37. RADIOLARIA: LEG 31 OF THE DEEP SEA DRILLING PROJECT[1]

Hsin Yi Ling, Department of Oceanography, University of Washington, Seattle, Washington

INTRODUCTION

During Leg 31 of the Deep Sea Drilling Project, 13 sites were drilled (Figure 1, Table 1) in the western Pacific region encompassing latitudes from 12° to 41°N. Because one of the main objectives was directed toward the tectonic history of the area, proposed sites drilled were clustered into three geographic areas. Accordingly, the occurrences of radiolarians reported herein are also grouped into these areas: Philippine Sea (Sites 290-295); southwest of Japan (Sites 296-298); and the Sea of Japan (Sites 299-302).

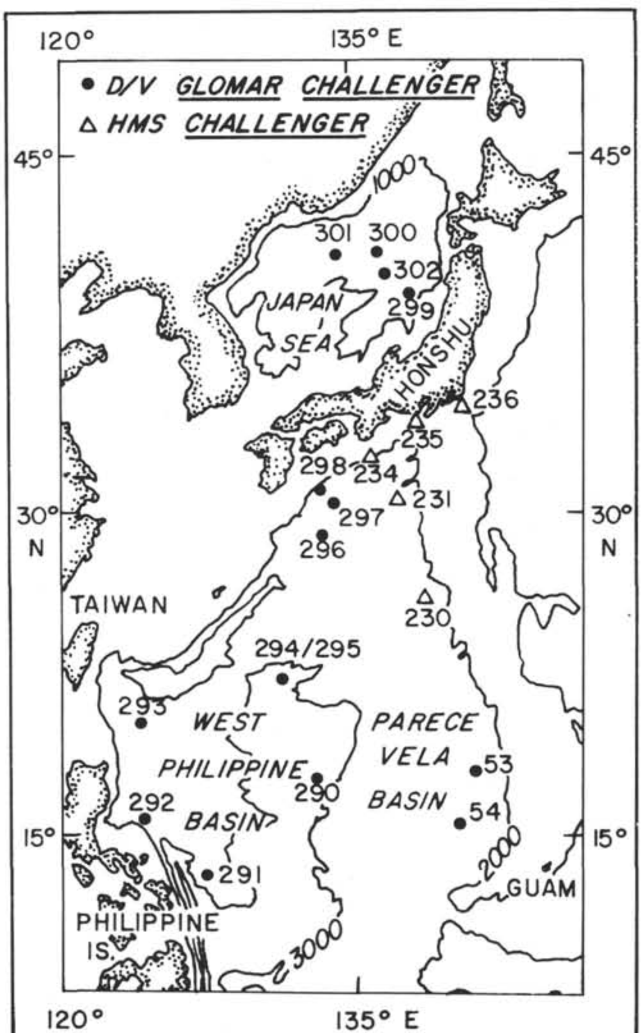

Figure 1. *Geographic locations of drilling sites, Deep Sea Drilling Project, Leg 31.*

TABLE 1
Coordinates of Drilling Sites, Deep Sea Drilling Project, Leg 31

Hole	Latitude (N)	Longitude (E)	Water Depth (m)
290	17°44.85′	133°28.09′	6062.5
290A	17°45.05′	133°28.44′	6062.5
291	12°48.43′	127°49.85′	5217
291A	12°48.45′	127°48.98′	5217
292	15°49.11′	124°39.05′	2943
293	20°21.25′	124°05.65′	5599
294	22°34.74′	131°23.13′	5784
295	22°33.76′	131°22.04′	5802
296	29°20.41′	133°31.52′	2920
297	30°52.36′	134°09.89′	4458
297A	30°52.36′	134°09.89′	4458
298	31°42.93′	133°36.22′	4628
298A	31°42.93′	133°36.22′	4628
299	39°29.69′	137°39.72′	2599
300	41°02.96′	136°06.30′	3427
301	41°03.75′	134°02.86′	3520
302	40°20.13′	136°54.01′	2399

The techniques of sample preparation, as well as describing the locations of illustrated specimens in the slides, are essentially the same as a similar investigation for Leg 19 (Ling, 1973).

All the microslides used for the present investigation, including the figured specimens, will be deposited permanently in the Micropaleontology Collection of the Department of Oceanography, University of Washington.

OCCURRENCES

In the following discussion, a history of the respective area on Radiolaria available at the time of actual drilling is summarized briefly to provide the background, followed by a description of the results of the present investigation from each site. The dates of publication referred to throughout the present study are based on the catalog by Foreman and Riedel (1972).

The radiolarian abundance in examined samples from each hole (Tables 2-10) is indicated as: A, abundant (over 26 specimens); C, common (11-25 specimens); F, few (6-10 specimens); R, rare (2-5 specimens) and +, for a single specimen. The state of preservation of these microfossils is classified into: G, good; M, moderate; and P, poor.

Among the samples examined, those which failed to yield radiolarians, contained too few specimens, or for which the preservation was too poor for stratigraphic consideration are not listed in the occurrence from each site. They are as listed as follows:

[1]Contribution No. 775 from the Department of Oceanography, University of Washington.

Site 290
1-1, 10-12
1, CC
2, CC
8, CC
9, CC
Site 291
1-1, 120-124
1, CC
2, CC
5, CC
Site 292
1-1, 20-22
1, CC-15, CC
38, CC
39, CC
Site 293
1, CC-17, CC
Site 294
1, CC-6, CC
Site 295
1, CC-3, CC
3A, CC
Site 296
2, CC
3-1, 16-18
3-3, 90-92
3, CC
4-2, 45-47
4, CC
5-2, 30-32
5, CC
6-2, 40-42
6, CC
7, CC
8-1, 142-144
8-3, 110-112
8-4, 60-62
8, CC
9-3, 5-7
9, CC
10-3, 80-82
10, CC
11-2, 70-72
11, CC
12-1, 130-132
12, CC
13-2, 15-17
13, CC
14-3, 23-25
15-2, 60-62
15, CC
16-5, 50-52
16-6, 64-66
17-3, 60-62
17, CC
18-1, 96-98
18, CC
19-3, 60-62
19, CC
20-2, 30-32
20, CC
21-2, 17-19
21-4, 60-62
21, CC
22-2, 26-28
22-4, 15-17
23-2, 88-90
23-3, 105-107
23, CC
44-1, 125-126
44, CC
45-3, 80-82
45, CC
46-1, 38-40
46-3, 98-100
46, CC
47-1, 133-135
47, CC
48-1, 140-142
48, CC-56, CC
57-1, 85-87
57-2, 20-22
57-4, 40-42
57, CC-65, CC
Site 297
7, CC
8-3, 40-42
8, CC
9-2, 40-42
9, CC
10-4, 30-32
10, CC
11-2, 101-103
11, CC-24, CC
25-2, 37-40
25-4, 50-52
25, CC
26-1, 32-35
26-1, 91-94
26-2, 64-66
26-2, 113-115
27-1, 50-52
27, CC
Site 298
4-1, 70-72
4, CC
5, CC
6-1, 90-92
6, CC
7-1, 80-82
7, CC
8-1, 142-144
8, CC
9-1, 72-74
9, CC
10-1, 110-112
10, CC
11-3, 71-74
11, CC
12-4, 70-72
12, CC
13-3, 28-30
13, CC
14-2, 103-105
14, CC
15-2, 32-34
15-2, 100-102
15, CC
16-1, 33-35
16, CC
Heat flow
Site 299
36, CC-38, CC
Site 302
16, CC
17-1, 94-96
17, CC
18-1, 75-77
18, CC

Philippine Sea

Background: Sites 290 through 295 were located in the Philippine Sea. From this area came Ehrenberg's (1860a) report and illustration (1872b). Several stations of the HMS *Challenger* were located in the area, and these samples furnished the materials for a part of Haeckel's (1887) monography. Riedel (1952) pointed out the Tertiary age for the sample from *Challenger* Station 225, and reported (Riedel, 1957) Eocene radiolarians from the Saipan Island. Sites 53 and 54 of DSDP Leg 6 were located within the area under consideration (Kling, 1971).

Information concerning the stratigraphic occurrences and biostratigraphic zonation is sought from the studies undertaken during previous legs: data from Leg 4 (Riedel and Sanfilippo, 1970); Leg 7 (Riedel and Sanfilippo, 1971); Leg 8 (Moore, 1971); Leg 10 (Foreman, 1973); Leg 14 (Petrushevskaya and Kozlova, 1972); Leg 16 (Dinkelman, 1973); and Leg 22 (Johnson, 1974) are relied upon heavily.

Results: Site 290 (Table 2) was west of the Palau-Kyushu Ridge and north of the Central Basin Fault. Silty clay sediments of Cores 1 and 2 (23-80 m) and Sample 3-1, 48-50 cm are barren of Radiolaria. Starting with Sample 3-3, 20-22 cm, approximately at 102 meters, through Core 7 (222.5 m), nannofossil ooze and the upper part of volcanic conglomerate units of Site 290, and Core 1 (107.5-118 m) and Sample 290A-2, CC (Table 2) contains moderately preserved, abundant to few radiolarians of the late Eocene *Thyrsocyrtis bromia* Zone. Radiolarians are absent from sediments of Cores 8 and 9 (241.5-255 m) of Site 290. As reported in this volume, this age determination disagrees with that of calcareous nannofossils which are considered as late Oligocene in age (Ellis, this volume).

Similar radiolarian assemblages are found at Site 291 (Table 3), drilled on the flanks of benches near the crest of the outer swell of the Philippine Trench, south of the

TABLE 2
Radiolarians From Holes 290 and 290A

Sample (Interval in cm)	Abundance	Preservation	*Dorcadospyris triceros*	*Druppatractus coronata laevis*	*Eucyrtidium* sp. cf. *E. montiparum*	*Lychnocanoma babylonis-turgidulum*	*Sethochytris triconiscus*	*Theocampe mongolfieri*	*Thyrsocyrtis rhizodon*	*T. tetracantha*	*T. triacantha*	*Calocyclas hispida*	*C. turris*	*Calocycloma ampulla*	*Liriospyris* sp.	*Lychnocanoma* sp. B	*Periphaena decora*	*Podocyrtis papalis*	*Rhopalocanium ornatum*	*Theocampe armadillo*	*Theocotyle (T.) cryptocephala cryptocephala*	*Lithocyclia ocellus* group	*Thyrsocyrtis bromia*	*Diplocyclas* sp.	*Lithocyclia aristotelis* group	*Theocorys anapographa*	*Spongodiscus quartus quartus*	*Lychnocanoma* sp. A.	*Theoperidae* gen. A.	*Lophochytris* (?) *jacchia*	*Phorticium embolum*	*Eusyringium fistuligerum*	*Amphicraspedum prolixum*	*Ceratospyris clavata*	*Lamptonium sanfilippoae*	*Tholospyris* sp. cf. T-Z group	*Liriospyris clathrata*	*Eusyringium tubulus*	*Lithomitra* sp. cf. *L. elizabethae*	*Dorcadospyris didiceros*	*Eucoronis hertwigii*	*Podocyrtis* (L) *mitra*	*Pterocodon* sp. cf. *P. campana*	*Theocampe amphora*	*Pterocyrtidium* sp.	Radiolarian Zones
Hole 290																																														
3-1, 48-50																																														
3-3, 20-22	C	M	C	R	R	F	F	R	R	R	F	F	R	F	R	F	F	F	R	R	F	R	F	R	R	R	R	R	R	R																
3, CC	C	M	F	F		F		R		R	F			R	R					R	R	R						R	R		R															
4-2, 60-62	C	M	C	F		F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	R	R	F	R	R			F	R	R	F	R	R	+	R							
4, CC	F	M	R	R		R		F			R						F	F														R		R	R		R		R							
5-1, 102-104	C	M	F	F		R	F	F	F	R	R	F	F	R		R			R	F			R				R					R		R	R	R	F			F	R					
5-3, 61-63	C	M	C	F		F	F	F		R	R	R	F	F	R	R	R	R		F				R	R	R	R				R	R				R	F			R		+	+			*Thyrsocyrtis bromia*
5, CC	F	M	F	R		R		R	R		R		R				R	R				R																								
6-1, 58-60	C	M	F	F		F		C	R	F	R	R	F	R	R	R	F	F	R	R		R		R		R	R				R		R			R	R	+			R			R		
6-3, 10-12	C	M	F	F	R	R	R	F		F	F	R	F	F	R	F	F	F		F	R	R		R	R	F					R	F			R	R	R				R			R		
6, CC	F	M		F				F		R	R			R	R	R	R	R		R		R	R									R					R								R	
7-2, 130-132	F	M		F		R	R	F	F		R	R	F	F	F		F	F		F	R	R										R		R	R	R				R				F		
7-4, 10-12	C	M	F	R	R	F		F	F	F	F	R	F	F	F	R	R	R	F	F	R												R	R	R									F	R	
7, CC	F	P	R	R	R	R	R	F	R	R	R																					R												R		
Hole 290A																																														
1-1, 110-112	A	M	F	F	R	F	F	F	R	F	F	R	F			R	F	R	R	F		R	R		F			R				F	R			F										
1-2, 60-62	A	M	F	F	R	F	R	F		F	F		R			R	F	R	R	R	R	F			R	R		R				F														*Thyrsocyrtis bromia*
1, CC	C	P	R	R		R		F		R	R		R					R				F										R														
2, CC	F	P	R	R				F			R		R															R																		

TABLE 3
Radiolarians From Holes 291 and 291A

Sample (Interval in cm)	Abundance	Preservation	*Dorcadospyris triceros*	*Lamprocyclas sanfilippoae*	*Periphaena decora*	*Pterocyrtidium* sp.	*Thyrsocyrtis bromia*	*Astrophacus* sp.	*Spongodiscus quartus quartus*	*Stauralastrum* sp.	*Giraffospyris circumflexa*	*Lithocyclia angusta*	*Theocampe pirum*	*Thyrsocyrtis triacantha*	*Liriospyris clathrata*	*Lychnocanoma babylonis-turgidulum*	*Lychnocanoma* sp. B.	*Theocampe mongolfieri*	Theoperidae gen. A.	*Amphicraspedum prolixum*	*Lychnocanoma* sp. A.	*Theocampe armadillo*	*Eucyrtidium* sp. A.	*Triactis tripyramis tripyramis*	*Lophocyrt* (?) *jacchia*	*Eucyrtidium* sp. cf. *E. panthera*	*Ceratospyris echinus*	*Stylosphaera* sp.	*Ellipsoxiphus* sp. cf. *E. atractus*	*Calocyclas hispida*	*Diplocyclas* spp.	*Druppatractus coronata laevis*	*Theocotyle* (*T.*) *cryptocephala cryptocephala*	*Calocyclas turris*	*Lithocyclia aristotelis* group	*Thyrsocyrtis hirsuta hirsuta*	*T. tetracantha*	*Dendrospyris didiceros*	*Pterocodon* sp. cf. *P. campana*	*Calocycloma ampulla*	*Eucoronis hertwigii*	*Eusyringium fistuligerum*	*Podocyrtis mitra*	*P. papalis*	*Patagospyris confluens*	*Rhopalocanium ornatum*	*Thyrsocyrtis rhizodon*	*Theocorys anapographa*	*Eucyrtidium* sp. cf. *E. montiparum*	*Lithocyclia ocellus* group	*Lithochytris vespertilio*	*Anthocyrtella* sp.	*Liriospyris* sp.	*Tholospyris* sp. cf. *T*-2 group	*Sethochytris triconiscus*	Radiolarian Zones
Hole 291																																																								
3-1, 100-102	C	G	C	C	+	R	+	+	R	R	R	R	R																																											*Theo. tuberosa*
3-1, 115-117	C	M	F	R		R	+	R	R	R	R			R	R	F	F	R	R	R	F	R	R	R	R	R																														*Thyrsocyrtis bromia*
3-1, 120-122	C	G	R	R	F	R			R	R	R				R	R	R	F	R	R		R	R	R	R		R	+	+																											
3-1, 133-135	A	G	R	R	R	R	F		R	R				R	R	R	F	F	R		R	R	R	R	F					R	+	R	+	F	R	R	F																			
3, CC	A	G		R			R		R	R				R	R			R				R	R	R						R			+	R		R	F	R	+																	
4-1, 68-70	A	G		R				R						F	R	F	R	C	R	C	R	C					R	F		F			C		R	R		F		R	R	F	R	R												
4-2, 65-67	A	G	F	F	F		R							C	R	F	R	C	R	F	R						R	R		C	R		F	F				R		F	F	F	R	F	R	R	C	R	F	F						
4-3, 63-65	A	G	R	R	R		F							C		F	R	C	R	F	R	R					R	R	+	F	R	R	F	C	R			R		R	F	F	F	F	R	F	F	F	F	R	R	+				
4-4, 5-8	F	M	R	R	R		R							F		R	R	C		+	R	R					R			F		R	F	R						R	R	F	R	R	R	R	F	R					R	R		
4-4, 30-32	F	M	R	R	R	R								F	R	R	R	F	R											R	R	F	R							R	R	F	R	R	R	R	F				R		R	R	F	
4, CC	R	P												+																																										
Hole 291A																																																								
1, CC	C	P	R			F	R		R					F		R		R		R	R	R			R							R	R		R	R				R	R		R	R			R							R		*Thyrsocyrtis bromia*
2, CC	F	M							R								R	R													R	R					R	R						R		R		R						R		
3, CC	C	M	C	R	F	R										F	C	C	R			R	C		C							R			F												R									

TABLE 4
Radiolarians From Site 292

Sample (Interval in cm)	Abundance	Preservation	*Carpocanistrum* sp. A	*Dorcadospyris ateuchus*	*Carpocanistrum* sp. B	*Liriospyris geniculosa*	*L. mutuaria*	*Calocycletta robusta*	*Astrophacus* sp.	*Rhodospyris* sp. cf. *De-1 group*	*Cannartus prismaticus*	*Calocycletta virginis*	*Dorcadospyris* sp.	*Triospyrid* sp.	*Tholospyris* sp. cf. T-2 group	*Dendrospyris pododendros*	*Bathropyramis* sp.	*Theocorys spongoconum*	*Giraffospyris circumflexa*	*Dorcadospyris circulus*	*Theocyrtis annosa*	*Clathrocorys* sp.	*Liriospyris* sp.	*Triactis tripyramis triangula*	*Lychnocanoma trifolium*	*L.. elongata*	*Liriospyris clathrata*	*Trissocyclas* sp.	*Dorcadospyris triceros*	*Lithocyclia angustum*	*Rhodospyris* sp. cf. *R. anthocyrtis*	*Euchitonia furcata*	*Tholospyris cortinisca*	*Petalospyris foveolata*	*Cyclampterium* (?) *milowi*
16, CC	F	M	F	+	R	+	+	+																											
17-1, 105-107	A	G	F	C	F	C	C	A	F	R	+	C																							
17-3, 48-50	A	G	F	C	A	F		A	F	R	F	F	F																						
17-5, 50-52	C	G		F	C		R	C	F	F	F																								
17, CC	C	M		R	R		F	F	R			R		+	+	R																			
18-1, 50-52	A	G	F	F	F	F	R	C	R	F	F	F	R			R	R	F	?																
18-3, 50-52	A	G	A			C		C	F	F	F		R			R		R																	
18-5, 50-52	A	G	A		A	C		C	F	F	R		F			R				R	C														
18, CC	A	G	R	R	R	R		R	R	R	R	+	R	R	R	R	+				R	F	F												
19-1, 50-52	A	G	A	F	A	F	+		F	C	R		F	R		R		R	F	F	R		C	F	R	+									
19-3, 50-52	A	G	F	F	F	F		F	F	R	F		R						R	R			R	F			+	C							
19-5, 60-62	A	G	F	F	F	R	+		F	F	F		F	R	F		+	R	F			R	F	F	F		R	F	?	R	R				
19, CC	C	G	R	R	F	F	+			R	R				+			R										R			R				
20-2, 50-52	A	G	F	C	F	R			F	C				R	R	R		F				F	C	F	C			F		F	F	R			
20, CC	R	M		R	F					F						R	+	R				R	C		F			R		R		R			
21-1, 90-92	A	G	R	F	F	F			F	R				R	R	R		F				R	R	R						R	R	R			
21-3, 50-52	A	G	C	F	F	F			F	R			F			R		F	R			R	R								R	R	+		
21-5, 50-52	A	G	F	C	F	C			F	R			F																			R	+		
21, CC	A	M	R	R	R	R				F			F	R			R					R	R						R	R					
22-2, 50-52	A	G	F	C	R	R			F	F	F		F	R	+		R		+			R	F	R					+	F			R	R	R
22, CC	C	G	F		F	F				F			R	R									R				+				R		F	R	
23-1, 50-52	A	G	R	C	R				C	F	F		F	F			R			R		F	R	F						F	R		R	R	R
23-3, 50-52	A	M		C	R				F		F						R	R					R	R						R			R		
23, CC	C	G							R	F	R						R			R	+	R	F							R	R			R	
24-2, 50-52	A	G	C	C					F	F	F		F	R			F	R	R	R	+	F	R							R	F	F	R	R	R
24, CC	A	G	F							R				R						R	R	R	R	+						F		F	R		
25-1, 50-52	A	G	R	R					R	F	R		F	R			R	R	R	R	R	R	R							F		R	F	F	R
25, CC	F	M	R							F				R								R									R	R			
26-1, 105-107	C	G	F	F					F	F			R				R	F	F			F					R		R	F	R	F	R	R	R
26, CC	A	G	R	R					R	F							R		R			F	R				F		R	R	R			R	
27-1, 50-52	A	G	R	R					R	F			F				R		C			C					R			F	R		F		F
27, CC	A	G	R							R									R			R								R	R				
28, CC	C	G	R						R	R				F					R			F								F	F				
29-1, 130-132	A	G	R							R			F	F			R		R			C	R				R		R	F	F			F	
29, CC	A	G	R	+										R				R	R			C							R	R				F	
30-1, 90-92	A	G	R										F	F			R	F	F			F	R				R			F					
30, CC	A	G	R						R	+			R	R				R				C	R						F	R				F	
31-2, 57-59	A	G	R						R					F			R	R				F	R				R		R	F	R				
31, CC	C	G	F																										R	R					
32-1, 50-52	C	G	R											F			+					F							R	R					
32, CC	C	M	+														+					F	R				R			R				F	
33-2, 90-92	C	M																				R							F						
33, CC	F	M																				R	R				R		R						
34-1, 45-47	F	M							+													R							C	R				R	
34, CC	F	M																				R							R	+					
35-1, 146-148	C	M							+																				F						
35-2, 115-117	C	M																																	
35-3, 115-117	A	G																																	
35, CC	C	M							R																				R						
36-1, 37-40	A	G																											R						
36-2, 36-38	C	M																																	
36-3, 36-38	A	G																											R						
36-4, 80-82	A	G																											R						
36-5, 35-37	A	G							+																				F						
36, CC	A	G																																	
37-1, 96-98	A	G																											F						
37-3, 60-62	A	G																											C						
37, CC	C	M																											R						
38-1, 60-62	C	G																											F						
38-2, 100-102	R	P																											R						

TABLE 4 – *Continued*

Sample (Interval in cm)	*Botryopyle dictyocephalus*	*Phormostichoartus coronata*	*Stauralastrum* sp.	*Artophormis gracilis*	*Dorcadospyris riedeli*	*Lithomitra* sp. cf. *L. elizabethae*	*Dicolocapsa microcephala*	*Calocycletta* spp.	*Eucyrtidium* sp. cf. *E.* "rocket"	*Artophormis barbadensis*	*Lamptonium sanfilippoae*	*Calocycletta acanthocephala*	*Theocampe pirum*	*Lithocyclia crux*	*Theocyrtis tuberosa*	*Spongodiscus quartus quartus*	*Pterocyrtidium* sp.	*Theocampe mongolfieri*	*Lophocyrt* (?) *jacchia*	*Eucyrtidium* sp. cf. *E. panthea*	*Lychnocanoma* sp. A.	*Theocampe amphora*	*Ceratospyris* sp. cf. *C. echinus*	*Druppatractus coronata laevis*	*Lychnocanoma* sp. B.	*L. babylonis-turgidulum*	*Theocampe armadillo*	*Eucyrtidium* sp. A.	*Periphaena decora*	*Lithocyclia aristotelis* group	*Petalospyris diaboliscus*	*Amphicraspedum prolixum*	*Petalospyris confluens*	*Ellipsoxiphus* sp. cf. *E. atractus*	*Theoperidae* gen. A.	*Thyrsocyrtis bromia*	Radiolarian Zones
16, CC																																					
17-1, 105-107																																					
17-3, 48-50																																					*Calocycletta*
17-5, 50-52																																					*virginis*
17, CC																																					
18-1, 50-52																																					
18-3, 50-52																																					
18-5, 50-52																																					
18, CC																																					
19-1, 50-52																																					
19-3, 50-52																																					*Lychnocanoma*
19-5, 60-62																																					
19, CC																																					
20-2, 50-52																																					*elongata*
20, CC																																					
21-1, 90-92																																					
21-3, 50-52																																					
21-5, 50-52																																					*Dorcadospyris*
21, CC																																					
22-2, 50-52																																					
22, CC																																					*ateuchus*
23-1, 50-52																																					
23-3, 50-52																																					
23, CC	R	F																																			
24-2, 50-52	R	R	R	C																																	
24, CC		R	F	F																																	
25-1, 50-52		R		R	+																																
25, CC	R			R		R																															
26-1, 105-107	R			R		R	+																														
26, CC	R			F		C	R	F	R	+																											*Theocyrtis*
27-1, 50-52			R			R		R	R		R																										
27, CC	R					R	R																														
28, CC	F		R	R		C	F	F	R																												*tuberosa*
29-1, 130-132			F	F				C	F	+	+	R	F	R	F																						
29, CC	F		F	R			R	F					F	R	F																						
30-1, 90-92			R	C				C			F	R	R	F	C																						
30, CC			R	F			R					R	F		F																						
31-2, 57-59				R				C	C		F	C	R	F																							
31, CC			R	R			R		F		F	F	F																								
32-1, 50-52			R	F				C	F		F	F	C	R		?																					
32, CC								F			F	R	F																								
33-2, 90-92											F	R	F																								
33, CC													R																								
34-1, 45-47			R									R	R				R																				
34, CC																																					
35-1, 146-148			R								F						F	C	F	R	F	C															
35-2, 115-117			R				+				C						C	F	F	F		C	F	C	F												
35-3, 115-117			F								C						F	F	F	F	F	F	C	C	C	F	C	R									
35, CC			R				R									R	F	F		R			C	F	C	F	C	R	R	F	R						
36-1, 37-40			R								F	+					C	C	F	R			C	C	C	C	C	F		F	R	+	R				
36-2, 36-38			F								F						F	F					F	C	F	F	C	F	R	F							*Thyrsocyrtis*
36-3, 36-38			F							R	F	+				R	F	F	F		F		F	F	C	C	C	F	R	F	R						
36-4, 80-82			F				R				C					R	F	C	C	F			C	F	C	F	F	F		R	R	R	R	R	R	R	
36-5, 35-37			F				R				F							A	C	R			C	F	C	C	C	F		F	R		R	R	F	R	*bromia*
36, CC			F				R			+	F						F	F	F	R			C	F	F	F	F	F				F	R				
37-1, 96-98			F								C						F	C	F	R	+		F	F	F	F	C	F	F	R	R	R					
37-3, 60-62			R								F					R	F	A	R				F	C	F	R	F	F	F			R		R	F		
37, CC							R				F						F	C					R	R	F	F	F	F		R				F	R		
38-1, 60-62			R				R				F						F	A					C	F	F	F	F	R	F			R		R	F		
38-2, 100-102			R																				+														

Central Basin Fault. The upper clay unit of Cores 1 and 2, from the sediment surface to 69.5 meters, failed to yield radiolarians. Sample 3-1, 100-102 cm, from about 80 meters, is assigned an early Oligocene age and may belong to *Theocyrtis tuberosa* Zone, while Sample 3-1, 115-117 cm, contains abundant, well-preserved radiolarians of late Eocene *Thyrsocyrtis bromia* Zone. Radiolarian-rich sediments of the latter zone extend to at least Sample 4-4, 5-8 cm, at about 102.5 meters. Sample 4-4, 30-32 cm, of zeolitic clay, may be slightly older due to the possibility of deposits prior to the initial appearance of *Thyrsocyrtis bromia,* but this is not conclusive. No radiolarians are found in Sample 4, CC and Core 5 sediments, the deepest of Hole 291 at 126.5 meters.

Sediments retained in Samples 1, CC through 3, CC of Hole 291A contain common to few, and moderately to poorly preserved radiolarians belonging to the *Thyrsocyrtis bromia* Zone. The radiolarian boundary of Oligocene and late Eocene ages observed from Site 291 agrees with that of calcareous nannoplankton data.

Continuous coring was attempted for biostratigraphic control at Site 292 (Table 4) on the southeastern part of the Benham Rise, a westernmost margin of the Philippine Sea adjacent to Luzon Island. Within the 367.5 meters of upper nannofossil ooze and chalks, few and moderately preserved radiolarians are noticed for the first time from this site in Sample 16, CC (149 m). Starting from Core 17 (149 m) to Sample 38-1, 60-62 cm (349 m), radiolarian specimens are moderate to well-preserved, and their occurrences range from common to abundant, and are very rich in species diversity. A radiolarian population in Sample 28-2, 100-102 cm (about 351 m) is quite low and preservation is poor; below this sample to the bottom of the hole, including the underlying basalt, Cores 40 to 47 (367.5-448.5 m), no radiolarians are found. The radiolarian zones recognized from this site are: *Calocycletta virginis* Zone, from Core 17 (149 m) to 18-1, 50-52 cm (159 m); *Lychnocanoma elongata-Dorcadospyris ateuchus* Zone, from 18-3, 50-52 cm (162 m) to 25-1, 50-52 cm (225.5 m); *Theocyrtis tuberosa* Zone, from 25, CC to Core 34 (320 m); and *Thyrsocyrtis bromia* Zone, from Core 35 (320 m) through 38-2 (351 m).

A thick apron of submarine sediments was cored at Site 293 from northeast of Luzon and immediately west of the Central Basin Fault zone and at Site 294 to the east of the Central Basin Fault zone of the northeastern Philippine Basin and were completely lacking in radiolarians. Site 295, 1.8 km west of Site 294, also failed to yield radiolarians except Sample 1-3, 13-15 cm (approximately 103.6 m), which contained species of *Lithopera bacca, Euchitonia* spp., *Polysolenia spinosa* group, *Spongaster tetras tetras,* and *Ommatartus tetrathalamus tetrathalamus,* that can be found in the surface sediments of the present warm-water region.

Southwest of Japan

Background: Among the three geographic areas, this is the least known due to an absence of publications dealing with this area in particular. The rather broad general information concerning modern and Pleistocene faunas have been reported by Nigrini (1970), Hays (1970), and Ling (1972). Some *Challenger* Stations, 231-236, were located east of the area, but only a few forms were recorded by Haeckel (1887). To the north, Nakaseko and Sugano (1973) reported a Pliocene radiolarian assemblage from the Nobori Formation of Shikoku Island. Early Miocene forms from the Hayama Group of Miura Peninsula were documented by Ling and Kurihara (1972).

Results: Continuous coring at Site 296 (Table 5) on the Palau-Kyushu Ridge was aimed at obtaining a biostratigraphic reference section for a mid-latitude, marginal western Pacific region. After the recovery of radiolarian assemblages generally found in a typical, modern warm-water area in Core 1 (0-6.5 m), radiolarian abundance decreases rather sharply in Core 2 (6.5-16 m), and radiolarians have completely disappeared in Cores 3 through 23 (215.5 m). Core 24 (215.5-225 m) contains only *Otosphaera auriculata* group and *Polysolenia spinosa* group; therefore, no specific zone could be assigned. Samples between 25-2, 40-42 cm (226.9 m) and 26-2, 40-42 cm (236.9 m) are considered to be in the *Ommatartus antepenultimus* Zone; Core 28 (253.5 m) to Sample 29-2, 38-40 cm (263.9 m) apparently belongs to *Cannartus laticonus* Zone. This indicates that the interval below 26-4, 40-42 cm (239.4 m) to the bottom of Core 27 (253.5 m) is time equivalent to the *Cannartus pettersoni* Zone, but samples from this interval contain only rare specimens. In the same interval, sediments corresponding to *Dorcadospyris alata* Zone were not recognized. A section between 29-4, 40-42 cm (267.9 m) and 30-4, 80-84 cm (277.3 m) is regarded as *Calocycletta costata* Zone, while from 39, CC (282 m) to 33-2, 40-42 cm (302.9 m) it is assigned as *Calocycletta virginis* Zone. Below this, only few to rare radiolarians are found down to 44-1, 125-126 cm (406.7 m), which is tentatively recognized as *Dorcadospyris ateuchus-Lychnocanoma elongata* Zone. They are completely absent to the bottom of the hole Core 65 (1087 m).

Site 297 (Table 6) is situated in the westernmost corner of the Shikoku Basin, immediately south of the Nankai Trough. Moderate to well-preserved Pleistocene assemblages are found in Cores 1 through 5, down to 67.5 meters. However, similar to Site 296, no radiolarians were observed from sediments in Core 6 (77 m), to 26-2, 113-115 cm (668.6 m), which encompass ages from at least a part of early Pleistocene to middle Miocene. Sample 26-2, 140-143 cm (668.4 m) contains a few radiolarian specimens, and fine sandy sediments recovered from 26, CC (675.5 m) is assigned to *Calocycletta costata* Zone by the presence of the zonal index species together with forms generally found within this zone. The sediments below in Core 27 (675.5-679.5 m) lack radiolarian specimens.

Holes 298 and 298A were located on the lower slope north of Nankai Trough. Within the thick Pleistocene turbidite sequence, which becomes more fine grained with depth, moderately preserved but few to rare radiolarians are found from the sediment surface down to 3, CC (183.5 m) and are completely absent to the deepest core of Hole 298, Core 16 (611 m) (Table 7).

TABLE 5
Radiolarians from Site 296

Sample (Interval in cm)	Abundance	Preservation	*Otosphaera auriculata* group	*Polysolenia spinosa* group	*Cycladophoera davisiana*	*Lithopera bacca*	*Spongaster tetras tetras*	*Liriospyris reticulata*	*Amphirhopalum ypsiron*	*Collosphaera tuberosa*	*Lamprocyclas maritalis maritalis*	*L.* sp.	*Carpocanistrum* sp. A	*C.* sp. B	*Rhodospyris* sp. cf. De-1 group	*Stichocorys delmontensis*	*Cannartus laticonus*	*Ommatartus antepenultimus*	*Cyrtocapsella japonica*	*Carpocanistrum* sp. C	*Cyrtocapsella elongata*	*Cornutella profunda*	*Stichocorys wolffii*	*Liriospyris ovalis*	*Dorcadospyris dentata*	*Dorcadospyris alata*	*D. damaecornis*	*Liriospyris mutuaria*	*Cyrtocapsella tetrapera*	*Carpocanopsis bramlettei*	*Calocycletta costata*	*Cannartus tubaria*	*Phormostichoartus corona*	*Lithopera baueri*	*Cannartus mammiferus*	*Eucyrtidium yatsuoense*	*Calocycletta virginis*	*Dicolocapsa microcephala*	*Stichocorys armata*	*Carpocanopsis favosum*
1-1, 42-44	F	G	R	F	R	F	R	R	R																															
1-3, 60-62	F	G		R	F			R		R																														
1, CC	C	M	R	F		R	F	R	F		R																													
2-2, 20-22	R	M		R	R	R																																		
2-4, 30-32	R	P		F																																				
24-2, 40-42	R	M	R	F																																				
24-4, 40-42	R	M		F																																				
24-6, 80-82		M		F																																				
24, CC	R	M	R	F								+																												
25-2, 40-42	C	G	R	F		+						+	+	+	+		R	F	R																					
25-4, 40-42	R	G		C										+																										
25, CC	C	G	F	R								R	+	+			R	F	+	R	+																			
26-2, 40-42	C	G	R	F		+						R	R			F	R	F	F	R		R	R																	
26-4, 40-42	R	M		F																																				
26, CC	R	M		R				+					+		+									+	+	+														
27-2, 40-42	R	M		F																							R													
27, CC	R	P		R																						+	+													
28-2, 40-42	A	G	R									F	C	F	F	F		F			+	F	+	R			F	R	F	F	+	F	+							
28-4, 40-42	C	G		R							R	R	F	R	R			F				R		R					R	R				R	R					
28, CC	A	G										F	R	F	F	R		C	R	+				R			R		R							R	R	R	R	
29-2, 38-40	C	G										C	F	R	C	R		F	R								R	R				R	R				R	R		R
29-4, 40-42	A	G	R								R	C	C	F	F			R	F			R		R				R	R	R		R	R	R			R	R		F
29-6, 40-42	A	G	R								F	F		R	R			R				R			+		F	F		F						F			R	C
29, CC	C	M									R							R				R					F	F		F		R		R		F	+			R
30-2, 110-112	A	G	F								R	R	F	F				R				R		+			R			C		R		R	R		R	R		
30-4, 80-82	A	G	A								R	R	C	F	R			F	F			F	+				F	C		R	R			R	R	R	R			F
30, CC	C	M	R									F						F	R	R							+	R								R				
31-2, 40-42	C	M	R									F	F					F	F			R					F	F						+						R
31-4, 38-40	C	M										R						C	R			R					R	F												R
31, CC	F	G										R	F	+				F	R								F	R												
32-2, 40-42	F	M																R									F													
32-4, 38-40	R	P											R														F													
32, CC	R	P																									R													
33-2, 40-42	R	P												+																										
33-4, 49-51	R	P										R	R																											
33, CC	R	P																									R													
34-1, 61-63	R	P											R														R													
34-4, 61-63	F	M										R	R														F													
34, CC	R	P										R															R													
35-3, 60-62	F	M										R	R														R													
35-5, 83-85	R	P											R														R													
35, CC	R	M												+													R													
36-2, 43-45	R	P										R	R																											
36-4, 53-55	F	P												+																										
36-6, 62-64	R	P										R	R																											
36, CC	F	M										R	R																											
37-2, 34-36	R	P											F	F																										
37-4, 50-52	F	M												R	F																									
37, CC	R	M											R																											
38-2, 80-82	F	M											R	F	R																									
38, CC	R	P												R																										
39-2, 67-69	F	M											F	F																										
39, CC																																								
40-2, 28-30	R	M												R																										
40, CC	R	M																																						
41-2, 52-54	R	M												R	R																									
41, CC	R	P																																						
42-1, 50-52	R	P												R	R																									
42, CC																																								
43-1, 53-55	R	P												R																										
43, CC																																								
44-1, 125-126	C	M											F	F	F																									

Cyrtocapsella cornuta	*Solenosphaera* sp.	*Cannartus violina*	*Theocorys spongoconus*	*Lychnocanoma elongata*	*Cannartus prismaticus*	*Liriospyris geniculosa*	*Calocyclas robusta*	*Cyclampterium* (?) *milowi*	*Dorcadospyris*	*Gorgospyris* sp.	*Lychnocanoma trifolium*	*Lithocyclia ocellus* group	*Eucyrtidium* sp. cf. *E.* "rocket"	*Clathrocorys* sp.	*Botryopyle dictyocephalus*	*Pterocyrtidium* sp.	Radiolarian Zones
																	Pleistocene
																	Ommatartus antepenultimus
																	Cannartus laticonus
+	R																*Calocycletta costata*
	+	R	R														
		R															
R		R	R														
R		R	R	+													
			R														*Calocycletta virginis*
		R															
		R															
					+												*Lychnocanoma elongata*
					R												
						F											
			+			R											
					R	F	R										
					R	R	R	R									
					R	F											
								F	R	+							
						F		R	R								
						F		R	R		R						*Dorcadospyris ateuchus*
						R			R								
			+					R	R								
						R											
									R								
						R			R								
									R								
			+														
			F									R	R	R	+	+	

Sea of Japan

Background: Up until the time that D/V *Glomar Challenger* sailed through the Kuan-Mon Bridge and entered into the Sea of Japan, published records of Radiolaria from the submarine deposits of the sea either from surface or subsurface materials were nonexisting. On the contrary, much works have been carried out in the Neogene sediments which crop out along the Japan Sea coast almost exclusively by Nakaseko and his co-workers; however, it is in his publication with Sugano (Nakaseko and Sugano, 1973) that these Japanese occurrences were compared with that of radiolarian zonation from the low-latitude region of the Pacific. They tabulated 52 stratigraphically diagnostic species into four radiolarian zones which span ages from late early Miocene to Pliocene (Figure 2), and correlative to the interval from the *Calocycletta costata* Zone to the *Pterocanium prismatium* Zone.

Results: In comparing the above stratigraphic ranges of radiolarians compiled by Nakaseko and Sugano (1973) with that of occurrences observed from the examined sediments, it is believed that the cores did penetrate through their *Thecosphaera japonica* Zone and into at least the upper part of *Lychnocanium nipponicu* (= *Lychnocanoma nipponica* in this paper) Zone. However, because of apparent differences concerning the range of taxa between the two, it is not possible to apply Nakaseko and Sugano's zonation directly at this time. Tables 8-10 are therefore prepared to present the events as observed from each hole as a means of correlation, and with the hope that future studies of land sections along the Japan Sea coast would verify the biostratigraphic applicability of these events.

Site 299 (Table 8) was located in the northwest part of the Yamato Basin. Within the 532 meters of sands, silts, clays, and claystones, radiolarians are moderately preserved, but rather low in population throughout, and below Sample 30-3, 38-40 cm (326.4 m) to the bottom of the hole, Core 38, radiolarians are completely absent.

Site 300 was drilled in the central portion of the Japan Basin adjacent to the north end of the Yamato Rise. Due to the difficulty of recovering sediments because of surface sand and gravel, the site was abandoned after the second coring attempt at the depth of 117 meters. Radiolarians observed in two core catcher samples are of Pleistocene age.

Site 301 was located in the Japan Basin about 200 km southwest of Site 300. Within the sedimentary sequences of 240.5 meters of silty clays and clay unit above and 256 meters of clayey diatomite and diatomaceous claystone below, radiolarians are moderately well preserved and their abundances in general range between rare to few (Table 9). It is believed that events observed from the samples of this hole which are listed in Table 9 are more reliable than those at Site 299.

The last site of the leg, Site 302 (Table 10), was drilled on a plateau-like area of the northern flank of the Yamato Rise. Four hundred meters of diatomaceous sediments of Pleistocene to late Miocene (?) age from this site yield moderately preserved and the most abundant, as well as diversified, radiolarian assemblages

TABLE 6
Radiolarians From Site 297

Sample (Interval in cm)	Abundance	Preservation	*Amphirhopalum ypsiron*	*Cycladophora davisiana*	*Ommatartus tetrathalamus tetrathalamus*	*Spongaster tetras tetras*	*Artostrobus annulatus*	*Polysolenia spinosa* group	*Saturnalis circularis*	*Collosphaera tuberosa*	*Lithopera bacca*	*Otosphaera auriculata* group	*Buccinosphaera invaginata*	*Druppatractus acquilonius*	*Botryocyrtis scutum*	*Botryopyle dictyocephalus*	*Carpocanistrum* sp. D.	*C.* sp. A.	*Dictyocryphalus papillosus*	*Liriospyris reticulata*	*Tholospyris cortinisca*	*Carpocanistrum* sp. B.	*Stichocorys wolfii*	*Calocycletta costata*	*Carpocanopsis bramlettei*	*Cyrtocapsella japonica*	*Dorcadospyris ateuchus*	*Lamprocyclas* sp.	*Liriospyris mutuaria*	*Stichocorys delmontensis*	Age
1, CC	A	G	R	R	R	R	R																								Pleistocene
2-1, 107-109																															
2-1, 110-112	A	G	R		R	F		F	R	R	F	R	R	+																	
2, CC	A	G	F		R	R		F		R	R		R		R	R															
3-1, 90-92	F	G	F	R	R	R		F			R	R	R																		
3-3, 30-32	F	G	R		F	F		F			F	R																			
3, CC	F	G	F	R				F																							
4-1, 60-62	F	M		F	F			R	R																						
4-3, 40-42	F	M	F	F	R	R		F	R																						
4-5, 40-42	R	M		F	R			F																							
4, CC	F	M	R	R		R		F	R	R	R						R														
5-1, 40-42	R	M	F	F		F		F									R														
5-3, 40-42	R	M	F	F	R			R																							
5-5, 45-47	F	M	R	F	F	R		F																							
5, CC	C	M	R	F	R			R	R								F	+	+	R	+										
6-1, 40-42																															
6-3, 40-42																															
6-5, 40-42																															
6, CC	F	M	R	R				+																							
26-2, 140-143	R	M																				+	+								Mio.
26, CC	C	G																				+		+	+	R	+	+	R	R	

TABLE 7
Radiolarians From Hole 298

Sample (Interval in cm)	Abundance	Preservation	*Cycladophora davisiana*	*Euchitonia furcata*	*Ommatartus tetrathalamus tetrathalamus*	*Polysolenia spinosa* group	*Liriospyris reticulata*	*Lithopera bacca*	*Spongaster tetras tetras*	*Lamplocyclas maritalis maritalis*	*Cornutella profunda*	Age
1, CC												Pleistocene
2-1, 112-114	F	M	R	R	R	R						
2-3, 60-62	F	M	R	R	R	R	R					
2, CC	F	M	F	R	R		R	R	R			
3-1, 130-132	R	M	R							R		
3, CC	F	M	R								R	

TABLE 8
Radiolarians From Site 299

Sample (Interval in cm)	Abundance	Preservation	*Triceraspyris* sp.	*Cycladophora davisiana*	*Stylochlamidium venustum*	*Euchitonia furcata*	*Spongodiscus* sp.	*Lithomitra arachnea*	*Amphirhopalum ypsiron*	*Spongaster tetras tetras*	*Spongurus pylomaticus*	*Cyrtocapsella tetrapera*	*Artostrobus annulatus*	*Druppatractus acquilonius*	*Thecosphaera japonica*	*Spongopyle osculosa*	*Spirema ? circularis*	*Thecosphaera akitaensis*	*Anthocorys ? akitaensis*	Age
1-1, 10-12	F	M	F																	Pleistocene
1-4, 20-22	R	M	R	R	R															
1, CC	F	M	F		F															
2-2, 10-12	R	M	R																	
2-4, 30-32																				
2, CC																				
3-2, 20-22																				
3-4, 25-27																				
3, CC	F	M	R	F	R	R	R													
4-2, 5-7	F	M	R					R												
4-4, 80-82	F	M		F	R		R	R	+	+										
4, CC	F	M	R	F		R	R	F												
5-2, 55-57																				
5-5, 10-12																				
5, CC	C	M	C				R	R												
6-2, 30-32																				
6-4, 27-29	C	M	C	A			C													
6, CC	R	M	R																	
7-2, 22-24	A	M	R	A			C	+			F									
7-4, 22-24	R	M	R	F			F													
7, CC																				
8-2, 28-30	C	M	F	F	F		F													
8, CC	R	M	R		R			R												
9-2, 5-7	R	M	F	R	R															
9-4, 8-10																				
9, CC	R	P																		
10-2, 1-3																				
10-4, 15-17																				
10, CC	R	P						R			R									
11-2, 30-32	R	M	R																	
11-4, 25-27	R	M	R																	
11, CC	R	M	R																	
12-2, 70-72																				
12-5, 30-32	R	M		F																
12, CC																				
13-2, 30-32	F	M		R								+								
13-4, 30-32	R	M	F	R									F							
13, CC																				?
14-2, 40-42	R	P				+														
14-4, 9-11	R	P		F																
14, CC	R	P						F												
15-2, 18-20	R	M						+						F	R					
15-4, 25-27	R	M															+			
15, CC																				
16-2, 130-132	R	M		+																
16-4, 55-57	R	M						+					+			R		+	+	
16, CC	R	M																		
17-2, 60-62	R	M	R									+				R				
17-4, 100-102	R	M						R												
17, CC																				
18-2, 68-69																				
18-4, 50-52																				
18, CC																				
19-2, 25-27	R	M													R	+				
19-4, 30-32	R	M						R						+						

TABLE 8 – *Continued*

Sample (Interval in cm)	Abundance	Preservation	*Triceraspyris* sp.	*Cycladophora davisiana*	*Stylochlamidium venustum*	*Euchitonia furcata*	*Spongodiscus* sp.	*Lithomitra arachnea*	*Amphirhopalum ypsiron*	*Spongaster tetras tetras*	*Spongurus pylomaticus*	*Cyrtocapsella tetrapera*	*Artostrobus annulatus*	*Druppatractus acquilonius*	*Thecosphaera japonica*	*Spongopyle osculosa*	*Spirema ? circularis*	*Theocsphaera akitaensis*	*Anthocorys ? akitaensis*	Age
19, CC																				Pliocene
20-2, 90-92																				
20, CC	R	M											+							
21-1, 46-48	R	M													+					
21, CC	R	M		F				R					+							
22-2, 30-32																				
22-4, 30-32	R	M						R												
22, CC	R	M						F						F						
23, CC	R	M	+					F												
24-1, 83-85																				
24, CC	C	M	+	+				F								+				
25-1, 55-57	F	M						C					F							
25, CC	R	P	+					R												
26-1, 110-112	R	P											+							
26, CC	R	P									+									
27, CC																				
28-1, 109-111	R	P													+					
28, CC																				
29-1, 133-135																				
29, CC	R	M											F			+		+		
30-1, 24-26	R	M						C									C			

(Table 10) among the sites drilled in the Sea of Japan, but they are completely absent in the underlying zeolitic clays, and the volcanic sands and green tuff recovered in the last core, (Core 18, 531.5 m).

RADIOLARIAN EVENTS

Occurrences of the majority of radiolarian taxa observed from the present Leg 31 materials provide the basis for a chronologically arranged list of radiolarian events. It is apparent that since radiolarian fauna encountered from the sediments of Philippine Sea sites are different from those of the Sea of Japan, it is necessary to prepare two tables for data presentation (Tables 11 and 12). Sites 293, 294, 295, 297, and 298 were not listed in the tables because of rare and inconsistent occurrences or complete absence of specimens.

The tables are constructed in the manner originally prepared by Riedel and Sanfilippo (1970) and also appeared since that time in the successive volumes of the Initial Reports. The letters "T" and "B" at the left of the name of taxa denote the top and bottom of the range of the taxa. The events recognized from the sites are given with paired core-sections between which the phenomena were observed. Sample depths, in centimeters, are indicated below the top of the section. The degree of reliability of such events at each site is designated at the right by letters "P," "M," and "G" for poor, moderate, and good, respectively, based on the nature of occurrence of the species in samples and their relative abundance.

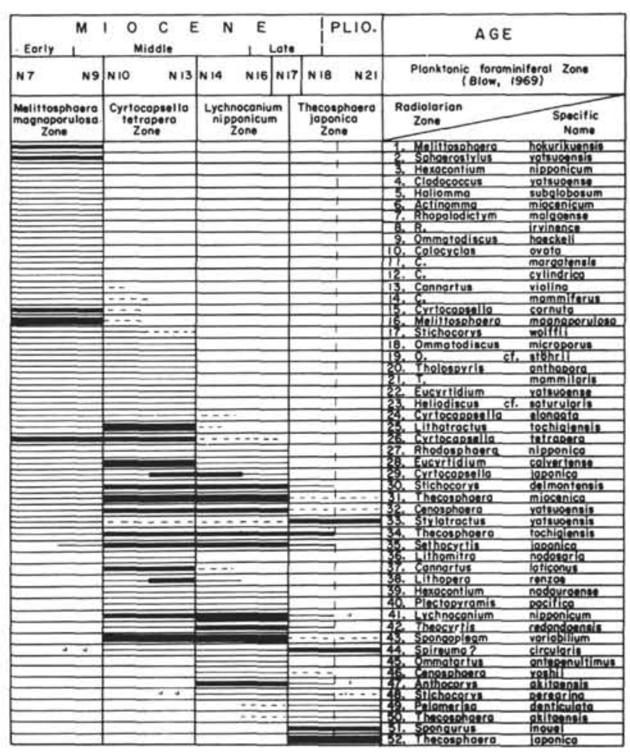

Figure 2. *Stratigraphic distribution of the important radiolarians in the Neogene formation of Japan (modified after Nakaseko and Sugano, 1973).*

TABLE 9
Radiolarians From Site 301

Sample (Interval in cm)	Abundance	Preservation	*Triceraspyris* sp.	*Cycladophora davisiana*	*Stylochlamidium venustum*	*Lithomitra arachnea*	*Spongodiscus* sp.	*Thecosphaera japonica*	*Artostrobus annulatus*	*Anthocorys ? akitaensis*	*Spirema ? circularis*	*Spongopyle osculosa*	*Druppatractus acquilonius*	*Thecosphaera akitaensis*	*Cornutella profunda*	Age
2-1, 12-14	R	M	R	R	R											
2-3, 30-32	F	M	F	F	R											
2-5, 55-57	F	M		F		R										
2, CC	R	M		R		R										
3-1, 117-119																Pleistocene
3-2, 25-27																
3, CC	C	M	C	R		R	C									
4-2, 60-62	R	M				R										
4-4, 65-67																
4, CC	R	M	F													
5-2, 68-70																
5-4, 72-74																
5, CC	R	M	R	F												?
6, CC	R	M		R												
7-1, 128-130																
7, CC																
8-2, 6-8	R	M				R										
8, CC	R	M		R												
9-1, 130-132						F										
9, CC	R	M		R												
10-1, 25-27																
10, CC																
11-1, 75-77																
11, CC	F	M	R			R		F	F							Pliocene
12, CC																
13-1, 68-70	R	M	R													
13, CC	R	M	R			R										
14-1, 73-75	R	M														
14, CC	C	M						R		C	C	R				
15-1, 14-16	F	M				F		F			F		R	R		
15-3, 70-72	F	M				F		R	R	R	F	F	R	R		
15, CC	A	M	R			C			C	F	F	F				
16-1, 73-75																
16, CC	R	M				R			R							
17-1, 31-33	R	M							R							
17, CC	F	M				R			R					R	+	
18-1, 66-68	R	M						R						R		
18-3, 6-8	R	M				R										Miocene
18, CC	R	M				R			R							
19-1, 70-72	R	M				F		R	R	R	R	R	R			
19-4, 47-49																
19, CC	F	M				C				F						
20-2, 116-118	F	M				F		R		R			R	R		
20-4, 50-52																
20, CC	R	P				R										

SYSTEMATIC MICROPALEONTOLOGY

It is an impossible task to attempt the detailed examination for rich and well-preserved radiolarian taxa recovered from the Leg 31 core sediments, particularly those from the Philippine Sea and Southwest of Japan, within a limited time. Therefore an effort was made to present as many forms as possible and to record their stratigraphic occurrences as observed, while keeping their synonymy lists at a minimum by following closely with the available publications, mainly from the previous legs of the Deep Sea Drilling Project.

It should be pointed out here, however, during the course of microscopic examination, several taxa apparently identical to those illustrated originally by Ehrenberg (1875), but which have never been discussed since that time, are observed. At present, only a few materials are in the present author's reference collection; therefore, detailed descriptions were not attempted.

This was particularly true for those nassellarians with sagittal ring, many forms of which cannot be placed satisfactorily into a recent classification scheme proposed by Goll (1968, 1969) and Petrushevskaya (1971a). Therefore, the original nomenclature of Ehrenberg's

TABLE 10
Radiolarians From Site 302

Sample (Interval in cm)	Abundance	Preservation	*Cornutella profunda*	*Triceraspyris* sp.	*Cycladophora davisiana*	*Lithomitra arachnea*	*Bathropyramis* sp.	*Artostrobus annulatus*	*Druppatractus acquilonius*	*Thecosphaera japonica*	*Spongurus pylomaticus*	*Anthocorys ? akitaensis*	*Spongopyle osculosa*	*Thecosphaea akitaensis*	*Spirema ? circularis*	*Stichocorys delmontensis*	*Theocorys redondoensis*	*Lychnocanoma nipponica*	Ages
1, CC	C	M	R	C	F														Pleistocene
2-1, 90-92	A	G		A	A	R													
2-3, 24-26	A	G		A	A	C													
2-5, 80-82	A	G		A	F														
2, CC	A	G		A	F	F	R												
3-1, 125-127	R	P		R															
3-3, 50-52																			
3-5, 20-22																			
3-6, 128-130	R	M			R			F											
3, CC	F	M		R		R			R										
4-1, 30-32	R	P							F										?
4-3, 20-22																			
4-5, 10-12	F	M		R	R	R	F		F	F									
4, CC	C	M		R	F	C	F		C	F									
5-1, 80-82	F	M		R		F	R	F			R								
5-3, 40-42	C	M		C						R	C	R	F	C					Pliocene
5-5, 80-82	C	M		F							C	F	F	R					
5, CC	F	M	F	F		C		F		R	R	F	F	R					
6, CC	R	M		F		C		R			R	F							
7-1, 20-22	F	M	R			F	R	C	F	R		F		F	R				
7-3, 20-22	C	M	F	R		C		C				C		F					
7-5, 20-22	C	G	R	R		C	R	F	R			C	R	R	R				
7, CC	F	M	F	R		C		F				F			R				
8-1, 20-22	F	M				F		R				F	R		R				Miocene
8-3, 20-22	F	M	R			C	R	F				C	R		F				
8-5, 20-22	F	M	R			R		F				F			F				
8, CC	C	M				A						R	R						
9-1, 36-38	R	M	R			F		F			R	C	R			+			
9, CC	C	M	R	R		A		F			R	R	R		R	R			
10-1, 20-22	F	M	F	R		F		F		R	R	F	F	F	R				
10-3, 20-22	R	M				F		C			R	R	R						
10-5, 20-22	R	M	R	R		F		F				R							
10, CC	A	G		R		A		R		R		F							
11-1, 130-132	R	M	R					F											
11-3, 20-22	R	M						R				R							
11-5, 20-22	R	M	F					F				F							
11, CC	C	M	F	R				F			R	F							
12-1, 65-67	C	M	F					F				F					+		
12-3, 20-22	C	M	C					F				F			R		R		
12, CC	C	M	C			R		F	R	R		F					R		
13-1, 22-24	F	M	R									F							
13, CC	C	M	F			F		F	R	R		F					R		
14-1, 100-102	C	M	R			F		R				F							
14-3, 20-22	C	M	R					F				F					+		
14-5, 20-22	C	M	R					F	R			C	R	R				R	
14, CC	C	M	R		+	F		R											
15-1, 50-52	F	M	F			F		R				F						+	
15, CC	C	M						R				C							
16-1, 96-98	R	M				F		R											
16, CC																			

(1872b, 1875) is adapted provisionally for the purpose of this report until a more detailed investigation can be made in the future.

Order POLYCYRTINA Ehrenberg, 1838, emend. Riedel, 1967

Suborder SPUMELLARIA Ehrenberg, 1875

Family COLLOSPHAERIDAE Müller, 1858

Genus BUCCINOSPHAERA Haeckel, 1887

Buccinosphaera invaginata Haeckel, 1887
(Plate 1, Figure 1)

Buccinosphaera invaginata Haeckel, 1887, p. 99, pl. 5, fig. 11.

Genus POLYSOLENIA Ehrenberg, 1872a

Polysolenia spinosa (Haeckel) group
(Plate 1, Figures 2, 3)

Collosphaera spinosa Haeckel, 1862, p. 536, pl. 34, fig. 12, 13.
Polysolenia spinosa (Haeckel), Nigrini, 1967, p. 14, pl. 1, fig. 1.
Remarks: The Miocene forms possess larger but fewer pores and longer spines than those found in Pleistocene sediments.

Genus SOLENOSPHAERA Haeckel, 1887

Solenosphaera sp.
(Plate 1, Figure 4)

Remarks: Throughout the Leg 31 analyses, the present species was found only in lower Miocene materials of Site 296.

Genus OTOSPHAERA Haeckel, 1887

Otosphaera auriculata Haeckel group
(Plate 1, Figures 5, 6)

Otosphaera auriculata Haeckel, 1887, p. 116, pl. 7, fig. 5.
Remarks: The Miocene forms, here considered as the possible ancestors of Pleistocene specimens, possess longer spines.

Family ACTINOMMIDAE Haeckel, 1862, emend. Riedel, 1967

Subfamily ACTINOMMINAE Haeckel, 1862, emend. Petrushevskaya and Kozlova, 1972

Genus THECOSPHAERA Haeckel, 1881

Thecosphaera akitaensis Nakaseko, 1971
(Plate 1, Figures 7, 8)

Thecosphaera akitaensis Nakaseko, 1971, p. 63, pl. 1, figs. 4a, 4b.

Thecosphaera japonica Nakaseko
(Plate 1, Figures 9, 10)

Thecosphaera japonica Nakaseko, 1971, p. 61, 62, pl. 1, fig. 3a,b.

Genus STYLOSPHAERA Ehrenberg, 1847b

Stylosphaera p.
(Plate 1, Figures 11, 12)

Remarks: These large specimens, with characteristic thick three-bladed polar spines, are found only from sediments of the *Thyrsocyrtis bromia* Zone at Site 291.

Genus ELLIPSOXIPHUS Dunikowski, 1882

Ellipsoxiphus ? sp. cf. E. atractus Haeckel
(Plate 1, Figures 13-15)

Ellipsoxiphus atractus Haeckel, 1887, p. 298, pl. 14, fig. 1.
Remarks: The specimens observed from upper Eocene sediments at Sites 291 and 292 possess very short polar spines and, in some cases, only one spine is discernible. The placing of this taxon here is based on the close resemblance in general appearance to that of Haeckel's species except for the nature of the two spines.

Genus DRUPPATRACTUS Haeckel, 1887

Druppatractus coronata laevis (Ehrenberg)
(Plate 1, Figure 16)

Stylosphaera laevis Ehrenberg, 1873, p. 259; 1875, pl. 25, fig. 6.
Druppatractus laevis (Ehrenberg), Haeckel, 1887, p. 327.
Stylosphaera coronata laevis Ehrenberg, Sanfilippo and Riedel, 1973, p. 520, 521, pl. 1, fig. 19; pl. 25, fig. 5, 6.

Druppatractus acquilonius Hays
(Plate 1, Figures 17, 18)

Druppatractus acquilonius Hays, 1970, p. 214, pl. 1, fig. 4, 5.
Stylacontarium acquilonium (Hays), Kling, 1973, p. 632; Ling, 1973, p. 777, pl. 1, fig. 6, 7.
Remarks: The nomenclature of Hays for the present species is retained here because genus *Stylacontarium* as proposed by Popofsky (1912) indicates the cortical shell of spherical rather than elliptical form.
It is interesting to observe that *Stylatractus yatsuoensis* Nakaseko illustrated in Nakaseko and Sugano (1973, pl. 1, fig. 4a,b) possesses the similar medullary shell.

Druppatractus sp.
(Plate 1, Figure 19; Plate 2, Figure 1)

Remarks: Shell of this species is near spherical rather than ellipsoidal form and covered with uniform circular pores with polygonal framework. The spine at one pole is much shorter than the other. Occurrence of this species is limited to *Theocyrtis tuberosa* Zone and the lowermost part of *Dorcadospyris ateuchus* Zone from Site 292.

Subfamily SATURNALINAE Deflandre, 1953

Genus SATURNALIS Haeckel, 1881, emend. Nigrini, 1967

Saturnalis circularis Haeckel
(Plate 2, Figure 2)

Saturnalis circularis Haeckel, 1887, p. 131; Nigrini, 1967, p. 25, 26, pl. 1, fig. 9.

Subfamily ARTISCINAE Haeckel, 1881, emend. Riedel, 1967

Genus CANNARTUS Haeckel, 1881, emend. Riedel, 1971

Cannartus laticonus Riedel
(Plate 2, Figures 3, 4)

Cannartus laticonus Riedel, 1959, p. 291, pl. 1, fig. 5.

Cannartus mammiferus (Haeckel)
(Plate 2, Figures 5, 6)

Cannartidium mammiferus Haeckel, 1887, p. 376, pl. 39, fig. 16.
Cannartus mammiferus (Haeckel), Riedel, 1959, p. 291, pl. 1, fig. 4.
Remarks: The phase contrast photomicrograph illustrates the double medullary shells and the pronounced protuberances.

Cannartus prismaticus (Haeckel)
(Plate 2, Figures 7, 8)

Pipettella prismatica Haeckel, 1887, p. 305; Riedel, 1959, p. 287-289, pl. 1, fig. 1.
Cannartus prismaticus (Haeckel), Riedel and Sanfilippo, 1970, p. 520, pl. 15, fig. 1.

Cannartus tubarius (Haeckel)
(Plate 2, Figures 9, 10)

Pipettaria tubaria Haeckel, 1887, p. 339.
Cannartus tubarius (Haeckel), Riedel and Sanfilippo, 1970, p. 520, pl. 15, fig. 2.

Cannartus violina Haeckel
(Plate 2, Figure 11)

Cannartus violina Haeckel, 1887, p. 348, pl. 39, fig. 10.

Genus OMMATARTUS Haeckel, 1881, emend. Riedel, 1971

Ommatartus antepenultimus Riedel and Sanfilippo
(Plate 2, Figures 12-16)

Ommatartus antepenultimus Riedel and Sanfilippo, 1970, p. 521, pl. 14, fig. 4.
Remarks: The specimens showing the incomplete and well-developed polar caps between the cortical shell and spongy columns are found from Site 296 samples and are considered under the present taxon.

TABLE 11
Radiolarian Events Observed at Sites From the Philippine Sea and the Southwest of Japan of Deep Sea Drilling Project, Leg 31

	Taxa	Hole					
		290	290A	291	291A	292	296
T	*Ommatartus antepenultimus*						24, CC 25-2, 40-42 M
T	*Cannartus laticonus*						24, CC 25-2, 40-42 M
T	*Cyrtocapsella japonica*						25-4, 40-42 25, CC G
T	*Cyrtocapsella elongata*						25-4, 40-42 25, CC M
B	*Ommatartus antepenultimus*						26-2, 40-42 26-4, 40-42 G
T	*Stichocorys delmontensis*						27, CC 28-2, 40-42 M
T	*Cyrtocapsella tetrapera*						27, CC 28-2, 40-42 M
T	*Calocycletta costata*						27, CC 28-2, 40-42 G
T	*Dorcadospyris dentata*						27, CC 28-2, 40-42 M
T	*Calocycletta virginis*					16, CC 17-1, 105-107 G	28-4, 40-42 28, CC M
T	*Stichocorys armata*						28-4, 40-42 28, CC M
B	*Cyrtocapsella cornuta*						28, CC 29-2, 40-42 M
T	*Dorcadospyris ateuchus*					16, CC 17-1, 107-109 G	36-6, 62-64 36, CC M
B	*Cannartus laticonus*						29-2, 38-40 29-4, 40-42 M
T	*Lychnocanoma elongata*					18, CC 19-1, 50-52 P	29-4, 40-42 29-6, 40-42 G
T	*Theocorys spongoconus*					17, CC 18-1, 50-52 G	29-4, 40-42 29-6, 40-42 G
T	*Cannartus prismaticus*					16, CC 17-1, 105-107 M	30-2, 110-112 30-4, 80-82 M
B	*Stichocorys armata*						30-2, 110-112 34-4, 80-82 P

TABLE 11 – *Continued*

Taxa		Hole 290	290A	291	291A	292	296
B	*Dorcadospyris dentata*						30-2, 110-112 30-4, 80-84 P
B	*Calocycletta costata*						30-4, 80-82 30, CC G
B	*Lychnocanoma elongata*					19-1, 50-52 19-3, 50-52	30, CC 31-2, 40-42 G
B	*Cyrtocapsella elongata*						30, CC 31-2, 40-42 M
B	*Cyrtocapsella cornuta*						31-4, 38-40 31, CC M
B	*Cyrtocapsella tetrapera*						31, CC 32-2, 40-42 M
B	*Cyrtocapsella japonica*						32-2, 40-42 32-4, 38-40 M
B	*Calocycletta virginis*					18-1, 50-52 18-3, 50-52 G	33-2, 40-42 33-4, 49-51 M
T	*Dorcadospyris circulus*					18-3, 50-52 18-5, 50-52 M	
T	*Theocyrtis annosa*					18-3, 50-52 18-5, 50-52 G	
T	*Liriospyris* sp.					18-5, 50-52 18, CC G	
T	*Lychnocanoma trifolium*					18, CC 19-1, 50-52 G	37-CC 38-2 80-82 P
T	*Triactic tripyramis triangula*					18, CC 19-1, 50-52 G	
T	*Trissocyclus* sp.					19-1, 50-52 19-3, 50-52 G	
B	*Calocycletta robusta*					19-3, 50-52 19-5, 50-52 G	37-4 50-52 37-CC G
T	*Lithocyclia angusta*					19-3, 50-52 19-5, 50-52	
B	*Lychnocanoma trifolium*					20, CC 21-1, 90-92 G	38-2 80-82 38-CC P

TABLE 11 – *Continued*

	Taxa	Hole 290	290A	291	291A	292	296
B	*Trissocyclus* sp.					20, CC 21-1, 90-92 M	
T	*Cyclampterium* (?) *milowi*					21, CC 22-2, 50-52 M	36-2, 43-45 36-4, 53-55 M
T	*Artophormis gracilis*					23, CC 24-2, 50-52 G	
B	*Triactic tripyramis triangula*					25, CC 25-1, 50-52 G	
B	*Cannartus prismaticus*					25-1, 50-52 25, CC G	
B	*Darcadospyris circulus*					25-1, 50-52 25, CC G	
B	*Theocyrtis annosa*					25-1, 50-52 25, CC G	
T	*Eucyrtidium* sp. cf. *E. "rocket"*					26-1, 105-107 26, CC G	43, CC 44-1, 125-126 P
T	*Lamptonium sanfilippoae*					26, CC 27-1, 50-52 M	
B	*Dorcadospyris ateuchus*					27-1, 50-52 27, CC M	41-2, 52-54 41, CC M
B	*Cyclampterium* (?) *milowi*					27-1, 50-52 27, CC G	39-2, 67-69 39, CC P
T	*Theocyrtis tuberosa*					28, CC 29-1, 130-132 G	
T	*Lithocyclia crux*					28, CC 29-1, 130-132 M	
T	*Theocampe pirum*					28, CC 29-1, 130-132 G	
B	*Theocyrtis tuberosa*					30, CC 31-2, 57-59 G	
B	*Triactis tripyramis triangula*					24, CC 25-1, 50-52 G	
B	*Artophormis gracilis*					32-1, 50-52 32, CC G	
B	*Eucyrtidium* sp. cf. *E. "rocket"*					32-1, 50-52 32, CC G	
B	*Lithocyclia crux*					32-1, 50-52 32, CC M	
T	*Thyrsocyrtis bromia*	3-1, 48-50 3-3, 20-22 M	above 1-1, 110-112 G	2, CC 3-1, 100-102 G	above 1, CC M	36-3, 36-38 36-4, 80-82 P	

TABLE 11 – *Continued*

	Taxa	Hole 290	290A	291	291A	292	296
B	*Theocampe pirum*			3-1, 100-102 3-1, 115-117 G		34-1, 45-47 34, CC M	
B	*Lithocyclia angustum*			3-1, 100-102 3-1, 115-117 M		34, CC 35-1, 146-148 M	
T	*Eucyrtidium* sp. A.			3-1, 100-102 3-1, 115-117 G	2, CC 3, CC M	35-2, 115-117 35-3, 115-117 M	
T	*Periphaena decora*	3-1, 48-50 3-3, 20-22 M	above 1-1, 110-112 M	2-CC 3-1 100-102 M		35-3, 115-117 35, CC M	
T	*Eucyrtidium* sp. cf. *E. montiparum*	3-1, 48-50 3-3, 20-22 P	above 1-1, 110-112 M	4-1 68-70 4-2 65-67 M			
T	*Lychnocanoma* sp. A	3-3, 20-22 3, CC M	above 1-1, 110-112 M	3-1, 100-102 3-1, 115-117 M	above 1, CC M	34, CC 35-1, 146-148 G	
T	*Theocampe mongolfieri*	3-1, 48-50 3-3, 20-22 M	above 1-1, 110-112 M	3-1, 100-102 3-1, 115-117' G	above 1, CC G	35-2, 115-117 35-3 115-117 G	
T	*Theocampe armadillo*	3-1, 48-50 3-3, 20-22 M	above 1-1, 110-112 G	3-1, 100-102 3-1, 115-117 G	above 1, CC M	35-2, 115-117 35-3, 115-117 G	
T	*Lophocyrt (?) jacchia*	3-1, 48-50 3-3, 20-22 M		3-1, 100-102 3-1, 115-117 M	above 1, CC P	34, CC 35-1, 146-148 M	
T	*Thyrsocyrtis triacantha*	3-1, 48-50 3-3, 20-22 G	above 1-1, 110-112 G	3-1, 100-102 3-1, 115-117 G	above 1, CC G		
T	*Thyrsocyrtis tetracantha*	3-1, 48-50 3-3, 20-22 G	above 1-1, 110-112 M	3-1, 100-102 3-1, 115-117 G	1, CC 2, CC		
T	*Lithocyclia ocellus* group	3-1, 48-50 3-3, 20-22 M	above 1-1 M				
T	*Lithocyclia aristotelis* group	3-1, 48-50 3-3, 20-22 M	above 1-1, 110-112 M	3-1, 100-102 3-1, 115-117 G	above 1, CC M	35-3, 115-117 35, CC M	
T	*Theoperidae* gen. A	3-1, 48-50 3-3, 20-22 M		3-1, 100-102 3-1, 115-117 G	2, CC 3, CC M	36-2 115-117 36-3, 36-38 G	
T	*Eucyrtidium* sp. cf. *E. panthea*			3-1, 100-102 3-1, 115-117 P		34, CC 35-1, 146-148 G	
T	*Lychnocanoma* sp. B	3-1, 48-50 3-3, 20-22 G	above 1-1, 110-112 G	3-1, 100-102 3-1, 115-117 G	1, CC 2, CC P	35-1, 146-148 35-2, 115-117 G	

TABLE 11 – *Continued*

	Taxa	Hole 290	290A	291	291A	292	296
T	*Calocyclas hispida*	3-1, 48-50 3-3, 20-22 G		3-1, 100-102 3-1, 115-117 M			
T	*Calocyclas turris*	3-1, 48-50 3-3, 20-22 M	above 1-1, 110-112 M	3-1, 100-102 3-1, 115-117 G		36-3, 36-38 36-4, 80-82 P	
B	*Lophochytris* (?) *jacchia*	3-3, 20-22 3, CC M		3-1, 133-135 3, CC G	below 3, CC M		
B	*Eucyrtidium* sp. A			3, CC 4-2, 60-62 G	below 3, CC	37, CC 38-1, 60-62 M	
T	*Eucyringium fistuligerum*	3, CC 4-1, 68-70 M	above 1-1, 110-112 M	3, CC 4-1, 68-70 G			
T	*Podocyrtis papalis*	3-1, 48-50 3-3, 20-22 G	above 1-1, 110-112 M	3, CC 4-1, 68-70 G	above 1, CC M		
T	*Calocyclas ampulla*	3-1, 48-50 3-3, 20-22 G	above 1-1, 110-112 G	3, CC 4-1, 68-70 M			
T	*Thyrsocyrtis rhizodon*	3-1, 48-50 3-3, 20-22 M	above 1-1, 110-112 P	4-1, 68-70 4-2, 65-67 G	above 1, CC		
T	*Rhopalocanium ornatum*	3-1, 48-50 3-3, 20-22 P	above 1-1, 110-112 M	4-1, 68-70 4-2, 65-70 G	1, CC 2, CC P		
T	*Lamptonium sanfilippoae*	3, CC 4-2, 60-62 M	above 1-1, 110-112 G	2, CC 3-1, 100-102 G	2, CC 3, CC		
B	*Eucyrtidium* sp. A			3, CC 4-1, 68-70	below 3, CC	37, CC 38-1, 60-62 M	
T	*Lithochytris vespertilio*		1-2, 60-62 1, CC P	4-2, 65-67 4-3, 63-65 P			
T	*Eucyrtidium* sp. cf. *E. montiparum*	3-1, 48-50 3-3, 20-22 P		4-1, 68-70 4-2, 65-67 M			
T	*Theocorys anapographa*	3-1, 48-50 3-3, 20-22 P	1-1, 110-112 1-2, 60-62 P	4-1, 68-70 4-2, 65-67 M			
T	*Sethochytris triconiscus*	3-1, 48-50 3-3, 20-22 M	above 1-1, 110-112 G	4-4, 5-8, 4-4, 30-32 M			
B	*Theoperidae* gen. A	4-2, 60-62 4, CC M		4-4, 5-8, 4-4, 30-32 M	below 3, CC M	38-1, 60-62 38-2, 100-102 G	
B	*Lychnocanoma* sp. A	4-2, 60-62 4, CC M	below 2, CC M	4-4, 5-8, 4-4, 30-32 M	below 3, CC P	36-3, 36-38 36-5, 35-37 M	

TABLE 11 – *Continued*

	Taxa	Hole 290	290A	291	291A	292	296
T	*Theocampe amphora*	5, CC 6-1, M 58-60					
B	*Lithocyclia aristotelis* group	6-3, 10-12 M 6, CC	1-2, 60-62 P 1, CC	4-3, 63-65 M 4-4, 5-8,	below 3, CC M	37, CC 38-1, P 60-62	
B	*Theocorys anapographa*	6-3, 10-12 G 6, CC	1-2, 60-62 P 1, CC	4-4, 5-8, M 4-4, 30-32	2, CC 3, CC P		
B	*Thyrsocyrtis bromia*	6, CC 7-2, P 130-132	1-1, 110-112 P 1-2, 60-62	4-4, 5-8, G 4-4, 30-32	1, CC 2, CC M	36-5, 35-37 P 36, CC	
B	*Lithocyclia ocellus*	7-2, 130-132 M 7-4, 10-12	1, CC 2, CC G	4-3, 63-65 G 4-4, 5-8,			
B	*Podocyrtis papalis*	7-4, 10-12 M 7, CC	1, CC 2, CC M	4-4, 30-32 M 4, CC	2, CC 3, CC M		
B	*Calocycloma ampulla*	7-4, 10-12 G 7, CC	below 2, CC G	4-4, 30-32 G 4, CC			
B	*Calocyclas hispida*	7-4, 10-12 M 7, CC		4-4, 30-32 M 4, CC			
B	*Periphaena decora*	7-4, 10-12 G 7, CC	1-2, 60-62 G 1, CC	4-4, 30-32 M 4, CC	below 3, CC M	38-1, 60-62 G 38-2, 100-102	
B	*Calocyclas turris*	7-4, 10-12 M 7, CC	1-1, 110-112 P 1-2, 60-62	4-4, 5-8, G 4-4, 30-32		36-4, 80-82 36-5, 35-37	
B	*Lychnocanoma* sp. B	7-4, 10-12 M 7, CC	1-2, 60-62 M 1, CC	4-4, 5-8, M 4-4, 30-32	below 3, CC P	38-1, 60-62 M 38-2, 100-102	
B	*Theocampe armadillo*	7-4, 10-12 G 7, CC	1-2, 60-62 G 1, CC	4-4, 5-8, G 4-4, 30-32	below 3, CC M	38-1, 60-62 G 38-2, 100-102	
B	*Rhopalocanium ornatum*	7-4, 10-12 M 7, CC	1-2, 60-62 M 1, CC	4-4, 5-8, M 4-4, 30-32	below 2, CC P		
B	*Lamptonium sanfilippoae*	7-4, 10-12 M 7, CC	1-1, 110-112 G 1-2, 60-62	4-4, 5-8, G 4-4, 30-32	below 3, CC M	38-1, 60-62 G 38-2, 100-102	
B	*Thyrsocyrtis rhizodon*	7-4, 10-12 M 7, CC	1-1, 110-112 P 1-2, 60-62	4-4, 5-8, G 4-4, 30-32	below 3, CC M		
B	*Eucyrtidium* sp. cf. *E. montiparum*	7-4, 10-12 M 7, CC	1-2, 60-62 M 1, CC	4-3, 63-65 G 4-4, 5-8,			
B	*Thyrsocyrtis tetracantha*	below 7, CC M	1, CC 2, CC M	3, CC 4-1, G 68-70	2, CC 3, CC M		

TABLE 11 – *Continued*

	Taxa	Hole 290	290A	291	291A	292	296
B	*Dorcadospyris triceros*	below 7, CC M	below 2, CC M	4-4, 30-32 M 4, CC	below 3, CC M	38-2, 100-102 M 38, CC	
B	*Sethochytris triconiscus*	below 7, CC M	1-2, 60-62 M 1, CC	4-4, 30-32 M 4, CC			
B	*Thyrsocyrtis triacantha*	below 7, CC M	below 2, CC M	below 4, CC M	1, CC 2, CC M		
B	*Theocampe mongolfieri*	below 7, CC G	below 2, CC M	4-4, 30-32 G 4, CC	below 3, CC G	38-2, 100-102 G 38, CC	
B	*Theocampe amphora*	below 7, CC M					
B	*Eucyrtidium fistuligerum*	below 7, CC M	1, CC 2, CC M	4-4, 30-32 M 4, CC			

TABLE 12
Radiolarian Events Observed at Sites From the Japan Sea of Deep Sea Drilling Project, Leg 31

	Taxa		Hole 299	301	302
T	*Spongodiscus* sp.	G	3-4, 25-27 3, CC	3-2, 25-27 3, CC	above 1, CC
B	*Spongodiscus* sp.	G	8-2, 28-30 8, CC	3, CC 4-2, 60-62	2, CC 3-1, 125-127
B	*Stylochlamydium venustum*	M	9-2, 5-7, 9-4, 8-10	2-3, 30-32 2-5, 55-57	2-5, 80-82 2, CC
T	*Thecosphaera japonica*	M	14, CC 15-2, 18-20	11-1, 75-77 11, CC	4-3, 30-32 4-5, 10-12
T	*Anthocorys ? akitaensis*	G	16-2, 130-132 16-4, 55-57	14-1, 73-75 14, CC	5-1, 80-82 5-3, 40-42
T	*Spirema ? circularis*	P	15-2, 18-20 15-4, 25-27	14-1, 73-75 14, CC	6, CC 7-1, 20-22
T	*Thecosphaera akitaensis*	M	16-2, 130-132 16-4, 55-57	14, CC 15-1, 14-16	5-1, 80-82 5-3, 40-42
T	*Theocorys redondoensis*	M			11, CC 12-1, 65-67
T	*Lychnocanoma nipponica*	P			14-3, 20-22 14-5, 20-22

Ommatartus tetrathalamus tetrathalamus (Haeckel)
(Plate 2, Figure 17)

Panartus tetrathalamus Haeckel, 1887, p. 378.
Panartus tetrathalamus tetrathalamus Haeckel, Nigrini, 1967, p. 168, pl. 1, fig. 11, 12.
Ommatartus tetrathalamus (Haeckel), Riedel and Sanfilippo, 1971, p. 1588, pl. 1C, fig. 5-7.

Family PHACODISCIDAE Haeckel, 1881

Genus ASTROPHACUS Haeckel, 1881

Astrophacus sp.
(Plate 2, Figures 18-20)

Remarks: Sanfilippo and Riedel's (1973, p. 522) opinion, to accommodate under the present genus those forms in which the cortical shell has rather larger pores, is followed here. The specimens recovered from the Leg 31 sediments in the Philippine Sea possess either a complete girdle of varying width or a discontinuous girdle with many short thick spines.

Genus PERIPHAENA Ehrenberg, 1873

Periphaena decora Ehrenberg
(Plate 3, Figures 1, 2)

Periphaena decora Ehrenberg, 1873, p. 246; 1875, pl. 28, fig. 6.

Genus TRIACTIS Haeckel, 1881

Remarks: In their recent article, Sanfilippo and Riedel (1973, p. 523) included the present genus under *Periphaena* Ehrenberg by enlarging the concept of the latter to include the closely related forms. This practice is not followed here until further examination can be made.

Triactis tripyramis triangula (Sutton)
(Plate 3, Figure 3)

Phacotriactis triangula Sutton, 1896, p. 61.
Triactis tripyramis triangula (Sutton), Riedel and Sanfilippo, 1970, p. 521, pl. 4, fig. 9, 10.

Triactis tripyramis tripyramis Haeckel
(Plate 3, Figure 4)

Triactiscus tripyramis Haeckel, 1887, p. 432, pl. 33, fig. 6.
Triactis tripyramis tripyramis Haeckel, Riedel and Sanfilippo, 1970, p. 521, pl. 4, fig. 8.

Family COCCODISCIDAE Haeckel, 1862

Genus LITHOCYCLIA Ehrenberg, 1847a

Lithocyclia angustum (Riedel)
(Plate 3, Figure 5, 6)

Trigonactura angusta Riedel, 1959, p. 292, pl. 1, fig. 6.
Lithocyclia angustum (Riedel), Riedel and Sanfilippo, 1970, p. 422, pl. 13, fig. 1, 2.

Lithocyclia aristotelis Ehrenberg group
(Plate 3, Figures 7, 8)

Astromma aristotelis Ehrenberg, 1847b, p. 55.
Lithocyclia aristotelis (Ehrenberg) group, Riedel and Sanfilippo, 1970, p. 522.

Lithocyclia crux Moore
(Plate 3, Figure 9)

Lithocyclia crux Moore, 1971, p. 737, pl. 6, fig. 4.

Lithocyclia ocellus Ehrenberg group
(Plate 3, Figure 10)

Lithocyclia ocellus Ehrenberg, 1873, p. 240.
Lithocyclia ocellus Ehrenberg group, Riedel and Sanfilippo, 1970, p. 522, pl. 5, fig. 1, 2.

Lithocyclia ? spp.
(Plate 3, Figures 11-13)

Remarks: The specimens presented are questionably assigned because of general resemblance to the above species of the present genus, except that the cortical shell is near spherical and not discoidal. Numbers of subcylindrical spongy arms vary from two to four from the present Leg 31 materials. The two-arm forms are also similar to *Cannartus prismaticus* suggesting probably the close relationship, but the latter possess ellipsoidal cortical shell and the number of arms remains only two.

Family SPONGODISCIDAE Haeckel, 1862, emend. Riedel, 1967

Genus AMPHICRASPEDUM Haeckel, 1881

Amphicraspedum proxilum Sanfilippo and Riedel
(Plate 4, Figure 1)

Amphicraspedum proxilum Sanfilippo and Riedel, 1973, p. 524, pl. 10, fig. 7-11; pl. 28, fig. 3, 4.
Remarks: The placing of the present taxon here is considered the best at the present time based on the similar nature of the distal end of the arms. No complete specimen was observed during the present study; therefore, there is a possibility that these specimens may not belong here at all, depending on the number of arms. Furthermore, it should be noted that the distal end of the arms is generally forked as evidenced by the type species of the genus, *Amphicraspedum maclaganium* Haeckel (1887, p. 523, pl. 45, fig. 11).

Genus AMPHIRHOPALUM Haeckel, 1881, emend. Nigrini, 1967

Amphirhopalum ypsilon Haeckel
(Plate 4, Figure 2)

Amphirhopalum ypsilon Haeckel, 1887, p. 522; Nigrini, 1967, p. 35, pl. 3, fig. 3a-d.

Genus EUCHITONIA Ehrenberg, 1860a

Euchitonia furcata Ehrenberg
(Plate 4, Figure 3)

Euchitonia furcata Ehrenberg, 1860a, p. 767; for discussion, see Ling and Anikouchine, 1967, p. 1484-1486, pl. 189, 190, fig. 1-2, 5-7.

Genus SPONGASTER Ehrenberg, 1860b

Spongaster tetras tetras Ehrenberg

Spongaster tetras Ehrenberg, 1860b, p. 833.
Spongaster tetras tetras Ehrenberg, Nigrini, 1967, p. 41-43, pl. 5, fig. 1a, b.

Genus SPONGODISCUS Ehrenberg, 1854

Spongodiscus quartus quartus (Borisenko)
(Plate 4, Figure 4)

Staurodictya quartus Borisenko, 1958, p. 96, pl. 2, fig. 5 (*fide* Sanfilippo and Riedel, 1973).
Spongodiscus quartus quartus (Borisenko), Sanfilippo and Riedel, 1973, p. 525, pl. 12, fig. 6, 7; pl. 29, fig. 5, 6.

Spongodiscus sp.
(Plate 4, Figure 5)

Spongodiscus sp. Ling, 1973, p. 778, pl. 1, fig. 9, 10.
Remarks: The specimens observed from sediments of the Japan Sea are apparently conspecific with those previously reported from the Bering Sea and high-latitude North Pacific.

Genus SPONGOPYLE Dreyer, 1889

Spongopyle osculosa Dreyer
(Plate 4, Figure 6)

Spongopyle osculosa Dreyer, 1889, p. 118, 119, pl. 11, fig. 99, 100.

Genus SPONGURUS Haeckel, 1860

Spongurus pylomaticus Riedel
(Plate 4, Figure 7)

Spongurus pylomaticus Riedel, 1958, p. 226, pl. 1, fig. 10, 11.

Genus STAURALASTRUM Haeckel, 1887

Stauralastrum sp.
(Plate 4, Figures 8, 9)

Remarks: This discoidal Radiolaria with concentric disc at the center and with four radiating undivided spongy arms which thickened at the distal end is quite distinct from any other species so far reported. Because of its relatively larger size (note here the lower magnification for Plate 4, Figure 9) and somewhat fragile nature of arms, it is rather rare to encounter the complete specimen.

Genus STYLOCHLAMYDIUM Haeckel, 1887

Stylochlamydium venustum (Bailey)

Perichlamidium venustum Bailey, 1856, p. 6, pl. 1, fig. 16, 17.
Stylochlamydium venustum (Bailey), Ling, Stadum, and Welch, 1971, p. 711, 712, pl. 1, fig. 7, 8; fig. 5.

Family LITHELIIDAE Haeckel, 1862

Genus SPIREMA Haeckel, 1881

Spirema ? circularis Nakaseko
(Plate 4, Figure 10)

Spirema ? circularis Nakaseko, in Nakaseko and Sugano, 1973, pl. 1, fig. 5.
Remarks: Although no description for the present species has been given until now, specimens encountered from the Sea of Japan sediments are believed to be conspecific with those recorded from Neogene deposits along the coast of the northeastern Honshu.

Suborder NASSELLARIA Ehrenberg, 1875

Family TRIOSPYRIDAE Haeckel, 1881, emend. Petrushevskaya, 1971a

Genus CERATOSPYRIS Ehrenberg, 1847b

Ceratospyris clavata Bütschli
(Plate 4, Figure 11)

Ceratospyris clavata Bütschli, 1882, p. 539, pl. 32, fig. 13a-c.
Remarks: There seems little doubt that specimens observed from the Philippine Sea sediments agree well with the illustration presented by Bütschli.

Ceratospyris sp. cf. C. echinus Ehrenberg
(Plate 4, Figures 12, 13)

Ceratospyris echinus Ehrenberg, 1873, p. 219; 1875, pl. 20, fig. 12.
Remarks: Although the generally spherical cephalus with numerous short spines, one long apical horn, and five to six long feet suggests that the present species is probably identical with Ehrenberg's species, positive identification at this time is not possible. Further, a cephalic horn and slender feet seem easy to break off (compare the illustrated two figures), the present species can still easily be recognized.

Genus DENDROSPYRIS Haeckel, 1881, Petrushevskaya and Kozlova, 1972

Dendrospyris damaecornis (Haeckel)
(Plate 4, Figures 14, 15)

see Goll, 1968, p. 1420, 1421, pl. 173, fig. 1-4.

Dendrospyris didiceros (Ehrenberg) group
(Plate 4, Figure 16)

see Petrushevskaya and Kozlova, 1972, p. 532, pl. 40, fig. 12.

Dendrospyris pododendros (Carnevale) group
(Plate 4, Figures 17-19)

see Petrushevskaya and Kozlova, 1972, p. 532, pl. 39, fig. 26-28.

Genus DESMOSPYRIS Haeckel, 1881

Desmospyris sp. cf. D. anthocyrtoides (Bütschli)
(Plate 7, Figure 1)

Petalospyris anthocyrtoides Bütschli, 1882, p. 533, 539, pl. 32, fig. 19a-c.
Desmospyris anthocyrtoides (Bütschli), Haeckel, 1887, p. 1090.
Remarks: The species here recovered seems to have close resemblance to the species reported by Bütschli. Specimens referred to as *Dendrospyris anthocyrtoides* by Goll (1968), Riedel and Sanfilippo (1971), and Petrushevskaya and Kozlova (1972) seem different from that of original Bütschli species.
Because of structural similarity, a specimen illustrated by Bütschli as ? *Dictoyocephalus obtusus* Ehrenberg (1881, p. 539, pl. 33, fig. 20a-c) may be closely related with present species.

Genus DORCADOSPYRIS Haeckel, 1881

Dorcadospyris alata (Riedel)
(Plate 5, Figures 1, 2)

Brachiospyris alata Riedel, 1959, p. 293, pl. 1, fig. 11, 12.
Dorcadospyris alata (Riedel), Riedel and Sanfilippo, 1970, p. 523, pl. 14, fig. 5.

Dorcadospyris ateuchus (Ehrenberg)
(Plate 5, Figures 3-6)

see Riedel and Sanfilippo, 1970, p. 523, pl. 15, fig. 4.

Dorcadospyris circulus (Haeckel)
(Plate 5, Figures 7-9)

Gamospyris circulus Haeckel, 1887, p. 1042, pl. 83, fig. 19.
Dorcadospyris circulus (Haeckel), Moore, 1971, p. 739, pl. 8, fig. 3-5.
Remarks: Included in the present species also is a specimen with accessory spinules on the feet as shown here (Plate 5, Figures 8, 9).

Dorcadospyris dentata Haeckel
(Plate 5, Figures 10-12)

Dorcadospyris dentata Haeckel, 1887, p. 1040, pl. 85, fig. 6

Dorcadospyris triceros (Ehrenberg)
(Plate 6, Figures 1-6)

see Moore, 1971, p. 739, pl. 6, fig. 1-3.

Dorcadospyris riedeli Moore
(Plate 6, Figure 7)

Dorcadospyris riedeli Moore, 1971, p. 739, pl. 9, fig. 1-3.
Remarks: Only few specimens are encountered in the present study which generally agree with the original description and illustrations. The degree of arching by one pair of legs is lower than those illustrated by the type specimens.

Dorcadospyris sp.
(Plate 6, Figures 8-12)

Remarks: Shell of moderate thickness with definite external stricture. A conical apical horn is generally present. Usually, four primary feet circular in cross-section extend from the basal ring; one pair curves downward to form a circle, the other pair extends laterally first before curving downward. In some specimens, there are a few small spines on the feet. Occasionally secondary feet in tabular shape are present.
This species is similar and seems closely related to *D. quadripes* Moore (1971, p. 739, 740, pl. 7, fig. 3-5), but differs in nature of feet.

Genus GIRAFFOSPYRIS Haeckel, 1881

Giraffospyris circumflexa Goll
(Plate 7, Figures 2, 3)

Giraffospyris circumflexa Goll, 1969, p. 332, pl. 60, fig. 1-4; text-fig. 2.

Genus GORGOSPYRIS Haeckel, 1881

Gorgospyris sp.
(Plate 7, Figures 4, 5)

Remarks: The placing of the present taxon is based on the overall structural similarity with species classified under the present genus.

Genus LIRIOSPYRIS Haeckel, 1881

Liriospyris clathrata (Ehrenberg)
(Plate 7, Figures 6-9)

see Goll, 1968, p. 1426, pl. 175, fig. 12, 13, 16, 17.

Liriospyris geniculosa Goll
(Plate 7, Figures 10, 11)

Liriospyris geniculosa Goll, 1968, p. 1427, pl. 175, fig. 21-24; text-fig. 9.

Liriospyris mutuaria Goll
(Plate 7, Figure 12)

Liriospyris mutuaria Goll, 1968, p. 1428, 1429, pl. 175, fig. 6, 10, 11, 14, text-fig. 9.

Liriospyris ovalis Goll
(Plate 7, Figure 13)

Liriospyris ovalis Goll, 1968, p. 1429, pl. 176. fig. 4, 6, 7; text-fig. 9.

Liriospyris reticulata (Ehrenberg)
(Plate 7, Figure 14)

see Goll, 1968, p. 1429, 1430, pl. 176, fig. 9, 11, 13; text-fig. 9.

Liriospyris sp.
(Plate 7, Figures 15-20)

Remarks: In photos of these three specimens, it is intended to illustrate the evolutional trend observed during the present study. The entire phylogenic series is observed within the Oligocene sediments. Apparently, the cephalic structure remains rather constant, but the length of the feet, as well as the spines, increases as the age of sediments becomes younger. At the end of the series, the distal ends are thickened to show a club shape.

Judging from illustrations, specimens recorded as *Liriospyris* sp. B. group from the North Atlantic by Petrushevskaya and Kozlova (1972, p. 531, p. 39, fig. 17-20) may be conspecific with the present taxon.

Genus PATAGOSPYRIS Haeckel, 1881

Patagospyris confluens (Ehrenberg)
(Plate 7, Figure 21)

Petalospyris confluens Ehrenberg, 1873, p. 146; p. 875, pl. 22, fig. 5.
Patagospyris confluens (Ehrenberg), Haeckel, 1887, p. 1088.
Dorcadospyris confluens (Ehrenberg), Goll, 1969, p. 337, pl. 58, fig. 9-12; text-fig. 2.

Genus PETALOSPYRIS Ehrenberg, 1847b

Petalospyris diaboliscus Ehrenberg
(Plate 7, Figure 22)

Petalospyris diaboliscus Ehrenberg, 1873, p. 246; 1875, pl. 22, fig. 3.

Remarks: There seems little doubt that the specimens recovered from the Philippine Sea are identical with those of Ehrenberg's, but the positive identification can be made only after samples from Barbados are examined.

Petalospyris foveolata Ehrenberg
(Plate 7, Figure 23)

Petalospyris foveolata Ehrenberg, 1873, p. 247; 1875, pl. 22, fig. 11.

Remarks: Like the preceding taxon, the specimens observed during the present study seem to agree well with those of Ehrenberg's except that the feet, plate-like in the proximal half, then distally narrowed to a point, are more numerous in the present Philippine Sea specimens.

Petalospyris sp. cf. P. foveolata Ehrenberg
(Plate 7, Figure 24)

Remarks: The difference between this form and the above lies mainly in the number of cephalic horns, three versus one. In tabulation of its occurrence, the present taxon is combined with the above species.

Genus RHODOSPYRIS Haeckel, 1881

Rhodospyris sp. cf. R. anthocyrtis Haeckel
(Plate 8, Figures 1, 2)

Patagospyris anthocyrtis Haeckel, 1887, p. 1088, pl. 95, fig. 19.

Remarks: Petrushevskaya and Kozlova (1972, p. 531, pl. 38, fig. 14) reported the similar form as *Rhodospyris* sp. aff. *R. anthocyrtis* from the North Atlantic. However, it should be noted that both Haeckel's and Petrushevskaya and Kozlova's specimens possess larger pores in cephalis than thorax, which is just opposite in the present specimens.

Rhodospyris ? sp. De 1 group
(Plate 8, Figures 3, 4)

Dendrospyris sp. 1, Goll, 1968, p. 1417, text-fig. 8.
Rhodospyris ? spp. *De* 1 group, Petrushevskaya and Kozlova, 1972, p. 531, pl. 38, fig. 15, 16.

Remarks: Although Goll's illustration for this form does not show the sagittal ring, the general characteristics seem to agree with the present species.

Genus THOLOSPYRIS Haeckel, 1881, emend. Goll, 1969

Tholospyris cortinisca (Haeckel)
(Plate 8, Figures 5-7)

see Goll, 1969, p. 325, 326, pl. 56, fig. 3, 5, 6, 8.

Tholospyris sp. cf. T-2 group
(Plate 8, Figure 8)

Tholospyris sp. 2, Goll, 1969, p. 323, text-fig. 1.

Genus TRICERASPYRIS Haeckel, 1881

Triceraspyris ? sp.
(Plate 8, Figure 9)

Triceraspyris ? sp., Ling, Stadum, and Welch, 1971, p. 713, 714, pl. 2, fig. 1-3; fig. 7; Ling, 1973, p. 780, pl. 1, fig. 13, 14.

Remarks: This name is continuously used to include two forms, those with and those without basal or primary spines below the basal ring.

Genus TRISSOCYCLUS Haeckel, 1881

Trissocyclus sp.
(Plate 8, Figures 10-12)

Remarks: In following Petrushevskaya and Kozlova's (1972, p. 533) opinion, this species is provisionally referred to under the present genus. Structurally, the present species is similar to *Liriospyris longicornuta* Goll (1968, p. 1428, pl. 176, fig. 8, 10, 12; text-fig. 9), but differs in possessing long, curved spines originating from both apical and basal parts, as well as much smoother skeletal elements.

Apparently, this species possesses a very limited range because specimens are found only in the uppermost part of the Oligocene section at Site 292. By its relatively larger size, as well as its characteristic shape, it may become one of the easily identifiable index species in the future.

Triospyrid sp.
(Plate 8, Figure 13)

Remarks: The present taxon is characterized by possessing two apical horns at the side of cephalis, distinct sagittal constriction, and a collar stricture. Although the present author was unable to find the similar form in published record, it may be related with forms considered under some genus, such as *Petalospyris* or *Rhodospyris.*

Family ACANTHODESMIIDAE Haeckel, 1862

Genus EUCORONIS Haeckel, 1881

Eucoronis hertwigii Bütschli group
(Plate 8, Figure 14)

Acanthodesmia hertwigii Bütschli, 1882, pl. 32, fig. 9.
Eucoronis hertwigii (Bütschli) group, Petrushevskaya and Kozlova, 1972, p. 533, pl. 41, fig. 15-17.

Family SETHOPERIDAE Haeckel, 1881, emend. Petrushevskaya, 1971a

Genus CLATHROCORYS Haeckel, 1881

Clathrocorys sp.
(Plate 8, Figures 15, 16)

Remarks: There is a possibility that the present species may be conspecific with *C. giltschii* Haeckel (1887, p. 1220, pl. 64, fig. 9) reported from the Central Pacific because of similarity in the nature of cephalus.

Family NEOSCIADIOCAPSIDAE Pessagno, 1969

Genus ANTHOCORYS Haeckel, 1881

Anthocorys ? akitaensis Nakaseko
(Plate 8, Figures 17, 18)

see Ling, 1971, p. 696, 697, pl. 2, fig. 10-13.

Remarks: Despite taxonomic uncertainty, the present species continues to be considered an index form during the present study of the submarine deposits as well as outcrop samples from the western Honshu of Japan.

Genus ANTHOCYRTELLA Ehrenberg, 1847a

Anthocyrtella sp.
(Plate 8, Figure 19)

Remarks: The present species is similar in general appearance to *Anthocyrtis collaris* Ehrenberg (1873, p. 215; 1875, pl. 6, fig. 8), particularly in the cephalis, which possesses radially arranged, longitudinally elongated pores that are separated by intervening ridges. There is a transverse line in the middle of the cephalis dividing the cephalic part in two, indicated by a constriction on outline. The differences in shape of the thorax, cylindrical rather than conical, and longer, more slender terminal feet, apparently warrant separation of this specimen from that of Ehrenberg's.

Genus CYCLADOPHORA Ehrenberg, 1847b

Cycladophora davisiana Ehrenberg
(Plate 8, Figures 20, 21)

Remarks: As in the previous studies from the subarctic Pacific regions (Ling, 1973; Ling et al., 1971), this nomenclature is continuously employed here.

Genus DIPLOCYCLAS Haeckel, 1881

Diplocyclas spp.
(Plate 9, Figures 1, 2)

Remarks: The placing of these two illustrated species in the present genus is based on the resemblance of cephalic and thoracic parts with the genus *Diplocyclas bicorona* Haeckel (1887, p. 1392, pl. 59, fig. 8), although the latter has a double corona. The present two specimens also resemble *Pterocodon davisiana* Ehrenberg (1872a, p. 300, 301; 1872b, pl. 2, fig. 10). These two, apparently belonging to different species, are recovered from upper Eocene sediments.

Family PLECTOPYRAMIDIDAE Haeckel, 1881, emend. Petrushevskaya, 1971a

Genus BATHROPYRAMIS Haeckel, 1881

Bathropyramis sp.
(Plate 9, Figures 3, 4)

Remarks: In this study, no attempt has been made to separate them into species level, but merely to report their occurrences.

Genus CORNUTELLA Ehrenberg, 1838, emend. Petrushevskaya, 1971b

Cornutella profunda Ehrenberg
(Plate 9, Figures 5-8)

see Nigrini, 1967, p. 60-63, pl. 6, fig. 5a-c.

Remarks: Although there is a possibility that differentiation of two or three species may be biostratigraphically useful at least in local correlation, the broader concept for this species by Nigrini is followed here.

Family THEOPERIDAE Haeckel, 1881, emend. Riedel, 1967

Genus ARTOPHORMIS Haeckel, 1881

Artophormis barbadensis (Ehrenberg)
(Plate 9, Figures 9, 10)

Calocyclas barbadensis Ehrenberg, 1873, p. 217.
Artophormis barbadensis (Ehrenberg), Haeckel, 1887, p. 1459.

Artophormis gracilis Riedel
(Plate 9, Figure 11)

Artophormis gracilis Riedel, 1959, p. 300, pl. 2, fig. 12, 13.

Genus CALOCYCLAS Ehrenberg, 1847b, emend. Foreman, 1973

Caluyclas hispida (Ehrenberg)
(Plate 9, Figure 12)

Anthocyrtis hispida Ehrenberg, 1873, p. 216.
Cycladophora hispida (Ehrenberg), Riedel and Sanfilippo, 1970, p. 529, pl. 10, fig. 9.
Calocyclas hispida (Ehrenberg), Foreman, 1973, p. 434, pl. 1, fig. 12-15.

Calocyclas turris Ehrenberg
(Plate 9, Figure 13)

Calocyclas turris Ehrenberg, 1873, p. 218; Foreman, 1973, p. 434.
Cycladophora turris (Ehrenberg), Riedel and Sanfilippo, 1970, p. 529, pl. 13, fig. 3, 4.

Genus CALOCYCLOMA Haeckel, 1887

Calocycloma ampulla (Ehrenberg)
(Plate 9, Figure 14)

Eucyrtidium ampulla Ehrenberg, 1873, p. 225.
Calocycloma (?) ampulla (Ehrenberg), Riedel and Sanfilippo, 1970, p. 524, pl. 6, fig. 1.
Calocycloma ampulla (Ehrenberg), Petrushevskaya and Kozlova, 1972, p. 543, pl. 34, fig. 4.

Genus CYRTOCAPSELLA Haeckel, 1887, emend. Sanfilippo and Riedel, 1970

Cyrtocapsella cornuta Haeckel
(Plate 9, Figure 15)

Cyrtocapsella cornuta Haeckel, 1887, p. 1513, pl. 78, fig. 9; Sanfilippo and Riedel, 1970, p. 453, pl. 1, fig. 19, 20.

Cyrtocapsella elongata Nakaseko
(Plate 9, Figure 16)

Theocapsa elongata Nakaseko, 1963, p. 185, pl. 3, fig. 4, 5.
Cyrtocapsella elongata (Nakaseko), Sanfilippo and Riedel, 1970, p. 452, pl. 1, fig. 11, 12.

Cyrtocapsella japonica (Nakaseko)
(Plate 9, Figure 17)

Eucyringium japonicum Nakaseko, 1963, p. 193, pl. 4, fig. 1-3.
Cyrtocapsella japonica (Nakaseko), Sanfilippo and Riedel, 1970, p. 452, pl. 1, fig. 13-15.

Cyrtocapsella tetrapera Haeckel
(Plate 9, Figure 18)

Cyrtocapsa tetrapera Haeckel, 1887, p. 1512.
Cyrtocapsella tetrapera Haeckel, Sanfilippo and Riedel, 1970, p. 453, pl. 1, fig. 16-18.

Genus EUSYRINGIUM Haeckel, 1881

Eusyringium fistuligerum (Ehrenberg)
(Plate 9, Figures 19, 20)

Eucyrtidium fistuligerum Ehrenberg, 1873, p. 229; 1875, pl. 9, fig. 3.
Eusyringium fistuligerum (Ehrenberg), Haeckel, 1887, p. 1498.
Eucyrtidium sipho Ehrenberg, 1873, p. 233; 1875, pl. 9, fig. 2.
Eusyringium sipho (Ehrenberg), Haeckel, 1887, p. 1497.
Eusyringium fistuligerum (Ehrenberg), Riedel and Sanfilippo, 1970, part, p. 527, pl. 8, fig. 8, 9.

Remarks: During the present study, specimens with small wings at the proximal part of the thorax, as illustrated here, are observed together with those without such structure.

Eusyringium lagena (Ehrenberg)
(Plate 9, Figure 21)

(?) *Lithopera lagena* Ehrenberg, 1873, p. 241.
Eusyringium lagena (Ehrenberg) ? Riedel and Sanfilippo, 1970, p. 527, pl. 8, fig. 5-7.

Eusyringium tubulus (Ehrenberg)
(Plate 9, Figure 22)

Eucyrtidium tubulus Ehrenberg, 1854, pl. 36, fig. 19; 1873, p. 233; 1875, pl. 9, fig. 6.
Theosyringium tubulus (Ehrenberg), Haeckel, 1887, p. 1410.
Remarks: The slender thoracic segment forming the smooth curved outline of the present species is characteristic, thus distinguishing it from other species under the present genus.

Genus LAMPTONIUM Haeckel, 1887

Lamptonium sanfilippoae Foreman
(Plate 9, Figures 23-25)

Lamptonium sanfilippoae Foreman, 1973, p. 436, pl. 6, fig. 15, 16; pl. 11, fig. 15, 16.

Genus LITHOCHYTRIS Ehrenberg, 1847a

Lithochytris vespertilio Ehrenberg
(Plate 10, Figures 1-3)

Lithochytris vespertilio Ehrenberg, 1873, p. 239.

Genus LITHOPERA Ehrenberg, 1847a

Lithopera bacca Ehrenberg
(Plate 10, Figure 4)

Lithopera bacca Ehrenberg, 1872a, p. 314; Sanfilippo and Riedel, 1970, p. 455, pl. 1, fig. 29.

Lithopera baueri Sanfilippo and Riedel
(Plate 10, Figure 5)

Lithopera baueri Sanfilippo and Riedel, 1970, p. 455, pl. 2, fig. 1, 2.

Lithopera renzae Sanfilippo and Riedel
(Plate 10, Figure 6)

Lithopera renzae Sanfilippo and Riedel, p. 454, pl. 1, fig. 21-23, 27.

Genus LOPHOCYRTIS Haeckel, 1887

Lophocyrtis (?) jacchia (Ehrenberg)
(Plate 10, Figure 7)

Thyrsocyrtis jacchia Ehrenberg, 1873, p. 261.
Lophocyrtis (?) *jacchia* (Ehrenberg), Riedel and Sanfilippo, 1970, p. 530.

Genus LYCHNOCANOMA Haeckel, 1887, emend. Foreman, 1973

Lychnocanoma babylonis-turgidulum group
(Plate 10, Figures 8-10)

Remarks: Although the two end members of this group, originally known as *Dictyophimus babylonis* Clark and Campbell (1942, p. 67, pl. 9, fig. 32, 36) and *Lychnocanium turgidulum* Ehrenberg (1873, p. 245; 1875, pl. 7, fig. 6), are known as a two-segment form, the presence of transitional forms between the two makes the morphologic speciation difficult. Therefore, they are combined during the present study.

Lychnocanoma elongata (Vinassa)
(Plate 10, Figure 11)

see Sanfilippo et al., 1973, p. 221, 222, pl. 5, fig. 19, 20 for synonymy.

Lychnocanoma trifolium (Riedel and Sanfilippo)
(Plate 10, Figure 12)

Lychnocanium trifolium Riedel and Sanfilippo, 1971, p. 1595, pl. 8, fig. 2, 3.
Remarks: The species seems to possess rather limited range, found only in sediments of late Oligocene from Site 292. It may, therefore, become an age index form in the future. Similar occurrence is reported by Johnson (1974) from Leg 22 of the Eastern Indian Ocean.

Lychnocanoma sp. A
(Plate 10, Figure 13)

Remarks: The present species is characterized by a large and robust thorax and smooth, comparatively short feet of which the distal part is sharply curved inward. Its uppermost occurrence seems to coincide with the top of the late Eocene *Thyrsocyrtis bromia* Zone observed from Sites 290, 291, and 292.

Lychnocanoma sp. B
(Plate 10, Figure 14)

Remarks: It is possible that the specimens considered under the present taxon are identical with those reported by Petrushevskaya and Kozlova (1972, p. 533, pl. 29, fig. 3) as *Lychnocanium hirundo* from Eocene and Oligocene sediments of the Atlantic because of their rather long, slender and smoothly curved three-bladed feet. The original illustration of *L. hirundo* by Ehrenberg (1854, pl. 36, fig. 6; 1875, pl. 7, fig. 8), however, shows a conical thorax with a vertical ridge-like structure separating the longitudinally aligned pores.

From the samples examined during the present study, the highest stratigraphic occurrence of the present species coincides with the upper limit of the *Thyrsocyrtis bromia* Zone, as occurred with the preceding species.

Genus PHORMOCYRTIS Haeckel, 1887

Phormocyrtis embolum (Ehrenberg) group
(Plate 10, Figure 15)

Eucyrtidium embolum Ehrenberg, 1873, p. 228; 1875, pl. 10, fig. 5.
Phormocyrtis embolum (Ehrenberg) group, Petrushevskaya and Kozlova, 1972, p. 537, pl. 22, fig. 8, 9.

Genus PTEROCODON Ehrenberg, 1847a

Pterocodon sp. cf. P. campana Ehrenberg
(Plate 10, Figure 16)

Pterocodon campana Ehrenberg, 1847b, p. 55, fig. 4; 1854, pl. 36, fig. 10; 1873, p. 255; 1875, pl. 19, fig. 1.
Remarks: The specimen recovered from Site 291 of the Philippine Sea agrees well in general with the original illustration of Ehrenberg, which is the type species, by monotype, of te genus. It differs from the latter by the rectangular rather than circular abdominal pores. The fourth segment is in a form of network rather than radiating spines or feet.

Genus PTEROCYRTIDIUM Bütschli, 1882

Pterocyrtidium barbadense (Ehrenberg)
(Plate 10, Figure 17)

Pterocyrtidium barbadense Ehrenberg, 1873, p. 254; 1875, pl. 17, fig. 6.
Remarks: A specimen here illustrated seems to agree with that of Ehrenberg's original illustration, particularly the presence of lateral solid spines, however, the lumbar stricture is less distinct in the present specimen.

Pterocyrtidium sp.
(Plate 10, Figures 18, 19)

Pterocyrtidium barbadense (Ehrenberg), Petrushevskaya and Kozlova, 1972, p. 552, pl. 27, fig. 18, 19.
Remarks: This species is placed provisionally under the present genus because of structural similarity with the above species. The difference between solid spines at the proximal part of the abdomen in the above specimen, and wing form at the lower part of thoracic and upper part of abdominal wall in the present species may suggest that these two are, after all, not related.

Genus RHOPALOCANIUM Ehrenberg, 1847a

Rhopalocanium ornatum Ehrenberg
(Plate 11, Figures 1-3)

Rhopalocanium ornatum Ehrenberg, 1947b, fig. 3.

Genus SETHOCHYTRIS Haeckel, 1881

Sethochytris triconiscus Haeckel
(Plate 11, Figures 4-6)

see Riedel and Sanfilippo, 1970, p. 528, pl. 9, fig. 6.

Genus STICHOCORYS Haeckel, 1881

Stichocorys armata (Haeckel)
(Plate 11, Figures 7, 8)

see Sanfilippo et al., 1973, p. 222, pl. 6, fig. 1, 2.

Stichocorys delmontensis (Campbell and Clark)
(Plate 11, Figure 9)

Eucyrtidium delmontensis Campbell and Clark, 1944, p. 56, pl. 7, fig. 19, 20.
Stichocorys delmontensis (Campbell and Clark), Sanfilippo and Riedel, 1970, p. 451, pl. 1, fig. 9.

Stichocorys wolffii Haeckel
(Plate 10, Figure 10)

Stichocorys wolffii Haeckel, 1887, p. 1479, pl. 80, fig. 10.

Genus THEOCORYS Haeckel, 1881

Theocorys anapographa Riedel and Sanfilippo
(Plate 11, Figures 11, 12)

Theocorys anapographa Riedel and Sanfilippo, 1973, p. 713, pl. 3, fig. 11.

Remarks: The specimens observed during the present investigation are those considered as "small, hyaline late forms with very few pores" by Riedel and Sanfilippo (op. cit., footnote e to Table 4) from the Leg 15 samples.

Theocorys redondoensis (Campbell and Clark)

Theocyrtis redondoensis Campbell and Clark, 1944, p. 49, pl. 7, fig. 4; Ling, 1971, p. 697, pl. 2, fig. 22.
Theocorys redondoensis (Campbell and Clark), Kling, 1973, p. 638, pl. 11, fig. 26-28; Ling, 1973, p. 781, pl. 2, fig. 13.

Theocorys spongoconum Kling
(Plate 11, Figure 13)

Theocorys spongoconum Kling, 1971, p. 1087, pl. 5, fig. 6.

Genus THEOCOTYLE Riedel and Sanfilippo, 1970

Subgenus THEOCOTYLE Riedel and Sanfilippo, 1970, Foreman, 1973

Theocotyle (Theocotyle) cryptocephala cryptocephala (Ehrenberg)
(Plate 11, Figure 14)

see Foreman, 1973, p. 440, pl. 4, fig. 6, 7; pl. 12, fig. 12.

Genus THYRSOCYRTIS Ehrenberg, 1847b

Thyrsocyrtis bromia Ehrenberg
(Plate 11, Figures 15, 16)

Thyrsocyrtis bromia Ehrenberg, 1873, p. 260; 1875, pl. 12, fig. 2.

Thyrsocyrtis hirsuta hirsuta (Krasheninnikov)
(Plate 11, Figure 17)

Podocyrtis hirsutus Krasheninnikov, 1960, p. 300, pl. 3, fig. 16 (*fide* Riedel and Sanfilippo, 1970).
Thyrsocyrtis hirsuta hirsuta (Krasheninnikov), Riedel and Sanfilippo, 1970, p. 526, pl. 7, fig. 8, 9.

Thyrsocyrtis rhizodon Ehrenberg
(Plate 11, Figure 18)

Thyrsocyrtis rhizodon Ehrenberg, 1873, p. 262; 1875, pl. 12, fig. 1.

Thyrsocyrtis tetracantha (Ehrenberg)
(Plate 11, Figure 19)

Podocyrtis tetracantha Ehrenberg, 1873, p. 254; 1875, pl. 13, fig. 2.
Thyrsocyrtis tetracantha (Ehrenberg), Riedel and Sanfilippo, 1970, p. 527.

Thyrsocyrtis triacantha (Ehrenberg)
(Plate 11, Figure 20)

see Reidel and Sanfilippo, 1970, p. 526, pl. 8, fig. 2, 3.

Theoperidae gen. A
(Plate 12, Figures 1, 2)

Remarks: It is believed that this tricyrtid is a new genus, characterized by the presence of a prominent lumbar stricture which separates upper cephalus and thorax parts from an abruptly robust abdomen, while the three solid, strong feet originate from the abdominal wall. There is a slight resemblance to forms reported by Riedel and Sanfilippo as "Gen. et sp. indet." (1970, pl. 10, fig. 1), but the above characteristics distinguish it from them.

The stratigraphic occurrence of this species is apparently restricted only to sediments of late Eocene *Thyrsocyrtis bromia* Zone.

Family CARPOCANIIDAE Haeckel, 1881, emend. Riedel, 1967

Genus CARPOCANISTRUM Haeckel, 1887

Carpocanistrum sp. A
(Plate 12, Figure 3)

Remarks: Included under the present species are specimens with circular pores on the thorax which are separated by intervening longitudinal ridges, and a well-developed hyaline peristome.

Carpocanistrum sp. B
(Plate 12, Figure 4)

Remarks: This species is characterized by a tube-form opening on the thoracic wall which is oriented obliquely to the thoracic wall. Hyaline peristome is well developed.

Carpocanistrum sp. C
(Plate 12, Figure 5)

Remarks: Similar to *C.* sp. A, but differs in possessing more distinct longitudinal ridges on the thorax, and three to five terminal teeth of short, conical shape.

Carpocanistrum sp. D
(Plate 12, Figure 6)

Remarks: Differentiated from the above three species by circular outline, more abundant, smaller circular pores in longitudinal rows on the thorax, and numerous slender terminal teeth.

Genus CARPOCANOPSIS Riedel and Sanfilippo, 1971

Carpocanopsis bramlettei Riedel and Sanfilippo
(Plate 12, Figure 7)

Carpocanopsis bramlettei Riedel and Sanfilippo, 1971, p. 1597, pl. 2G, fig. 8-14; pl. 8, fig. 7.

Carpocanopsis favosum (Haeckel)
(Plate 12, Figure 8)

see Riedel and Sanfilippo, 1971, p. 1697, pl. 2G , 15, 16; pl. 8, fig. 9-11.

Family PTEROCORYTHIDAE Haeckel, 1881, emend. Riedel, 1967, Moore, 1972

Genus CALOCYCLETTA Haeckel, 1887, emend. Riedel, 1967

Calocycletta acanthocephala (Ehrenberg)
(Plate 12, Figure 9)

Eucrytidium acanthocephalum Ehrenberg, 1873, p. 225; 1875, pl. 9, fig. 8.
Calocycletta acanthocephala (Ehrenberg), Petrushevskaya and Kozlova, 1972, p. 544, pl. 35, fig. 5-7; Johnson, 1974, p. 550, pl. 6, fig. 3.

Calocycletta costata (Riedel)
(Plate 12, Figures 10, 11)

see Moore, 1972, p. 147, pl. 1, fig. 8.

Calocycletta robusta Moore
(Plate 12, Figure 12)

Calocycletta robusta Moore, 1971, p. 743, pl. 10, fig. 5, 6.

Calocycletta virginis (Haeckel)

see Moore, 1972, p. 147, pl. 1, fig. 7.

Calocycletta spp.
(Plate 12, Figures 13, 14)

Remarks: At least two forms illustrated here are ancestral within the present genus. Their phylogenetic relationship with published species cannot be determined at this time.

Genus CYCLAMPTERIUM Haeckel, 1887

Cyclampterium (?) milowi Riedel and Sanfilippo
(Plate 12, Figure 15)

Cyclampterium (?) *milowi* Riedel and Sanfilippo, 1971, p. 1593, pl. 3B, fig. 3; pl. 7, fig. 8, 9.

Genus EUCYRTIDIUM Ehrenberg, 1847a

Eucyrtidium yatsuoense Nakaseko
(Plate 12, Figure 16)

Eucyrtidium yatsuoense Nakaseko, 1955, p. 110, 111, pl. 10, fig. 1a, b; Ling and Kurihara, 1972, p. 34, pl. 1, fig. 10, 11.

Eucyrtidium sp. cf. E. montiparum Ehrenberg
(Plate 12, Figure 17)

?*Eucyrtidium montiparum* Ehrenberg, 1873, p. 230; 1875, pl. 9, fig. 5.
Eucrytidium sp. aff. *E. montiparum* Ehrenberg, Petrushevskaya and Kozlova, 1972, p. 548, pl. 26, fig. 2-4.

Eucyrtidium sp. cf. E. panthera Ehrenberg
(Plate 12, Figure 18)

Eucrytidium panthera Ehrenberg, 1873, p. 231; 1875, pl. 11, fig. 18.
Remarks: There is serious doubt in placing this species under the present genus; nevertheless, there seems little doubt that specimens found in Philippine Sea subbottom sediments are closely related to that of Ehrenberg's except that the present Philippine Sea forms show more regularly arranged circular abdominal pores surrounded by hexagonal framework. At least in the present study, occurrence of this taxon is stratigraphically restricted within late Eocene *Thyrsocyrtis bromia* Zone.

Eucyrtidium sp. cf. E. "rocket"
(Plate 12, Figure 19)

Eucyrtidiidae gen. sp. "rocket," Petrushevskaya and Kozlova, 1972, p. 547, pl. 28, fig. 2, 3.
Remarks: As reported by Petrushevskaya and Kozlova, stratigraphic occurrence of this taxon is also found only in Oligocene sediments from the Philippine Sea.

Eucyrtidium sp. A
(Plate 12, Figure 20)

Theoperid. gen et ap. indet., Johnson, 1974, pl. 4, fig. 13, 14.
Remarks: At least superficially, the present species resembles *Stichocorys wolfii* (Haeckel). It is distinguishable from the latter by its overall larger size and the more regularly arranged circular pores on the wall of the fourth segments. The upward stratigraphic range of this species is limited to the top of the *Thyrsocyrtis bromia* Zone.

Genus LAMPROCYCLAS Haeckel, 1881

Lamprocyclas maritalis maritalis Haeckel
(Plate 13, Figure 1)

see Nigrini, 1967, p. 74-76, pl. 7, fig. 5.

Lamprocyclas sp.
(Plate 13, Figure 2)

Remarks: It is believed that the specimen here illustrated, which was encountered in Miocene sediments, is an ancestral form of the modern warm-water species, but it was not possible to firmly establish this phylogenic lineage.

Genus PODOCYRTIS Ehrenberg, 1847a

Subgenus LAMPTERIUM Haeckel, 1881

Podocyrtis (Lampterium) mitra Ehrenberg
(Plate 13, Figures 3, 4)

Podocyrtis mitra Ehrenberg, 1854, pl. 36, fig. B, 20; 1873, p. 251.
Podocyrtis (Lampterium) mitra Ehrenberg, Riedel and Sanfilippo. 1970, p. 534, pl. 11, fig. 5, 6.
Remarks: Included also under the present taxon is a transitional form from *P. mitra* to *P. chalara,* an example of which is illustrated here (Plate 13, Figure 4). Throughout the present study, no typical specimen of *P. chalara* was encountered.

Subgenus PODOCYRTIS Ehrenberg, 1847a

Podocyrtis (Podocyrtis) papalis Ehrenberg
(Plate 13, Figure 5)

Podocyrtis papalis Ehrenberg, 1847b, fig. 2; 1873, p. 251.
Podocyrtis (Podocyrtis) papalis Ehrenberg, Riedel and Sanfilippo, 1970, p. 533, pl. 11, fig. 1.

Genus THEOCYRTIS Haeckel, 1887

Theocyrtis annosa (Riedel)
(Plate 13, Figure 6)

Phormocyrtis annosa Riedel, 1959, p. 295, pl. 2, fig. 7.
Theocyrtis annosa (Riedel), Riedel and Sanfilippo, 1970, p. 535, pl. 15, fig. 9.

Theocyrtis tuberosa Riedel
(Plate 13, Figure 7)

Theocyrtis tuberosa Riedel, 1959, p. 258, pl. 2, fig. 10, 11

Family ARTOSTROBIIDAE Riedel, 1967, emend. Foreman, 1973

Genus ARTOSTROBUS Haeckel, 1887

Artostrobus annulatus (Bailey)
(Plate 13, Figure 8)

Cornutella ? *annulata* Bailey, 1856, p. 3, pl. 1, fig. 5a, b.
Artostrobus annulatus (Bailey), Haeckel, 1887, p. 1481.

Genus DICOLOCAPSA Haeckel

Dicolocapsa microcephala Haeckel
(Plate 13, Figure 9)

Dicolocapsa microcephala Haeckel, 1887, p. 1312, pl. 57, fig. 1.

Genus DICTYOCRYPHALUS Haeckel, 1887

Dictyocryphalus papillosus (Ehrenberg)
(Plate 13, Figure 10)

see Nigrini, 1967, p. 63, 64, pl. 6, fig. 6.

Genus LITHOMITRA Bütschli, 1882

Lithomitra arachnea (Ehrenberg)
(Plate 13, Figure 11)

see Riedel, 1958, p. 242, 243, pl. 4, fig. 7, 8.

Lithomitra sp. cf. L. elizabethae Clark and Campbell
(Plate 13, Figure 12)

Lithomitra elizabethae Clark and Campbell, 1942, p. 92, pl. 9, fig. 18.
Eucyrtidiidae gen. sp. aff. *Lithomitra elizabethae* Clark and Campbell, Petrushevskaya and Kozlova, pl. 22, fig. 11, 12.
Remarks: It is believed that the present species is very closely related to, if not conspecific with, those of Clark and Campbell, and of Petrushevskaya and Kozlova. However, the confirmation cannot be made until future observation of some Eocene Californian samples is completed.

Genus PHORMOSTICHOARTUS Campbell, 1951

Phormostichoartus corona Haeckel
(Plate 13, Figure 13)

see Riedel and Sanfilippo, 1970, p. 1600, pl. 11, fig. 13-15; pl. 2J, fig. 1-5.

Genus THEOCAMPE Haeckel, 1887

Theocampe amphora (Haeckel) group
(Plate 13, Figure 14)

? *Dictyocephalus amphora* Haeckel, 1887, p. 1305, pl. 62, fig. 4.
Theocampe amphora (Haeckel) group, Foreman, 1973, p. 431, 432, pl. 8, fig. 7, 9-13; pl. 9, fig. 8, 9.

Remarks: Although the original Haeckel's specimen from the Central Pacific, *Challenger* Stations 265 to 272, differs from the present forms, Foreman's opinion of the species is followed during the present analysis.

Theocampe armadillo (Ehrenberg) group
(Plate 13, Figure 15)

Eucyrtidium armadillo Ehrenberg, 1873, p. 224; 1875, pl. 9, fig. 10.
Theocampe armadillo (Ehrenberg) group, Riedel and Sanfilippo, 1971, p. 1601, pl. 3E, fig. 3-6.

Theocampe mongolfieri (Ehrenberg)
(Plate 13, Figures 16, 17)

Eucyrtidium mongolfieri Ehrenberg, 1854, pl. 36, B, fig. 18; 1873, p. 230; 1875, pl. 10, fig. 3.
Sethamphora mongolfieri (Ehrenberg), Haeckel, 1887, p. 1251.
Theocampe mongolfieri (Ehrenberg), Burma, 1959, p. 329; Riedel and Sanfilippo, 1970, p. 536, pl. 12, fig. 9.

Theocampe pirum (Ehrenberg)
(Plate 13, Figure 18)

Eucyrtidium pirum Ehrenberg, 1873, p. 232; 1875, pl. 10, fig. 14.
Theocampe pirum (Ehrenberg), Riedel and Sanfilippo. 1971, p. 1601, pl. 3E, fig. 10, 11.

Family CANNOBOTRYIDAE Haeckel, 1881, emend. Riedel, 1967

Genus BOTRYOCYRTIS Ehrenberg, 1860b

Botryocyrtis scutum (Harting)
(Plate 13, Figure 19)

see Nigrini, 1967, p. 52-54, pl. 6, fig. 1a-c.

Genus BOTRYOPYLE Haeckel, 1881

Botryopyle dictyocephalus Haeckel group
(Plate 13, Figures 20, 21)

Botryopyle dictyocephalus Haeckel, 1887, p. 1113, pl. 96, fig. 6.
Botryopyle dictyocephalus Haeckel group, Riedel and Sanfilippo, 1971, pl. 1602, pl. 1J, fig. 21-26; pl. 2J, fig. 16-18; pl. 3F, fig. 9-12.

Genus CENTROBOTRYS Petrushevskaya, 1965

Centrobotrys thermophila Petrushevskaya
(Plate 13, Figures 22, 23)

Centrobotrys thermophila Petrushevskaya, 1965, p. 115, text-fig. 20.

Suborder PHAEODARINA Haeckel, 1879

Remarks: Although radiolarians belonging to this group are found very rarely throughout the examined samples, they are illustrated here to record their occurrences in this part of the North Pacific.

Genus BORGERTELLA Dumitrica, 1973

Borgertella caudata (Wallich)
(Plate 13, Figure 24)

Cadium caudatum Wallich, Bütschli, 1882, pl. 32, fig. 15a.
Cadium iauris Borgert, 1910, p. 402, pl. 30, fig. 4-10.
Borgertella caudata (Wallich), Dumitrica, 1973, p. 755, 756, pl. 8, fig. 6-8; pl. 12, fig. 13-17.

Genus EUPHYSETTA Haeckel, 1887

Euphysetta sp. cf. E. nathorstii Cleve
(Plate 13, Figure 25)

Euphysetta nathorstii Cleve, 1899, p. 29, pl. 2, fig. 3.

Remarks: The specimen presented here from the southwest of Japan is referred to as Cleve's species because of the similarities in outline and surface ornamentation. It differs in that the elongated oral spine is curved rather than straight.

Euphysetta sp.
(Plate 13, Figures 26, 27)

Remarks: This form resembles *E. elegans* (Borgert, 1906, p. 154, pl. 11, fig. 7-9), but distinctly differs from the latter in possessing an obliquely aligned surface ornamentation.

Genus LIRELLA Ehrenberg, 1872c

Lirella baileyi Ehrenberg
(Plate 13, Figure 28)

Cadium marinum Bailey, 1856, p. 3, pl. 1, fig. 2.
Lirella baileyi Ehrenberg, 1872c, p. 248, pl. III, fig. 29a, b; Loeblich and Tappan, 1961, p. 231, 232; Ling, 1973, p. 781, 782.
Lirella marina (Bailey), Dumitrica, 1973, p. 755, pl. 6, fig. 28; pl. , fig. 8; j. 12, fig. 1012.

Lirella bullata (Stadum and Ling)
(Plate 13, Figure 29)

Cadium bullatum Stadum and Ling, 1969, p. 484, 485, pl. 1, fig. 9-14.

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PLATE 1

(Magnification ×200 unless otherwise indicated)

Figure 1	*Buccinospaera invaginate* Haeckel, 297-2, CC, R-1 (O34/3), ×250.
Figures 2, 3	*Polysolenia spinosa* (Haeckel) group. 2. 296-1, CC, R-1 (F18/3). 3. 296-25, CC, R-2 (M15/0).
Figure 4	*Solenospaera* sp., 296-30-4, 80-82 cm, R-1 (P37/0).
Figures 5, 6	*Otosphaera auriculata* Haeckel group. 5. 296-29-4, 40-42 cm, R-2 (Y41/3). 6. 296-24, CC, R-2 (K11/0).
Figures 7, 8	*Thecospaera akitaensis* Nakaseko, 302-7-3, 20-22 cm, R-2 (F43/1), ×250.
Figures 9, 10	*Thecospaera japonica* Nakaseko, 302-4-5, 10-12 cm, R-2 (N3/1), ×250.
Figures 11, 12	*Stylosphaera* sp., 291-4-3, 63-65 cm, R-3 (F11/0), ×115.
Figures 13-15	*Ellipsoxiphus* ? sp. cf. *E. atractus* Haeckel. 13. 292-37-3, 60-62 cm, R-1 (M26/0), ×250. 14. 292-37-3, 60-62 cm, R-1 (Q42/0), ×250. 15. 292-17-3, 49-50 cm, R-1 (F28/0), ×250.
Figure 16	*Druppatractus coronata laevis* (Ehrenberg), 290-3, CC, R-1 (Q7/0).
Figures 17, 18	*Druppatractus acquilonius* Hays, 297-2-1, 110-112 cm, R-1 (G18/2).
Figure 19	*Druppatractus* sp., 292-25-1, 50-52 cm, R-1 (N40/1).

PLATE 1

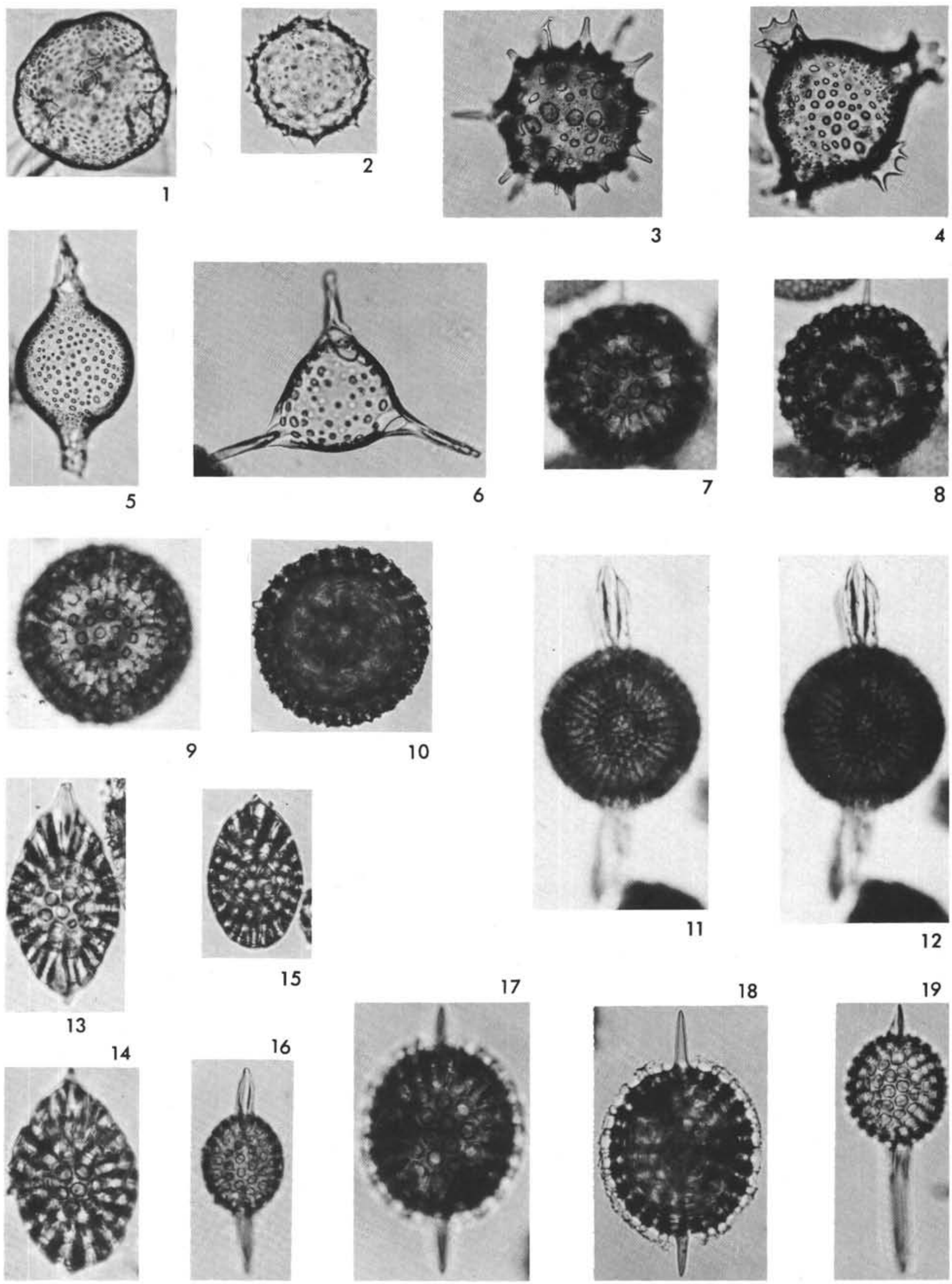

PLATE 2

(Magnification ×200 unless otherwise indicated)

Figure 1	*Druppatractus* sp., 292-25-1, 50-52 cm, R-1 (N40/1).
Figure 2	Saturnalis circularis Haeckel, 297-2-1, 110-112 cm, R-1 (U39/1).
Figures 3, 4	*Cannartus laticonus* Riedel, 296-26-2, 40-42 cm, R-1 (B47/3).
Figures 5, 6	*Cannartus mammiferus* (Haeckel, 296-29, CC, R-2 (M35/4).
Figures 7, 8	*Cannartus prismaticus* (Haeckel). 7. 292-18, CC, R-1 (D33/1). 8. 292-19-5, 60-62 cm, R-1 (N26/4).
Figures 9, 10	*Cannartus tubarius* (Haeckel), 296-30-4, 80-82 cm, R-2 (N19/0).
Figure 11	*Cannartus violina* Haeckel, 296-29-4, 40-42 cm, R-1 (J16/0).
Figures 12-16	*Ommatartus antepenultimus* Riedel and Sanfilippo. 12, 13. 296-26-2, 40-42 cm, R-1 (S40/1). 14-16. 296-26-2, 40-42 cm, R-2 (R45/1).
Figure 17	*Ommatartus tetrathalamus tetrathalamus* (Haeckel), 296-1, CC, R-1 (G42/0).
Figures 18-20	*Astrophacus* sp. 18. 292-17-1, 105-107 cm, R-1 (U17/0). 19. 292-17-1, 105-107 cm, R-2 (U25/2), ×115. 20. 292-21-5, 50-52 cm, R-1 (K34/1).

PLATE 2

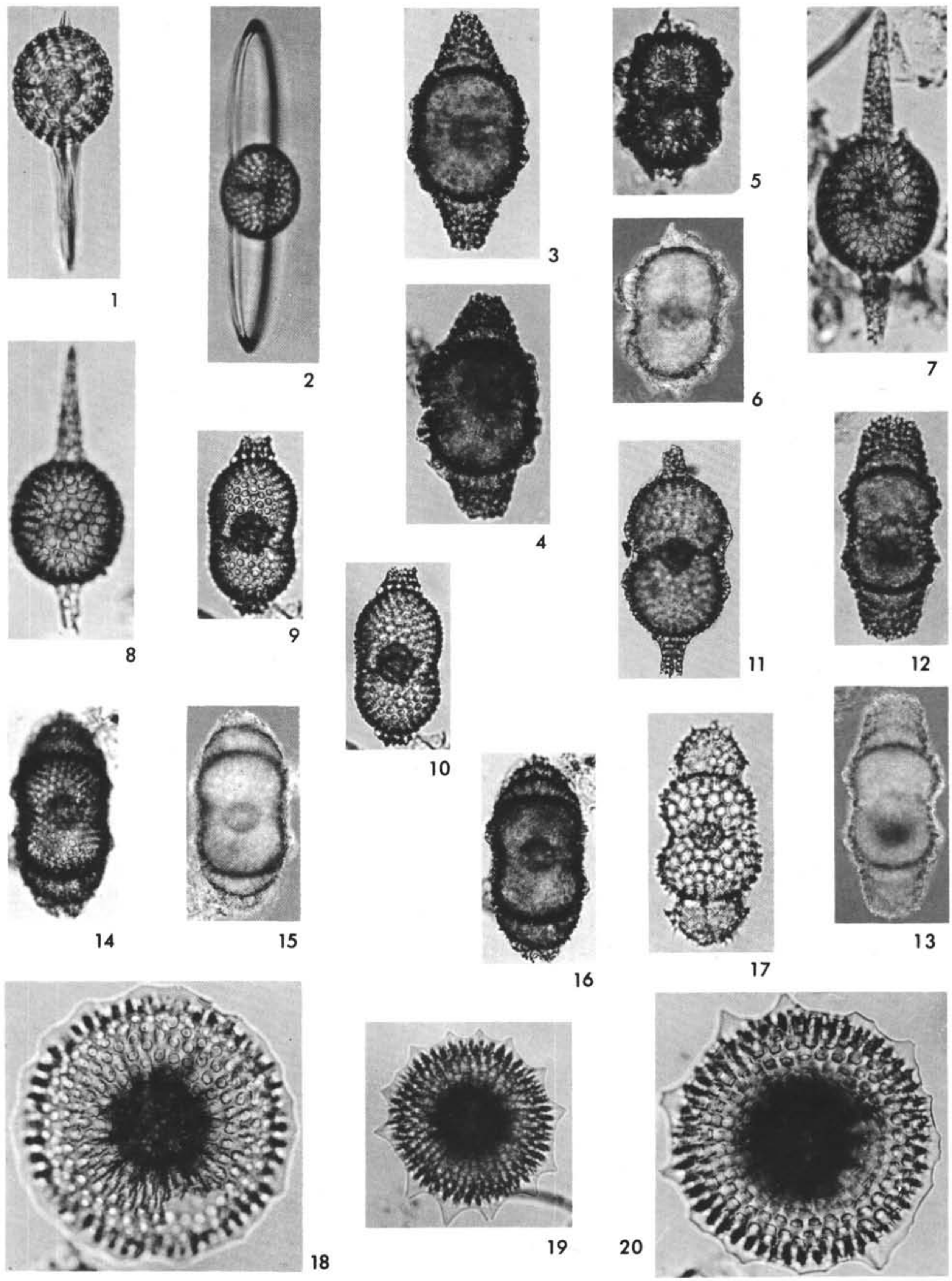

PLATE 3

(Magnification ×200 unless otherwise indicated)

Figures 1, 2 — *Periphaena decora* Ehrenberg.
1. 292-37-1, 96-98 cm, R-1 (Q43/0).
2. 291-4-2, 65-67 cm, R-2 (013/4).

Figure 3 — *Triactis tripyramis triangula* (Sutton), 292-19-5, 60-62 cm, R-1 (W43/3).

Figure 4 — *Triactis tripyramis tripyramis* Haeckel, 291-3, CC, R-2 (E17/4).

Figures 5, 6 — *Lithocyclia angustum* (Riedel).
5. 292-24, CC, R-2 (X37/3).
6. 292-24, CC, R-1 (L13/4), lateral view of a broken specimen showing inside structure and a medullary shell.

Figures 7, 8 — *Lithocyclia aristotelis* (Ehrenberg) group.
7. 291A-3, CC, R-1 (U40/1).
8. 292-36-5, 35-37 cm, R-1 (J50/1).

Figure 9 — *Lithocyclia crux* Moore, 292-30-1, 90-92 cm, R-1 (P47/0).

Figure 10 — *Lithocyclia ocellus* Ehrenberg group, 291-40-3, 63-65 cm, R-3 (H26/0).

Figures 11-13 — *Lithocyclia* sp.
11. 292-25-1, 50-52 cm, R-1 (R15/2).
12. 292-25-1, 50-52 cm, R-1 (T50/0).
13. 292-30-1, 90-92 cm, R-1 (L42/1).

PLATE 3

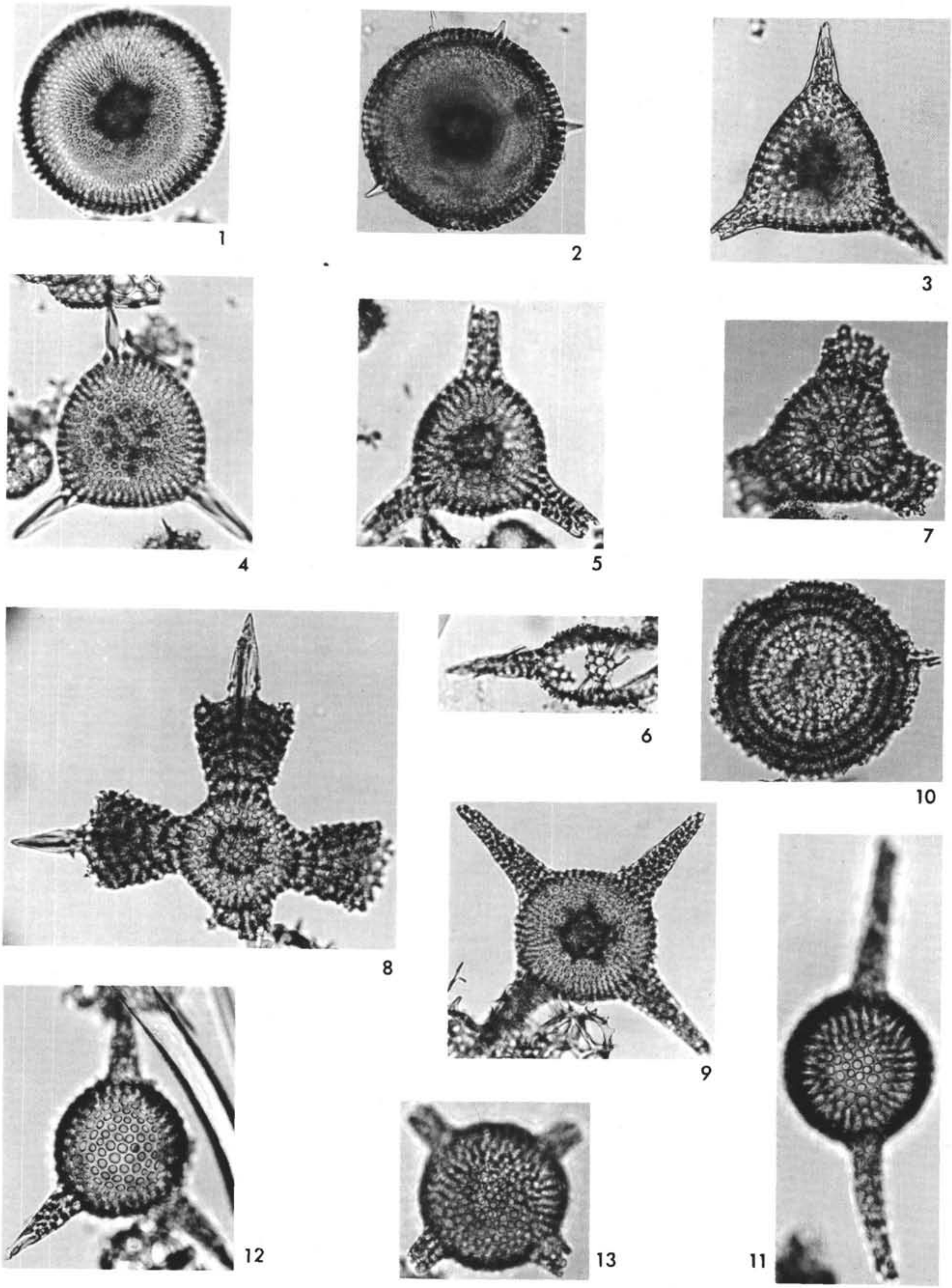

PLATE 4

(Magnification ×200 unless otherwise indicated)

Figure 1	*Amphicraspedum proxilum* Sanfilippo and Riedel, 291-4-1, 68-70 cm, R-1 (R51/0).
Figure 2	*Amphirhopalum ypsilon* Haeckel, 297-3, CC, R-1 (J8/0).
Figure 3	*Euchitonia furcata* Ehrenberg, 292-26-1, 105-107 cm, R-1 (V31/4).
Figure 4	*Spongodiscus quartus quartus* (Borisenko), 291A-1, CC, R-1 (K35/0).
Figure 5	*Spongodiscus* sp., 299-6-4, 27-29 cm, R-1 (Y18/0).
Figure 6	*Spongopyle osuclosa* Dreyer, 301-15-3, 70-72 cm, R-1 (F19/3).
Figure 7	*Spongurus pylomaticus* Riedel, 299-7-2, 22-24 cm, R-1 (H10/0).
Figures 8, 9	*Stauralastrum* sp. 8. 291-3, CC, R-3 (V32/0). 9. 292-32-1, 50-52 cm, R-1 (D32/4), ×115.
Figure 10	*Spirema* ? *circularis* Nakaseko, 301-15-1, 14-16 cm, R-2 (L12/3).
Figure 11	*Ceratospyris clavata* Bütschli, 292-37-1, 96-98 cm, R-1 (P37/2), ×250.
Figures 12, 13	*Ceratospyris* sp. cf. *C. echinus* Ehrenberg. 12. 292-38-1, 60-62 cm, R-2 (018/4), ×250. 13. 292-36-1, 37-40 cm, R-1 (E47/3).
Figures 14, 15	*Dendrospyris damaecornis* (Haeckel), 296-26, CC, R-1 (V25/3), ×250.
Figure 16	*Dendrospyris didiceros* (Ehrenberg) group, 291-4-1, 68-70 cm, R-1 (X22/1).
Figures 17-19	*Dendrospyris pododendros* (Carnevale) group. 17, 18. 292-18, CC, R-2 (X26/1), ×250. 19. 292-18-3, 50-52 cm, R-1 (T44/4), ×250.

PLATE 4

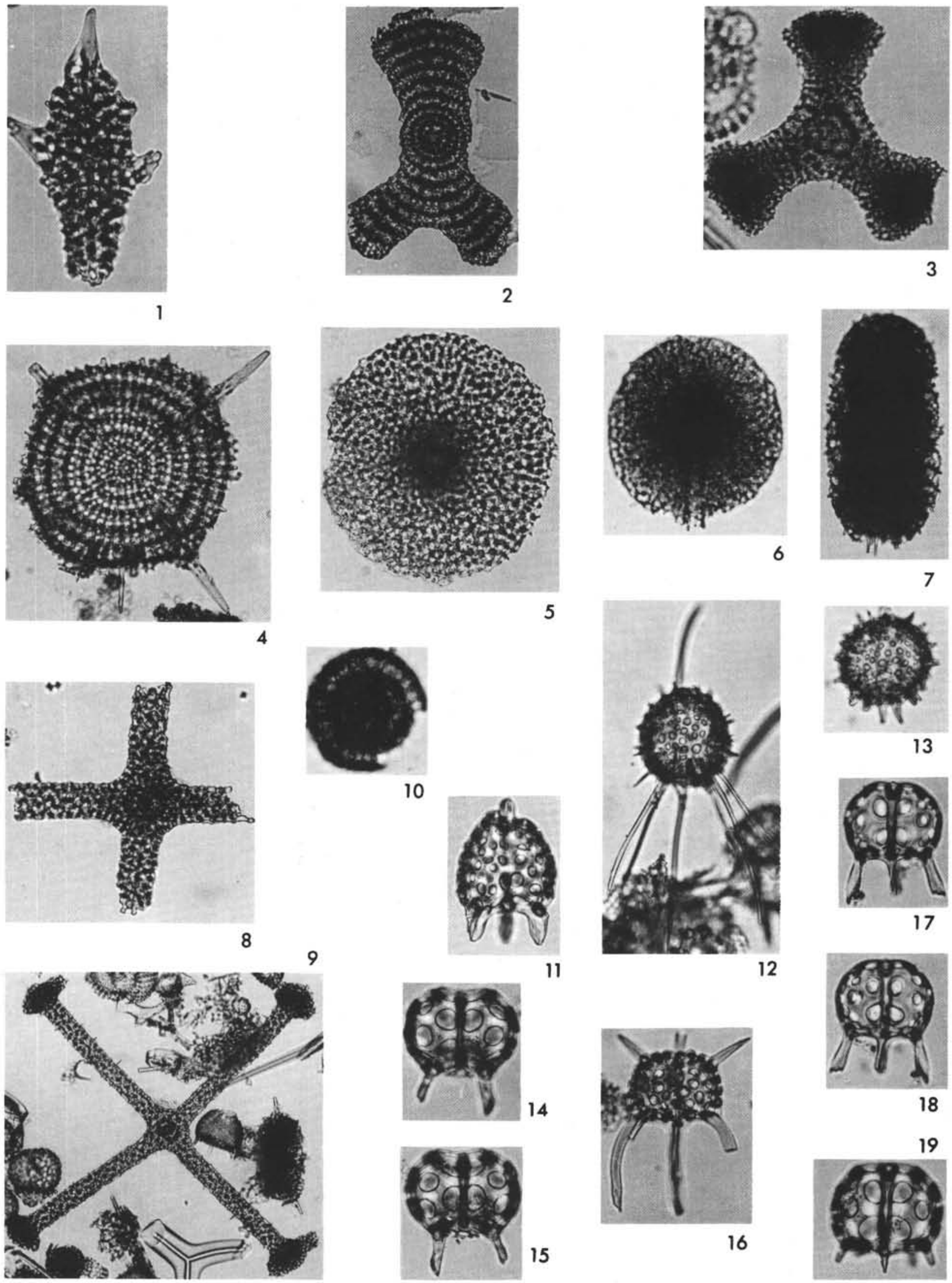

PLATE 5

(Magnification ×160 unless otherwise indicated)

Figures 1, 2	*Dorcadospyris alata* (Riedel). 1. 296-26, CC, R-2 (Y6/4). 2. Same specimen, ×250.
Figures 3-6	*Dorcadospyris ateuchus* (Ehrenberg). 3, 4. 292-22-2, 50-52 cm, R-1 (N40/2). 5, 6. 292-23-1, 50-52 cm, R-1 (B41/3)
Figures 7-9	*Dorcadospyris circulus* (Haeckel). 7. 292-22, CC, R-1 (D19/1). 8. 292-17-1, 105-107 cm, R-2 (X37/1). 9. Same specimen as Figure 8, ×250.
Figures 10-12	*Dorcadospyris dentata* Haeckel. 10, 11. 296-28-4, 40-42 cm, R-2 (K49/2). 12. Same specimen, ×250.

PLATE 5

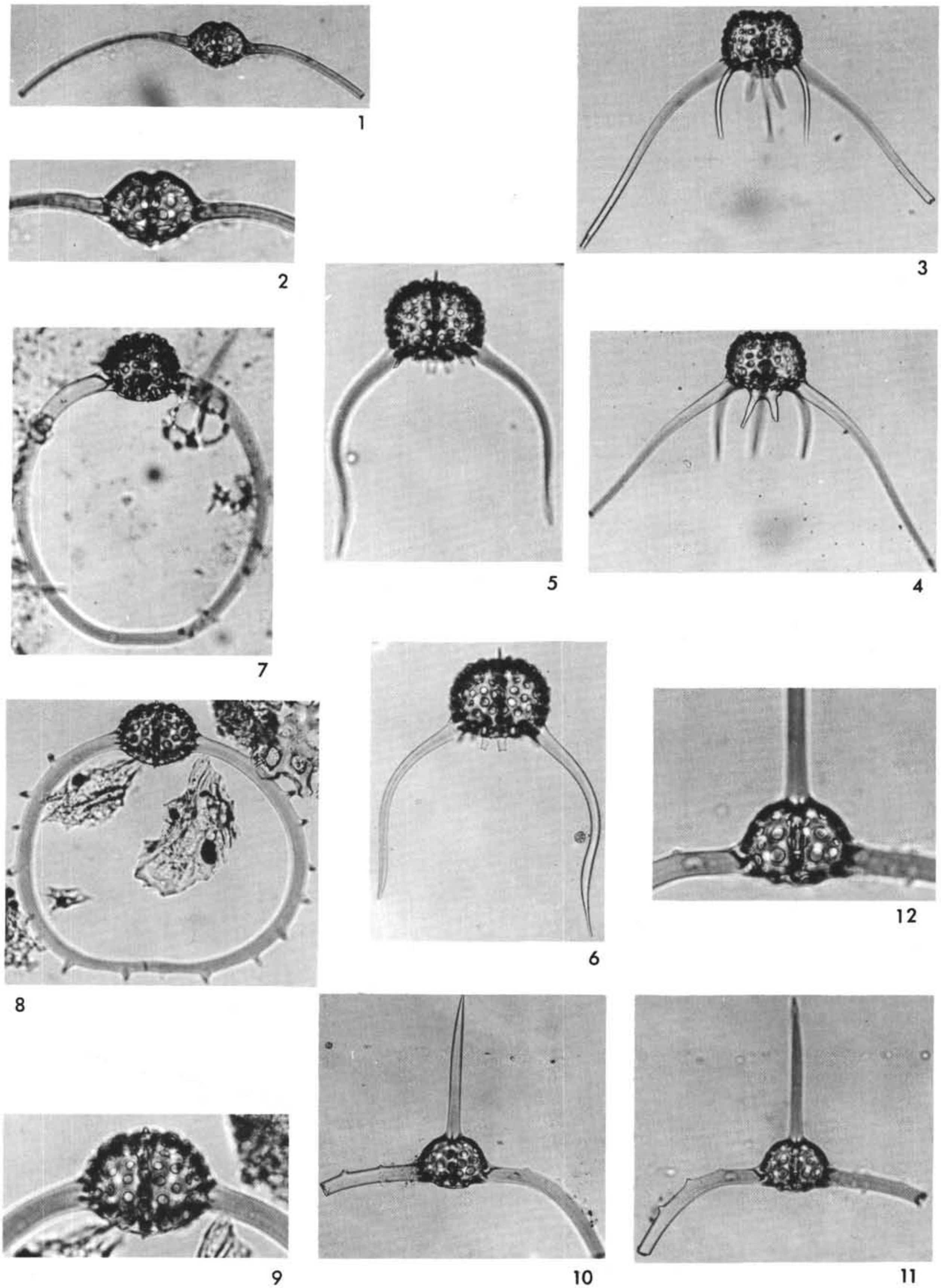

PLATE 6

(Magnification ×160 unless otherwise indicated)

Figures 1-6	*Dorcadospyris triceros* (Ehrenberg). 1. 291-3-1, 100-102 cm, R-1 (M37/3). 2. 291-3-1, 100-102 cm, R-1 (029/4). 3. Same specimen as Figure 2, ×250. 4. 292-30, CC, R-2 (R30/0). 5. Same specimen as Figure 4, ×250. 6. 292-21, CC, R-1 (M31/3), ×115.
Figure 7	*Dorcadospyris riedeli* Moore, 292-25-1, 50-52 cm, R-1 (C15/3), ×115.
Figures 8-11	*Dorcadospyris* sp. 8. 292-30, CC, R-1 (Z41/2). 9. Same specimen as Figure 8, ×250. 10. 292-30, CC, R-1 (N39/1). 11. Same specimen as Figure 10, ×250.

PLATE 6

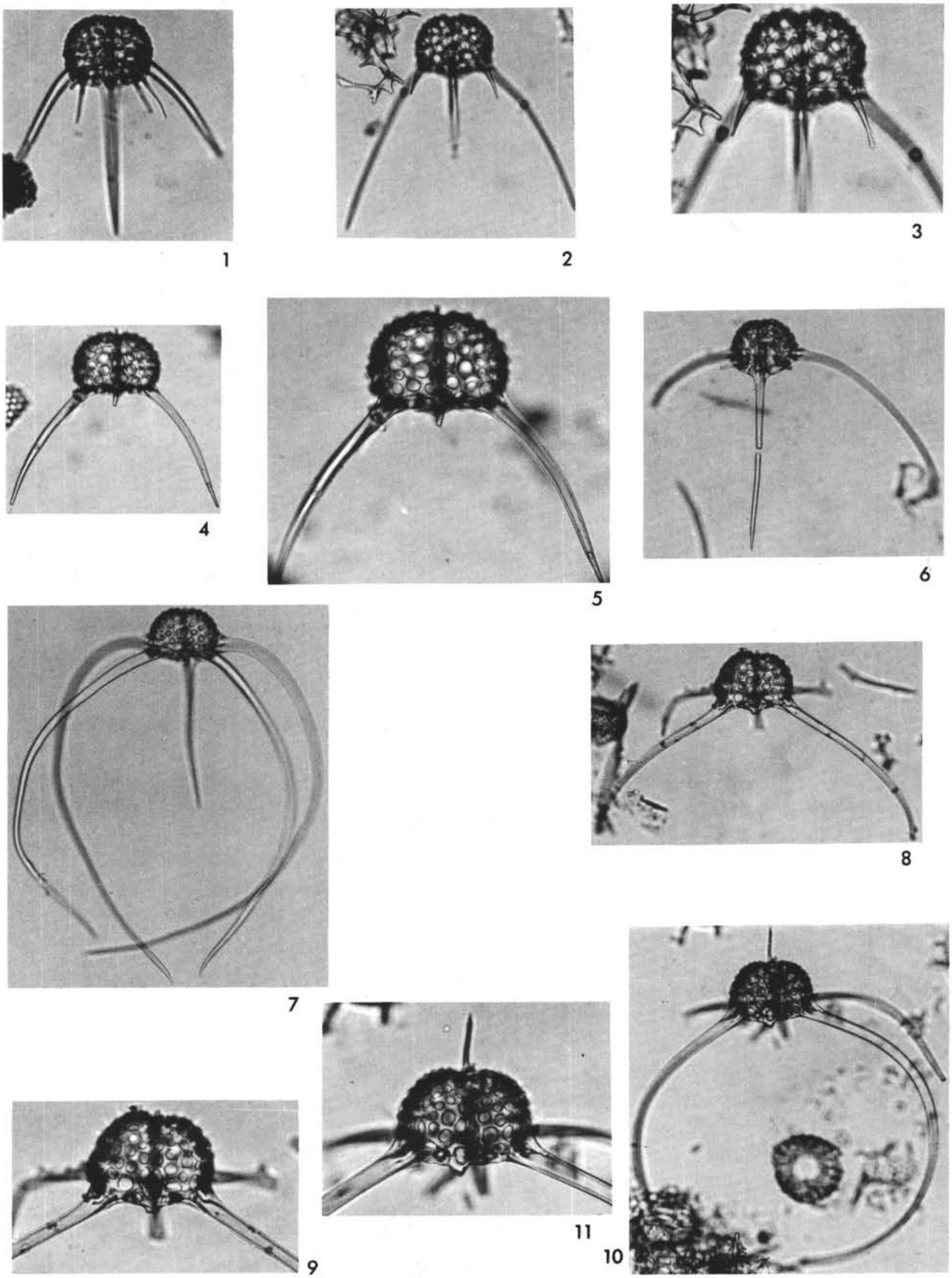

PLATE 7

(Magnification ×250 unless otherwise indicated)

Figure 1	*Desmospyris* sp. cf. *D. anthocyrtoides* (Bütschli), 292-38-1, 60-62 cm, R-1 (H26/1).
Figures 2, 3	*Giraffospyris circumflexa* Goll, 292-30-1, 90-92 cm, R-1 (J31/1)
Figures 4, 5	*Gorgospyris* sp., 296-37-4, 50-52 cm, R-1 (M42/0).
Figures 6-9	*Liriospyris clathrata* (Ehrenberg). 6, 7. 290-5-3, 61-63 cm, R-1 (V49/2). 8, 9. 292-26, CC, R-2 (S20/3).
Figures 10, 11	*Liriospyris geniculosa* Goll. 10. 292-19, CC, R-1 (M7/3). 11. 292-17-3, 48-50 cm, R-1 (024/3).
Figure 12	*Liriospyris mutuaria* Goll, 296-30-2, 110-112 cm, R-1 (U18/3).
Figure 13	*Liriospyris ovalis* Goll, 296-26-2, 40-42 cm, R-1 (U21/0).
Figure 14	*Liriospyris reticulata* (Ehrenberg), 296-26, CC, R-2 (N32/0).
Figures 15-20	*Liriospyris* sp. 15, 16. 292-30-1, 90-92 cm, R-1 (W32/1). 17, 18. 292-33, CC, R-2 (U30/0). 19, 20. 292-20, CC, R-2 (V24/2), ×200.
Figure 21	*Patagospyris confluens* (Ehrenberg), 291-4-2, 65-67 cm, R-1 (N35/4).
Figure 22	*Petalospyris diaboliscus* Ehrenberg, 292-36-5, 35-37 cm, R-1 (T19/0).
Figure 23	*Petalospyris foveolata* Ehrenberg, 292-22-2, 50-52 cm, R-1 (K36/1).
Figure 24	*Petalospyris* sp. cf. *P. foveolata* Ehrenberg, 292-24-2, 50-52 cm, R-1 (H51/4).

PLATE 7

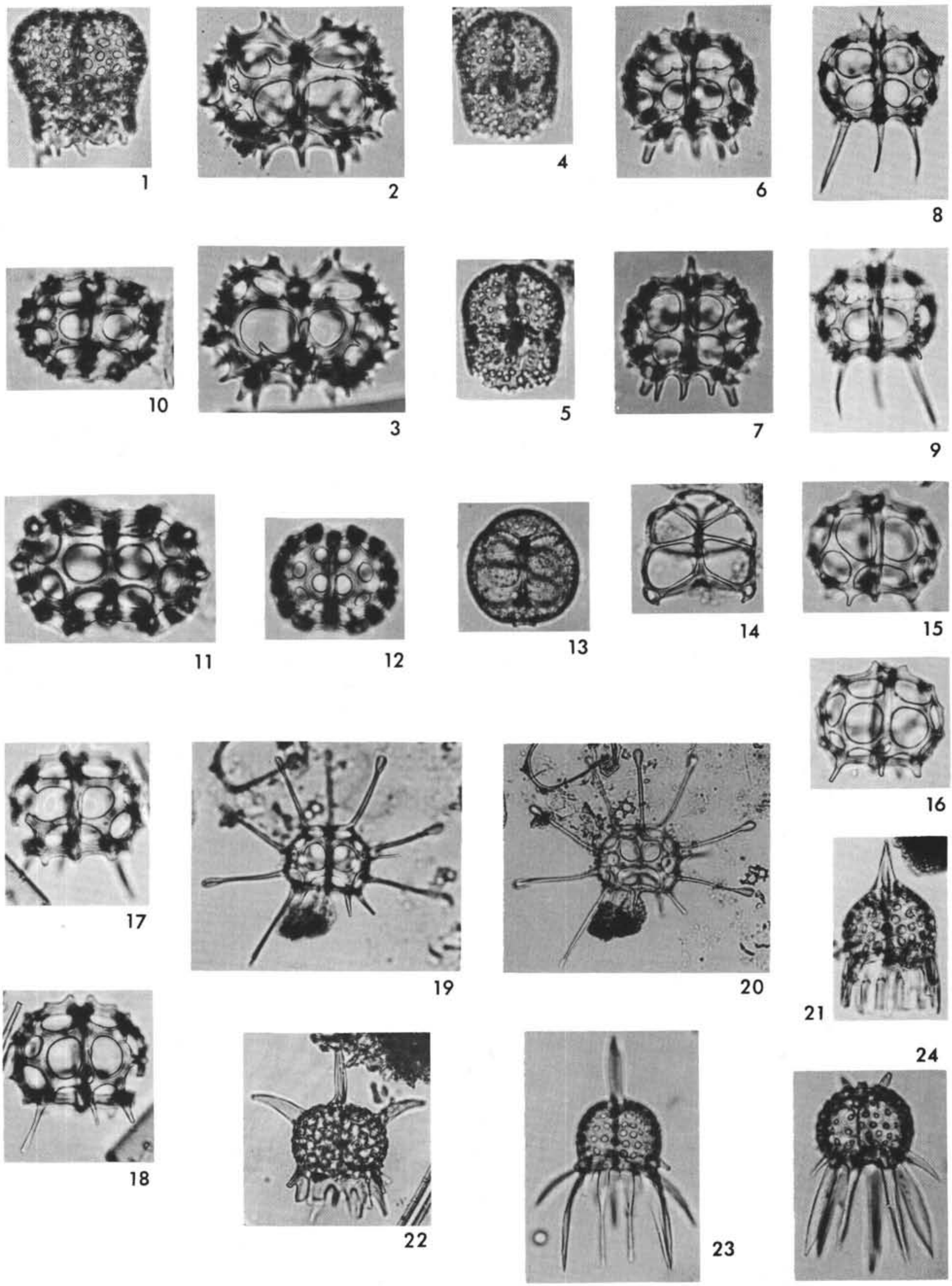

PLATE 8

(Magnification ×250 unless otherwise indicated)

Figures 1, 2	*Rhodospyris* sp. cf. *R. anthocyrtis* Haeckel. 1. 292-31-2, 57-59 cm, R-1 (T46/0). 2. 292-27-1, 50-52 cm, R-1 (S24/2).
Figures 3, 4	*Rhodospyris* sp. cf. *De*-1 group. 3. 292-24, CC, R-1 (V39/1), ×200. 4. 296-28-4, 40-42 cm, R-1 (G29/3).
Figures 5-7	*Tholospyris cortinisca* (Haeckel). 5. 292-25-1, 50-52 cm, R-1 (T43/4). 6, 7. 292-23-1, 50-52 cm, R-1 (W20/0).
Figure 8	*Tholospyris* sp. cf. *T-2* group, 292-19-5, 60-62 cm, R-1 (W29/0).
Figure 9	*Triceraspyris* sp., 302-6, CC, R-1 (W31/0).
Figures 10-12	*Trissocyclus* sp. 10, 11. 292-19-3, 50-52 cm, R-1 (M50/3), ×160. 12. 292-20-2, 50-52 cm, R-2 (F36/3), ×160.
Figure 13	*Triospyrid* sp., 292-29-1, 130-132 cm, R-1 (G39/1).
Figure 14	*Eucoronis hertwigii* Bütschli, 290A-1-1, 110-112 cm, R-1 (K24/2), ×200.
Figures 15, 16	*Clathrocorys* sp. 15. 292-25-1, 50-52 cm, R-1 (G16/1), ×200. 16. 292-26-1, 105-107 cm, R-1 (K20/2), ×200.
Figures 17, 18	*Anthocorys* ? *akitaensis* Nakaseko, 302-10, CC, R-1 (V43/3), ×200.
Figure 19	*Anthocyrtella* sp., 291-4-3, 63-65 cm, R-2 (050/0), ×200.
Figures 20, 21	*Cycladophora davisiana* Ehrenberg. 20. 299-6-4, 24-26 cm, R-1 (D34/3). 21. 302-4, CC, R-2 (Y22/3).

PLATE 8

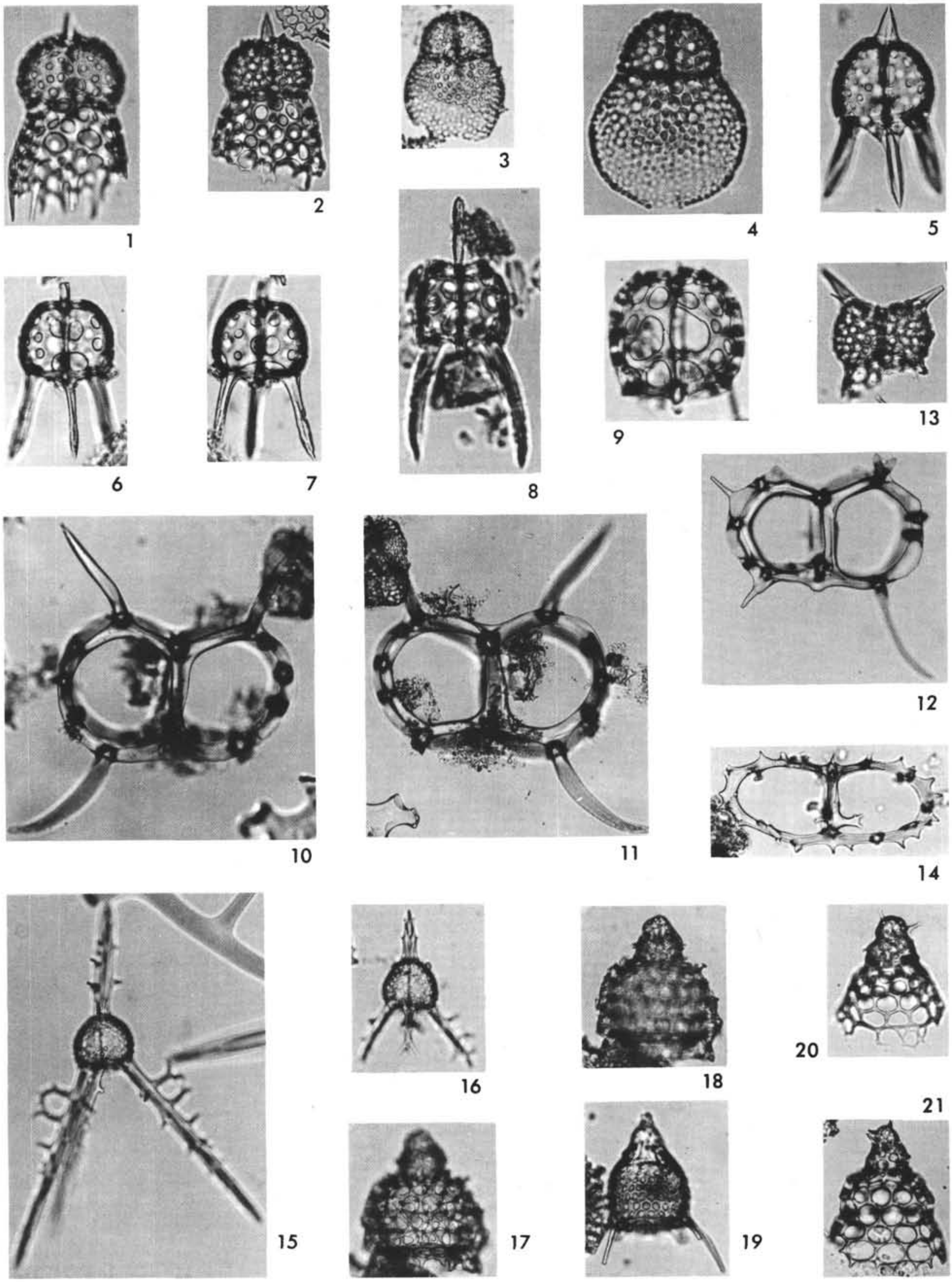

PLATE 9

(Magnification ×200 unless otherwise indicated)

Figures 1, 2	*Diplocyclas* spp. 1. 290-3-3, 20-22 cm, R-1 (H10/4). 2. 291-4-4, 30-32 cm, R-2 (V31/0), ×250.
Figures 3, 4	*Bathropyramis* sp. 3. 292-30-1, 90-92 cm, R-1 (P47/0), ×160. 4. 292-27-1, 50-52 cm, R-1 (J29/1).
Figures 5-8	*Cornutella profunda* Ehrenberg. 5. 298-3, CC, R-2 (K27/3), ×250. 6. 302-12, CC, R-1 (T6/4), ×250. 7. 296-28-2, 40-42 cm, R-2 (N17/4), ×250. 8. 302-11-3, 20-22 cm, R-2 (J12/2), ×250.
Figures 9, 10	*Artophormis barbadensis* (Ehrenberg). 9. 292-29-1, 130-132 cm, R-1 (T33/0). 10. 292-26, CC, R-1 (M25/0).
Figure 11	*Artophormis gracilis* Riedel, 292-30-1, 90-92 cm, R-1 (F19/0).
Figure 12	*Calocyclas hispida* (Ehrenberg), 291-4-3, 63-65 cm, R-1 (R52/0).
Figure 13	*Calocyclas turris* Ehrenberg, 291-3, CC, R-3 (C4/3).
Figure 14	*Calocycloma ampulla* (Ehrenberg), 290-5-1, 102-104 cm, R-2 (E25/3).
Figure 15	*Cyrtocapsella cornuta* Haeckel, 296-29-6, 40-42 cm, R-1 (E39/1).
Figure 16	*Cyrtocapsella elongata* (Nakaseko), 296-30, CC, R-1 (N22/1).
Figure 17	*Cyrtocapsella japonica* (Nakaseko), 296-28-2, 40-42 cm, R-2 (M37/3).
Figure 18	*Cyrtocapsella tetrapera* (Haeckel), 296-29, CC, R-2 (D21/4).
Figures 19, 20	*Eusyringium fistuligerum* (Ehrenberg), 290A-1-1, 110-112 cm, R-1 (J40/2).
Figure 21	*Eusyringium lagena* (Ehrenberg), 290A-1-2, 60-62 cm, R-2 (T34/2).
Figure 22	*Eusyringium tubulus* (Ehrenberg), 290-6-1, 58-60 cm, R-1 (L33/0), ×160.
Figures 23-25	Lamptonium sanfilippoae Foreman. 23. 291-3, CC, R-3 (K29/4). 24. 292-31, CC, R-2 (T19/0). 25. 290-4-2, 60-62 cm, R-2 (U17/2).

PLATE 9

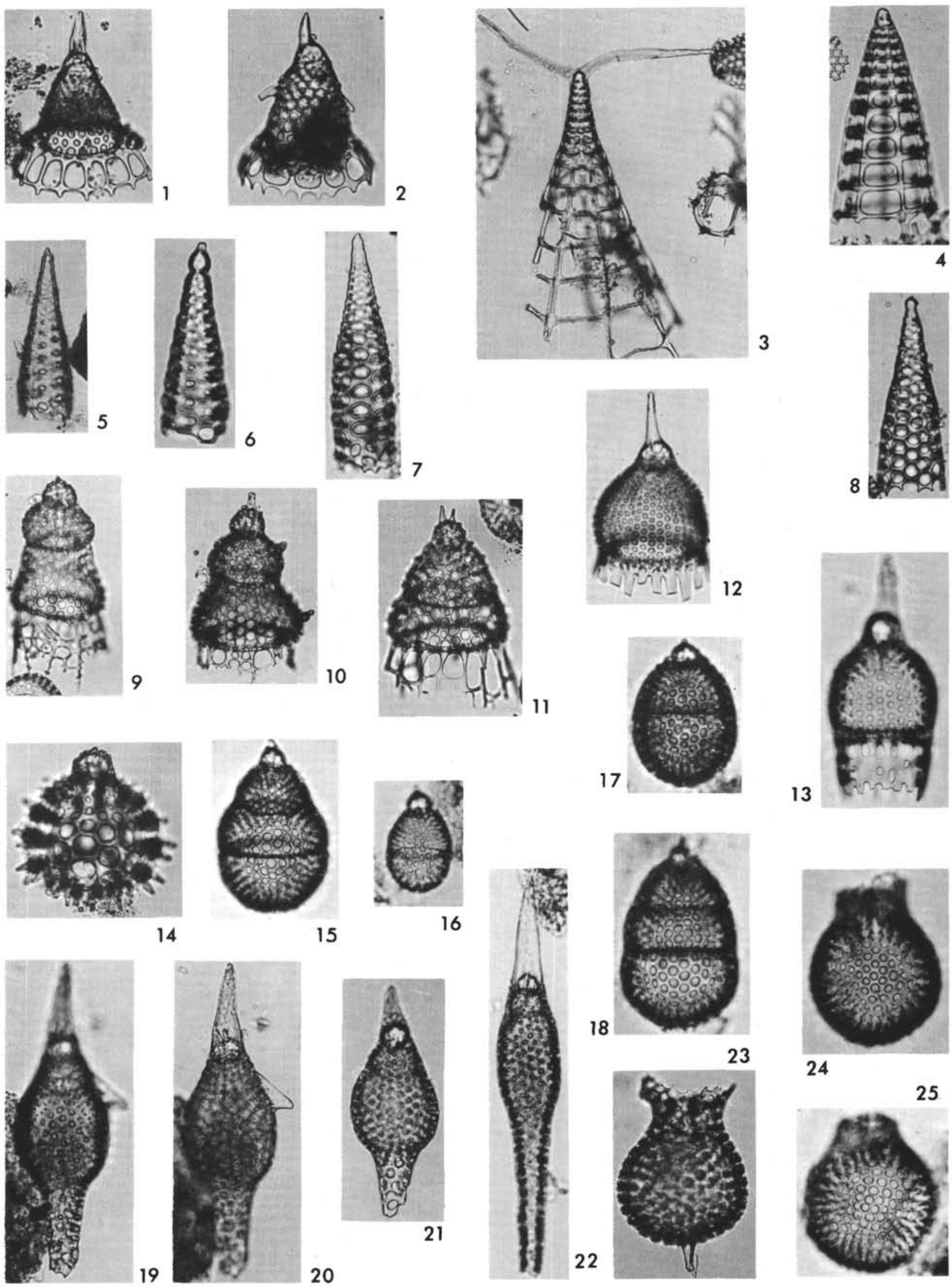

PLATE 10

(Magnification ×200 unless otherwise indicated)

Figures 1-3	*Lithochytris vespertilio* Ehrenberg. 1. 291-4-4, 30-32 cm, R-2 (014/4), ×115. 2, 3. 291-4-4, 30-32 cm, R-1 (G31/0), ×160.
Figure 4	*Lithopera bacca* Ehrenberg, 297-2-1, 110-112 cm, R-1 (P34/1).
Figure 5	*Lithopera baueri* Sanfilippo and Riedel, 296-29-4, 40-42 cm, R-1 (P48/0).
Figure 6	*Lithopera renzae* Sanfilippo and Riedel, 296-26-2, 40-42 cm, R-2 (M41/1).
Figure 7	*Lophocyrtis ? jacchia* (Ehrenberg), 291A-3, CC, R-2 (Y15/1).
Figures 8-10	*Lychnocanoma babylonis-turgidulum* group. 8. 290A-2, CC, R-3 (L10/0). 9. 291A-3, CC, R-1 (C31/4). 10. 291-4-2, 65-67 cm, R-2 (R9/3).
Figure 11	*Lychnocanoma elongata* (Vinassa), 296-29-6, 40-42 cm, R-1 (24/2).
Figure 12	*Lychnocanoma trifolium* (Riedel and Sanfilippo), 292-20-2, 50-52 cm, R-2 (E17/2).
Figure 13	*Lychnocanoma* sp. A, 290A-2, CC, R-1 (G37/0).
Figure 14	*Lychnocanoma* sp. B, 92-35-3, 115-117 cm, R-1 (K49/0), ×160.
Figure 15	*Phormocyrtis embolum* (Ehrenberg) group, 290-6-3, 10-12 cm, R-1 (M20/3), ×250.
Figure 16	*Pterocodon* sp. cf. *P. campana* Ehrenberg, 291-3, CC, R-4 (X2/2).
Figure 17	*Pterocyrtidium barbadense* (Ehrenberg), 296-44-1, 125-126, R-1 (L42/1), ×250.
Figures 18, 19	*Pterocyrtidium* sp. 18. 292-36-3, 36-38 cm, R-1 (Q42/2). 19. 292-36-5, 35-37 cm, R-1 (U42/0), ×250.

PLATE 10

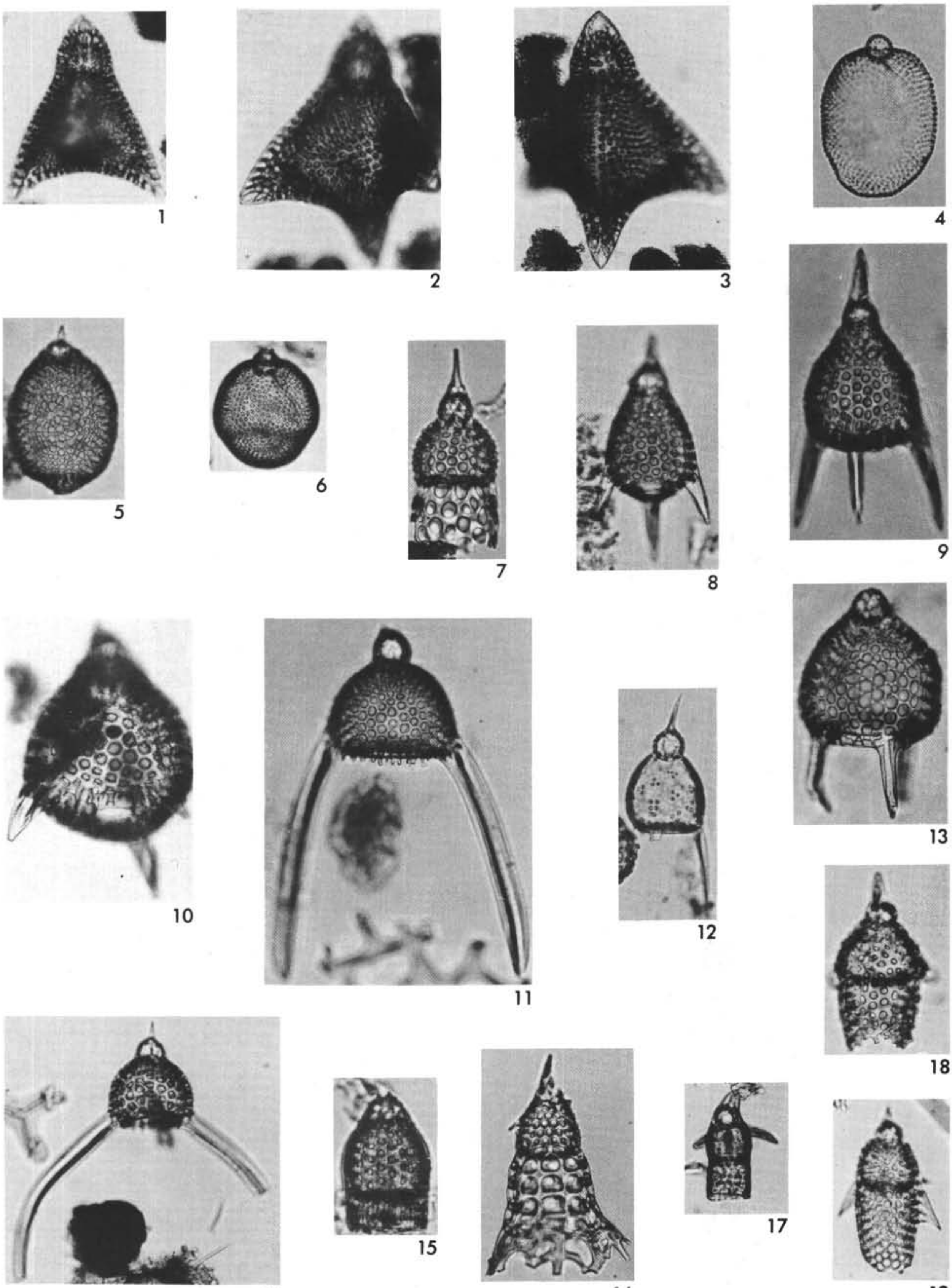

PLATE 11

(Magnification ×200 unless otherwise indicated)

Figures 1-3	*Rhopalocanium ornatum* Ehrenberg. 1. 291-4-3, 63-65 cm, R-1 (Y49/2). 2. 290-5-1, 102-104 cm, R-2 (026/0). 3. 291A-2, CC, R-2 (V22/1).
Figures 4-6	*Sethochytris triconiscus* Haeckel. 4, 5. 290A-1-2, 60-62 cm, R-1 (W44/2). 6. 291-4-4, 5-7 cm, R-2 (J39/0).
Figures 7, 8	*Stichocorys armata* (Haeckel). 7. 296-28, CC, R-1 (E9/1). 8. 296-30-2, 110-112 cm, R-2 (E42/1).
Figure 9	*Stichocorys delmontensis* (Campbell and Clark), 297-26, CC, R-1 (H13/2).
Figure 10	*Stichocorys wolfii* Haeckel, 296-30-4, 80-82 cm, R-1 (H32/0).
Figures 11, 12	*Theocorys anapographa* Riedel and Sanfilippo, 291-4-4, 5-7 cm, R-1 (040/3), ×250.
Figure 13	*Theocorys spongoconum* Kling, 292-30, CC, R-2 (D41/0).
Figure 14	*Theocotyle (Theocotyle) cryptocephala cryptocephala* (Ehrenberg), 291-3-1, 133-135 cm, R-2 (J49/0).
Figures 15, 16	*Thyrsocyrtis bromia* Ehrenberg. 15. 291-3, CC, R-2 (U17/0). 16. 291-3, CC, R-3 (X30/2).
Figure 17	*Thyrsocyrtis hirsuta hirsuta* (Krasheninnikov), 291A-1, CC, R-2 (E37/2).
Figure 18	*Thyrsocyrtis rhizodon* Ehrenberg, 291-4-3, 63-65 cm, R-3 (P20/0).
Figure 19	*Thyrsocyrtis tetracantha* (Ehrenberg), 291-3, CC, R-1 (D28/0).
Figure 20	*Thyrsocyrtis triacantha* Ehrenberg, 291-4-3, 63-65 cm, R-3 (P23/0).

PLATE 11

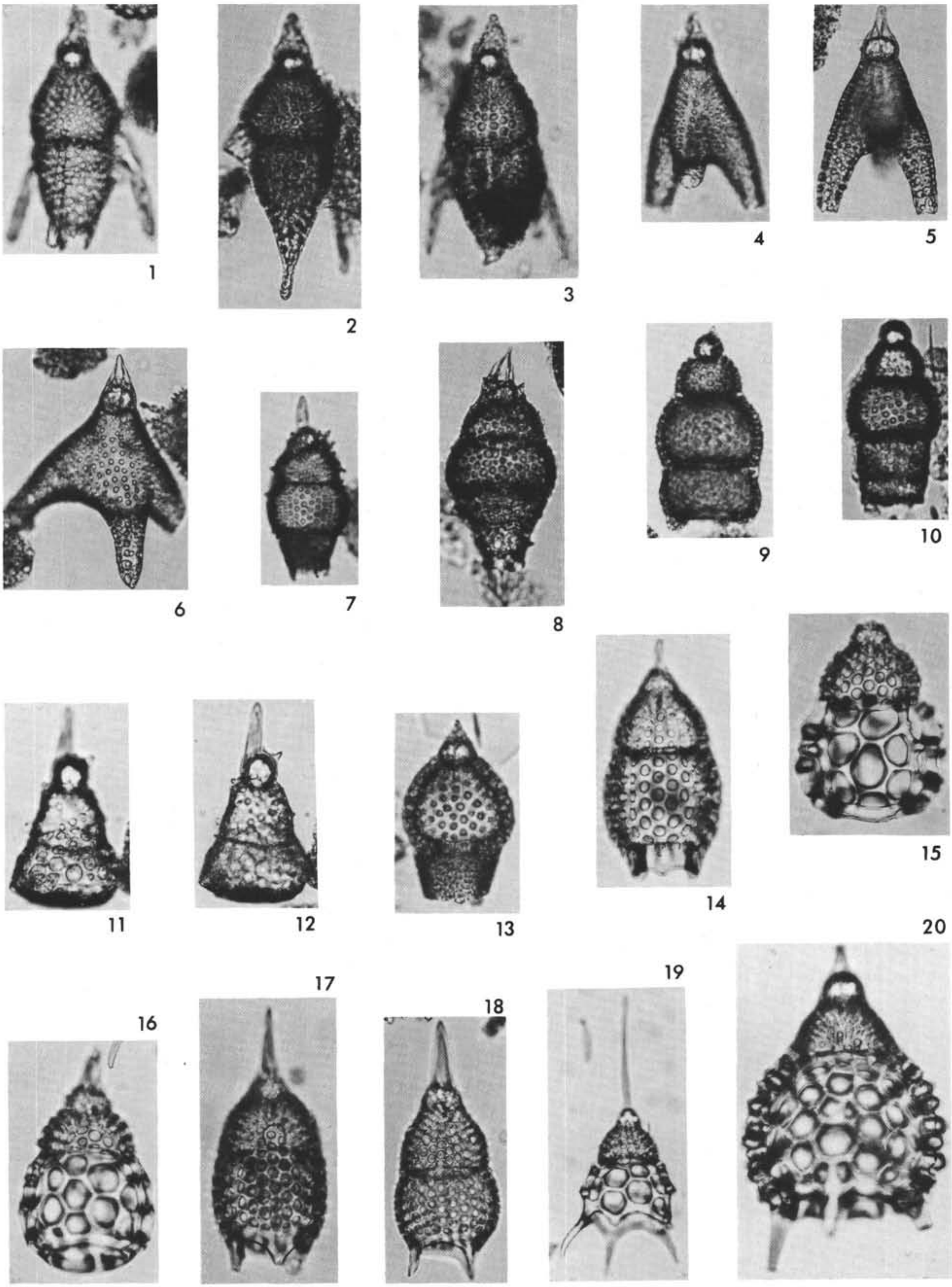

PLATE 12

(Magnification ×200 unless otherwise indicated)

Figures 1, 2	Theoperidae gen. A, 291-4-1, 68-70 cm, R-2 (Y30/2).
Figure 3	Carpocanistrum sp. A, 292-18, CC, R-2 (P14/4).
Figure 4	Carpocanistrum sp. B, 292-20, CC, R-2 (L25/0).
Figure 5	Carpocanistrum sp. C, 296-31-4, 38-40 cm, R-1 (G33/0), ×250.
Figure 6	Carpocanistrum sp. D, 297-4, CC, R-1 (Y17/4), ×250.
Figure 7	Carpocanopsis bramlettei Riedel and Sanfilippo, 296-28, CC, R-2 (Y32/1), ×250.
Figure 8	Carpocanopsis favosum (Haeckel), 296-29-6, 40-42 cm, R-1 (E27/0).
Figure 9	Calocycletta acanthocephala (Ehrenberg), 292-30-1, 90-92 cm, R-1 (H34/0).
Figures 10, 11	Calocycletta costata (Riedel). 10. 296-29, CC, R-1 (R6/3). 11. 296-29, CC, R-2 (S15/4).
Figure 12	Calocycletta robusta Moore, 296-36, CC, R-1 (J17/2).
Figures 13, 14	Calocycletta spp. 13. 292-29-1, 130-132 cm, R-1 (M29/0). 14. 292-32-1, 50-52 cm, R-1 (F40/2).
Figure 15	Cyclampterium (?) *milowi* Riedel and Sanfilippo, 292-27-1, 50-52 cm, R-1 (T15), ×115.
Figure 16	Eucyrtidium yatuoense Nakaseko, 296-30-4, 80-82 cm, R-1 (1/2).
Figure 17	Eucyrtidium sp. cf. *E. montiparum* Ehrenberg, 290A-1-1, 110-112 cm, R-1 (N27/2).
Figure 18	Eucyrtidium sp. cf. *E. panthera* Ehrenberg, 292-35-3, 115-117 cm, R-1 (G40/0), ×250.
Figure 19	Eucyrtidium sp. cf. *E.* "rocket," 292-31-2, 57-59 cm, R-1 (W51/2).
Figure 20	Eucyrtidium sp. A, 291A-3, CC, R-2 (W4/2).

PLATE 12

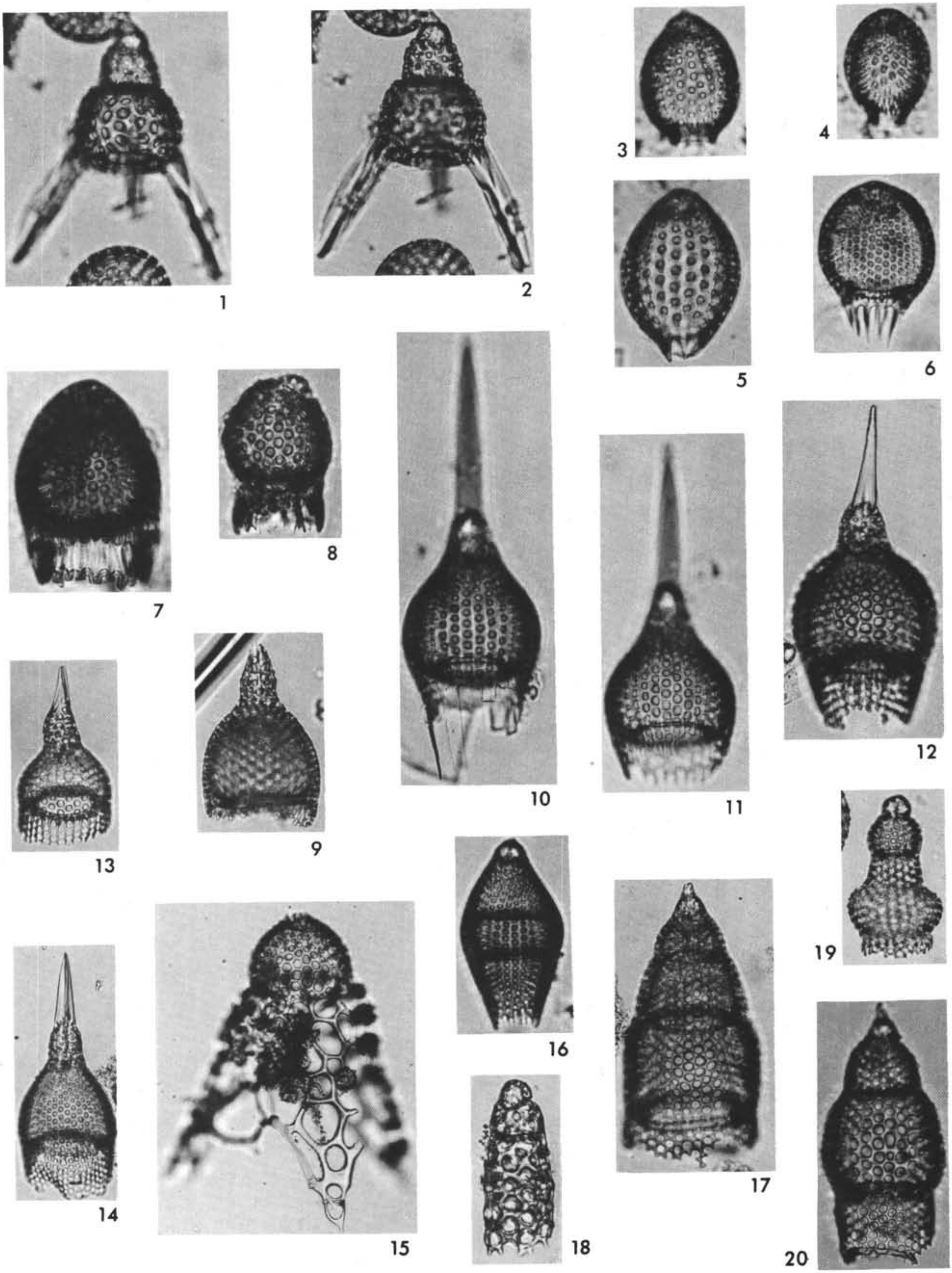

PLATE 13

(Magnification ×200 unless otherwise indicated)

Figure 1	Lamprocyclas maritalis maritalis Haeckel, 296-1, CC, R-2 (J40/0).
Figure 2	Lamprocyclas sp., 296-24, CC, R-2 (J40/4).
Figures 3, 4	Podocyrtis (Lampterium) mitra Ehrenberg. 3. 294-4-4, 30-32 cm, R-2 (X49/3). 4. 291-4-3, 63-65 cm, R-2 (U45/0).
Figure 5	Podocyrtis (Podocyrtis) papalis Ehrenberg, 291-4-1, 68-70 cm, R-1 (G39/4).
Figure 6	Theocyrtis annosa (Riedel), 292-24, CC, R-2 (M8/2).
Figure 7	Theocyrtis tuberosa Riedel, 202-29, CC, R-1 (M8/2).
Figure 8	Artostrobus annulatus (Bailey), 302-13, CC, R-2 (024/0), ×250.
Figure 9	Dicolocapsa microcephala Haeckel, 292-26, CC, R02 (E27/0).
Figure 10	Dictyocryphalus papillosus (Ehrenberg), 302-13, CC, R-2 (N17/0), ×250.
Figure 11	Lithomitra arachnea (Ehrenberg), 292-28, CC, R-1 (N5/0), ×250.
Figure 12	Lithomitra sp. cf. *L. elizabethae* Clark and Campbell, 292-28, CC, R-1 (E41/1), ×250.
Figure 13	Phormostichoartus corona Haeckel, 296-29, CC, R-2 (W29/1).
Figure 14	Theocampe amphora (Haeckel) group, 292-35-2, 115-117 cm, R-1 (M10/4).
Figure 15	Theocampe armadillo (Ehrenberg) group, 290-3, CC, R-1 (D23/0).
Figures 16, 17	Theocampe mongolfieri (Ehrenberg). 16. 290-6, CC, R-1 (J17/0). 17. 291A-3, CC, R-2 (W3/1).
Figure 18	Theocampe pirum (Ehrenberg), 292-32-1, 50-52, R-1 (L46/0).
Figure 19	Botryocyrtis scutum (Harting), 297-2, CC, R-1 (R40/0), ×250.
Figures 20, 21	Botryopyle dictyocephalus Haeckel group. 20. 292-30, CC, R-1 (H41/1). 21. 297-2, CC, R-1 (X42/3), ×250.
Figures 22, 23	Centrobotrys thermophila Petrushevskaya. 22. 292-31, CC, R-2 (V39/0). 23. 292-23-1, 50-52 cm, R-1 (T15/4), ×250.
Figure 24	Borgetella caudata (Wallich), 299-10-2, 1-3 cm, R-1 (K9/4), ×500.
Figure 25	Euphysetta sp. cf. *E. nathorstii* Cleve, 297-2-1, 110-112 cm, L-2 (T23/3), ×250.
Figures 26, 27	Euphysetta sp., 302-3-6, 128-130 cm, R-1 (E9/4), ×250.
Figure 28	Lirella baieyi Ehrenberg, 296-1, CC, L-2 (T20/1), ×500.
Figure 29	Lirella bullata (Stadum and Ling), 299-11-2, 30-32 cm, L-2 (C5/0), ×500.

PLATE 13