Sceptrotrinis pesplanus</i>						
<i>Sceptrotrinis propinquua</i>						
<i>Sceptrotrinis</i> sp. 1						
<i>Sceptrotrinis</i> sp. 2						
<i>Sceptrotrinis</i> spp.						
<i>Stephanopyxis</i> spp.						
<i>Stephanopyxis turris</i>						
<i>Stictodiscus kittonianus</i>						
<i>Synedra miocenica</i>						
<i>Synedra jouseana</i>						
<i>Thalassionema nitzschioides</i>						
<i>Thalassionema hiroakiensis</i>						
<i>Thalassiosira convexa</i>						
<i>Thalassiosira dubiosa</i>						
<i>Thalassiosira eccentrica</i>						
<i>Thalassiosira miocenica</i>						
<i>Thalassiosira oestrupii</i>						
<i>Thalassiosira cf. plicata</i>						
<i>Thalassiothrix longissima</i>						
<i>Triceratium balearicum</i> (benthic)						
<i>Triceratium barbadensis</i>						
<i>Trinacria excavata</i>						
<i>Trinacria pileolus</i>						
		R F F R F F F F C F		F		
	F	R F F F R R	R	R		
			F R F F			
		R R	R			
			R R			
		R	R			
	R	R F R R F F R R R F R	R R R R R			
			F R R F F R R F R			
	R	R F F R R R R R R R F R F F	R R R R F			
			F F F R R R R R R R			
	R	R R	R F			
			F R F R R F F F F			
	R	R F F R F R R F F F				
			F F F F F F F R			
	R	R R F F R R R R R R R R R R R R F R	R R R R			
			C F F R R R R R R R R R R R R			

TABLE 2 - *Continued*

Sample (Interval in cm)	<i>Navicula lyra</i> (benthic) <i>Nitzschia cylindrica</i> <i>Nitzschia fossilis</i> <i>Nitzschia interrupta</i> <i>Nitzschia jouseae</i> <i>Nitzschia marina</i> <i>Nitzschia miocenica</i> <i>Nitzschia porteri</i> <i>Nitzschia reinholdii</i> <i>Peponia barbadense</i> <i>Plagiogramma</i> spp. (benthic) <i>Pleurosigma planktonica</i> <i>Pseudodimerogramma elegans</i> <i>Pseudodimerogramma oligocenica</i> <i>Pseudopyxilla americana</i> <i>Pseudopyxilla directa</i> <i>Pseudopyxilla rossica</i> <i>Pseudorutularia monomenthanaceae</i> <i>Pseudotriceratium chenevieri</i> <i>Pteriptera</i> sp. 1 <i>Pterotheca</i> spp. <i>Pyrgopyx Johnsoniana</i> <i>Rhaphidodiscus marylandicus</i> <i>Rhaphoneis amphiceros</i> <i>Rhaphoneis angustata</i> <i>Rhaphoneis elongata</i> <i>Rhaphoneis margarita-limbata</i> <i>Rhaphoneis</i> sp. 1 <i>Rhaphoneis</i> spp. <i>Rhizosolenia alata</i> forma indet. <i>Rhizosolenia bergenii</i> <i>Rhizosolenia firma</i> <i>Rhizosolenia hebetata</i> forma <i>hiemalis</i> <i>Rhizosolenia hebetata</i> forma <i>subacuta</i> <i>Rhizosolenia praebergonii</i> <i>Rhizosolenia styliformis</i> <i>Riedelia clariger</i>
23-1, 68-69	R
23-2, 68-69	R
23-3, 68-69	
23-4, 68-69	
23-5, 68-69	
23-6, 68-69	
24-2, 68-69	
24-3, 68-69	
24-4, 68-69	
24-5, 68-69	
24-6, 68-69	
24, CC	
25-3, 68-69	
25-4, 68-69	
25-5, 68-69	
25-6, 68-69	
26-1, 93-94	
26-2, 68-69	
26-3, 68-69	
26-4, 68-69	
26-5, 60-61	
27-2, 110-111	
27-3, 68-69	
27-4, 88-89	
27-5, 88-89	
27-6, 68-69	
27, CC	
28-2, 68-69	
28-3, 79-80	
28-4, 68-69	
28-5, 79-80	R
28, CC	R
29-1, 68-69	R
29-2, 68-69	R
29-5, 68-69	R
29-6, 98-99	
30-2, 78-79	
30-3, 78-79	
30-4, 78-79	
30-5, 78-79	
32-2, 78-79	
32-3, 78-79	
32-4, 88-89	
32, CC	
33-2, 78-79	
33-3, 78-79	
33-4, 68-69	
33, CC	
34-1, 98-99	
34-2, 78-79	
34, CC	
35-2, 77-78	

TABLE 2 - *Continued*

<i>Riedelia</i> spp.									
<i>Rouxia obesa</i>									
<i>Roperia tessellata</i>									
<i>Scepironensis caducea</i>									
<i>Scepironensis humuncia</i>									
<i>Scepironensis pesplanus</i>									
<i>Scepironensis propinqua</i>									
<i>Scepironensis</i> sp. 1									
<i>Scepironensis</i> sp. 2									
<i>Scepironensis</i> spp.									
<i>Stephanopyxis</i> spp.									
<i>Stephanopyxis turris</i>									
<i>Stictodiscus kittonianus</i>									
<i>Synedra miocenica</i>									
<i>Synedra iowenseana</i>									
<i>Thalassionema nitczchioides</i>									
<i>Thalassionema hirotsakienesis</i>									
<i>Thalassiosira convexa</i>									
<i>Thalassiosira dubiosa</i>									
<i>Thalassiosira eccentrica</i>									
<i>Thalassiosira miocenica</i>									
<i>Thalassiosira oestrupii</i>									
<i>Thalassiosira cf. plicata</i>									
<i>Thalassiothrix longissima</i>									
<i>Triceratium balearicum</i> (benthic)									
<i>Triceratium barbadensis</i>									
<i>Triceratium schulzii</i>									
<i>Trinacia excavata</i>									
<i>Trinacia pileolus</i>									

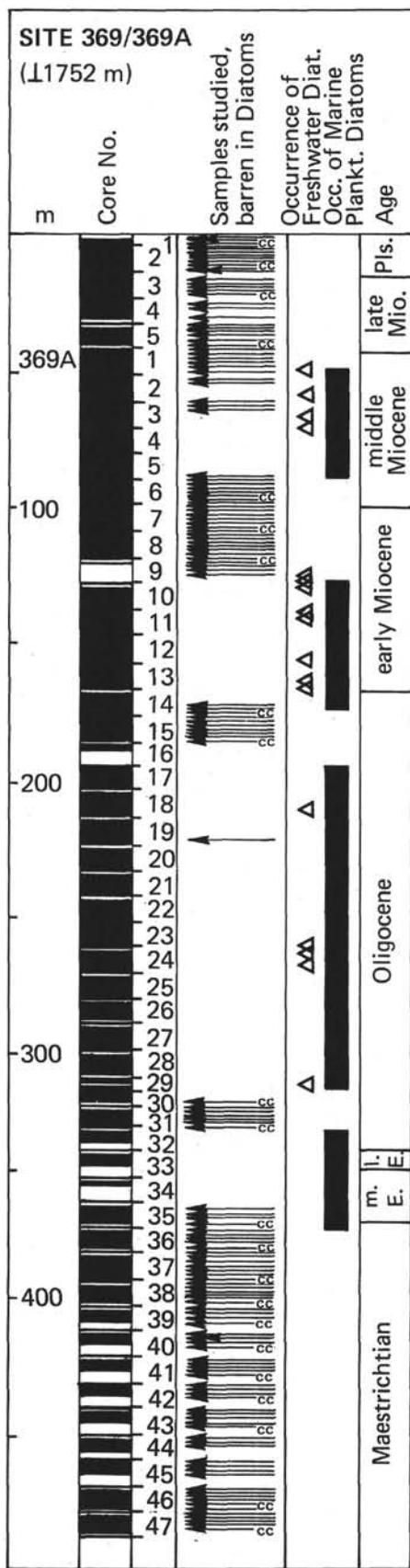


Figure 4. Site 369 and Hole 369A summary figure. Arrows indicate samples

barren in diatoms, triangles occurrence of displaced fresh-water diatoms. Age assignments are taken from the site reports (this volume).

Site 369 (Holes 369 and 369A)

This section consists predominantly of nannofossil marls with siliceous components in the Eocene through Miocene intervals (Figure 4). Samples barren in opal phytoplankton are listed as arrows in Figure 4.

Ranges of selected diatom species are compiled in Figures 5 and 6. The range of *Annulus californicus* Core 12 through the base of Core 9 places the middle-early Miocene boundary in between Cores 10 and 11 (for definition see Schrader and Burckle, in press).

Displaced fresh-water diatoms, phytoliths, and displaced marine benthic diatoms are listed in Figure 4.

Site 370

None of the 169 samples from Cores 1-51 (except Cores 4 and 11) in the deep basin off Morocco contain opal phytoplankton remains.

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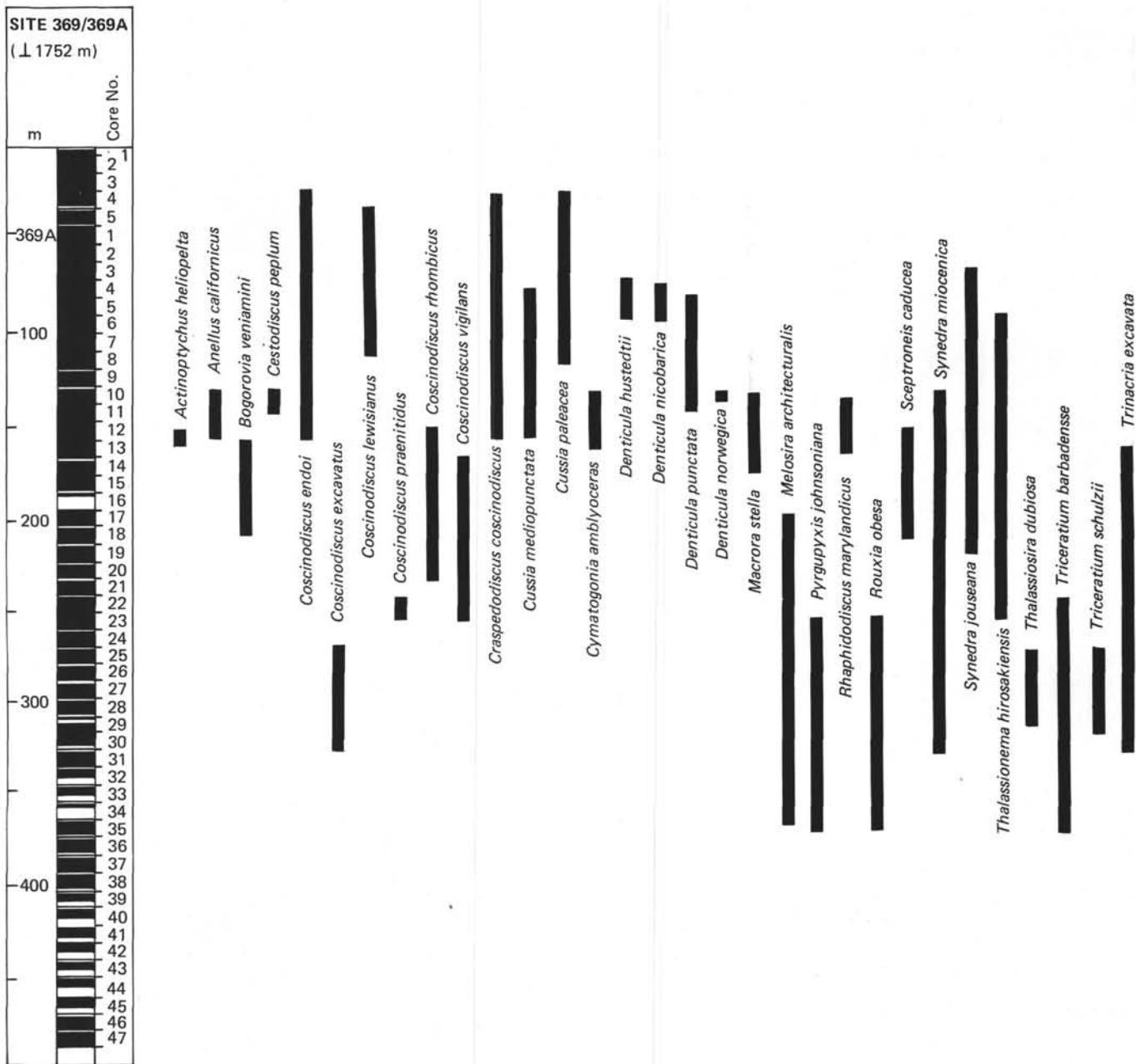


Figure 5. Occurrence of selected diatoms at Site 369 and Hole 369A (range chart).

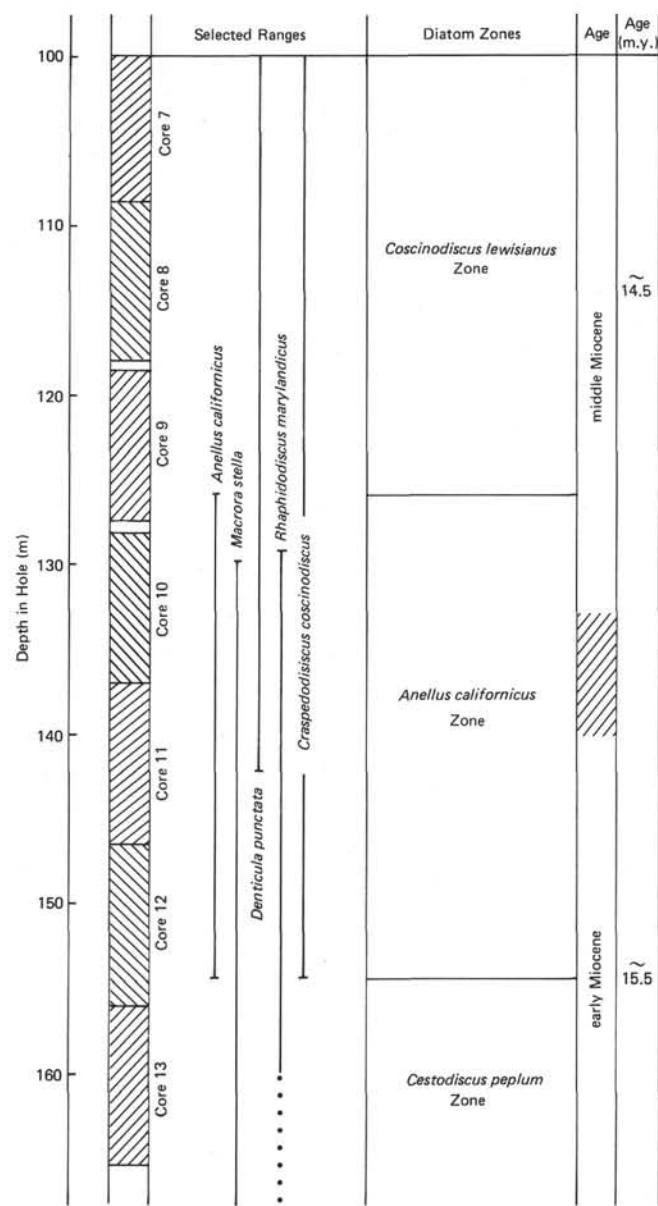


Figure 6. Range chart of important early to middle Miocene diatoms at Hole 369A. Diatom zones are those of Schrader and Burkle (in press). The early-middle Miocene boundary is placed between Cores 10 and 11.