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21. RADIOLARIANS FROM SEDIMENTS OF THE IZU-BONIN REGION, LEG 126[1]

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ABSTRACT

Radiolarians occur at five Leg 126 sites. Well-preserved radiolarians were recovered from Miocene and Pliocene through Holocene sections. The results of this study may help to fill the informational gap on Quaternary radiolarian distribution at mid-latitudes in the western Pacific. Radiolarian preservation is discontinuous, and, although present in Oligocene sections, specimens are poorly preserved.

INTRODUCTION

Siliceous microorganisms are abundant in Quaternary sediments from sites drilled during Ocean Drilling Program (ODP) Leg 126, and their abundance may be related to the availability of silica associated with arc volcanism. Several species that are important for detailed resolution of biostratigraphy in equatorial regions are not present in mid-latitude sediments from the Izu-Bonin region. Leg 126 data will help to fill the informational gap on Quaternary radiolarian distribution at mid-latitudes in the western Pacific.

Moderately well-preserved radiolarian assemblages were recovered from Miocene sections in the Izu-Bonin forearc. Below the Miocene sections, although radiolarians are often abundant, specimens have typically experienced significant dissolution and are not preserved well enough for biostratigraphic analysis.

MATERIAL

Radiolarians were recovered at Sites 787, 790, 791, 792, and 793. Preservation and abundance are generally good in the Quaternary sections of all sites. Although radiolarians are abundant in some Miocene and Oligocene sections, they are generally poorly preserved.

Site 787 (32°22.51′N, 140°44.64′E, 3259 m water depth) is located on the eastern edge of the Izu-Bonin forearc sedimentary basin, about 95 km east of the arc volcano Aoga Shima and 135 km west of the axis of the Izu-Bonin Trench (Fig. 1). Quaternary sediments from Site 787 contain abundant radiolarians, with the exception of rare, poorly preserved specimens in Core 126-787B-13R. Identifiable radiolarians are absent below Core 126-787B-5R, although infilled and highly corroded radiolarian ghosts were frequently observed.

Sites 790 (30°54.96′N, 139°50.66′E, 2223 m water depth) and 791 (30°54.97′N, 139°52.50′E, 2268 m water depth) are located near the center of Sumisu Rift, a backarc graben west of the Izu-Bonin island-arc-volcanoes Sumisu Jima and Tori Shima (Fig. 1). Well-preserved radiolarians occur in many samples from Sites 790/791 and have a late Pliocene to Holocene age range. The abundance of radiolarians is variable and they are often diluted by volcanic ash.

Site 792 (32°23.96′N, 140°22.80′E, 1787 m water depth) is located on the western half of the Izu-Bonin forearc sedimentary basin, about 60 km east of the arc-volcano Aoga Shima and 170 km west of the axis of the Izu-Bonin Trench (Fig. 1). Radiolarians are common to abundant and generally well preserved in Miocene to Quaternary sections of holes drilled at Site 792.

Site 793 (31°06.33′N, 140°53.27′E, 2964 m water depth) is located in the center of the Izu-Bonin forearc sedimentary basin, about 70 km east of the volcanic front between the islands of Sumisu Jima and Tori Shima and 125 km west of the axis of the Izu-Bonin Trench (Fig. 1). All core-catcher samples from Hole 793A were examined. Quaternary radiolarians are present in all samples except Samples 126-793A-2H-CC and -8H-CC. The occurrence of *Druppatractus acquilonius* in and below Sample 126-793A-3H, 0 cm, indicates an age >300 k.y. for samples at and below this level (Foreman, 1981). Rare, moderately preserved radiolarians are present in samples from Hole 793B in Sample 126-793B-2R-CC and Samples 126-793B-4R-CC through -8R-CC. No identifiable faunas were found in, or below, Sample 126-793B-9R-CC. Radiolarians are present in many samples but are typically infilled and have suffered considerable dissolution.

METHODS

Samples were taken at least every section. Because of the high sedimentation rates and the absence of important equatorial biostratigraphic index species in these mid-latitude sediments, core-catcher samples only were examined at most sites. More detailed examinations, as closely spaced as three per section, were conducted in the vicinity of particular radiolarian events to describe and compare the sites adequately. To obtain clean radiolarian concentrates for microscopic examination, sediments were disaggregated and sieved to remove the clay-silt fraction. A 5-cm^3 sample was placed in a 400-cm^3 beaker containing 150 ml of a 10% solution of hydrogen peroxide and a small amount of calgon (to aid in disaggregating the sediment). If calcareous components were evident, they were dissolved by adding hydrochloric acid. The residue was sieved through a 63-μm sieve, and the remaining siliceous microfossils were pipetted evenly onto labeled glass slides. The accompanying water was then evaporated under a heat lamp, after which the remaining residue was mounted using Norland Optical Adhesive and covered with a 22 ×50 mm cover slip. Two slides were prepared and examined for each sample. Qualitative assessments of the radiolarians in each slide were recorded for abundance and preservation using the following terms: C = common, F = few, R = rare, and B = barren for abundance; and G = good, M = moderate, and P = poor for preservation.

BIOSTRATIGRAPHIC FRAMEWORK

The Cenozoic radiolarian zonation of Sanfilippo et al. (1985), derived for the tropical equatorial Pacific, was used at all sites. Sanfilippo et al. (1985) summarized the taxonomy and evolutionary lineages of all stratigraphically important radiolarian taxa commonly found in low-latitude regions of this zonation. In suggesting tentative "absolute" ages for radiolarian datum levels and zonal boundaries, the schemes of Nigrini (1985) and Barron et al. (1985), established on the basis of Deep Sea Drilling Project (DSDP) Leg 85 sites in the equatorial Pacific, were followed. Quaternary biostratigraphic data listed by Foreman (1981) were also used. Although much of the

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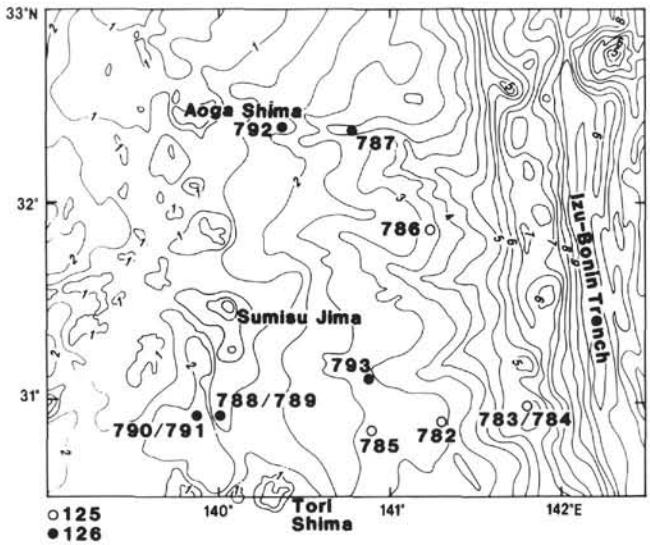

Figure 1. Leg 126 site location map. Bathymetric contours are given every 0.5 km but are only labeled every 1 km.

material obtained on Leg 85 could not be directly dated paleomagnetically, there were sufficient duplicate sites in which all major microfossil events could be identified, some of which had been correlated to the polarity time scale in nearby piston cores. Thus, the ages of Pacific radiolarian events estimated by Foreman (1981), Nigrini (1985), and Barron et al. (1985) are considered to provide a satisfactory working model.

RESULTS

Site 787

Radiolarians are abundant in Quaternary sediments from Site 787. An abundant and well-preserved radiolarian assemblage was recovered from Samples 126-787B-1R-CC through -3R-CC (Table 1). This assemblage contains *Lamprocyclas maritalis, Anthocyrtidium angulare, Axoprunum angelinum, Theocorythium trachelium,* and *Eucyrtidium calvertense* and is typical of the *Anthocyrtidium angulare* Zone of the lower Pleistocene. Younger calcareous nannofossils in these samples indicate possible reworking of radiolarians from slightly older sediments. Sample 126-787B-5R-CC contains a radiolarian assemblage that is diluted by volcanogenic debris. The assemblage includes *Diartus hughesi.* The occurrence of this species in the assemblage allows assignment to the *Didymocyrtis antepenultima* Zone in the upper Miocene.

Below Core 126-787B-5R, infilled and highly corroded radiolarian ghosts were frequently observed; however, with the exception of rare, poorly preserved specimens in Core 126-787B-13R identifiable radiolarians were not seen. A single identifiable specimen *Lithocyclia angusta* was recovered from Sample 126-787B-13R. The specimen is poorly preserved but permits tentative assignment to the *Dorcadospyris ateuchus* Zone of the upper Oligocene.

Sites 790/791

Well-preserved radiolarians occur in many samples from Sites 790/791 and are of late Pliocene to Holocene age (Tables 2–6). The abundance of radiolarians is variable, and they are often diluted by volcanic ash. Preservation is generally good. A diverse radiolarian assemblage that includes *Didymocyrtis tetrathalamus, Lamprocyclas maritalis maritalis, Theocorythium trachelium dianae, Botryostrobus auritus/australis* group, *Amphirhopalum ypsilon, Stylochlamydium asteriscus, Eucyrtidium* spp., *Tetrapyle octacantha,* and *Spongaster tetras tetras* occur in samples from throughout all holes drilled at Sites 790/791. The common occurrence of *Theocorythium trachelium dianae* indicates a maximum late Pliocene age. Specimens of *Druppatractus acquilonius* occur in Sample 126-790C-12X-CC and in samples below this level. This species was also observed at Site 791 in and below Sample 126-791B-17R-CC. The occurrence of *Druppatractus acquilonius* indicates an age >0.3 Ma (Foreman, 1981) for samples deeper than 184.2 mbsf at Site 790 and more than 540.9 mbsf at Site 791. Specimens of *Axoprunum angelinum* occur in Sample 126-790C-15X-CC. This species was first observed downhole at Site 791 in Sample 126-791B-24R-CC. The last occurrence of *Axoprunum angelinum* was at 0.41 Ma (Foreman, 1981), and its presence indicates an age greater than this for samples below 213.2 mbsf at Site 790 and below 608.4 mbsf at Site 791. More precise dating using radiolarians was not possible as published Quaternary zonations are based on the occurrence of rare equatorial forms (Sanfilippo et al., 1985) that were not observed at Sites 790/791, which are at middle latitudes.

Radiolarians are generally common to abundant in the samples examined except where diluted by volcanic ash. Preservation is typically moderate to good. Two radiolarian datums were recognized: the last appearance of *Druppatractus acquilonius,* at 300 Ka and the last appearance of *Axoprunum angelinum* about 410 Ka (Foreman, 1981). Diatoms and silicoflagellates are also common in many samples.

Site 792

Radiolarians are common to abundant and generally well preserved in Miocene to Quaternary sections of holes drilled at Site 792 (Tables 7–11). Radiolarians from Hole 792A occur in Samples 126-792A-1H-CC, -3H-CC, -4H-CC, -5H-CC, and -9H-CC. Moderately diverse, well-preserved faunas are present and indicate a Quaternary age. The faunas present typically include *Didymocyrtis tetrathalamus, Lamprocyclas maritalis, Botryostrobus auritus/australis* group, *Amphirhopalum ypsilon,* and *Spongaster tetras.* The occurrence of *Druppatractus acquilonius* in Sample 126-792A-5H-CC and *Axoprunum angelinum* in Sample 126-792A-9H-CC provides minimum age constraints of 0.3 and 0.41 Ma for samples at and below these levels (Foreman, 1981).

Moderately diverse, well-preserved radiolarian faunas are present in core-catcher samples from all cores of Hole 792B except for Samples 126-792B4X-CC, -8X-CC, and -10X-CC. The occurrence of faunas including *Tetrapyle octacantha, Didymocyrtis tetrathalamus,* and *Spongaster tetras* suggest a late Pliocene to Holocene age. Upper Pliocene to Holocene radiolarians are common and well preserved in Sample 126-792C-1X-CC from Hole 792C. In Hole 792D, Sample 126-792D-1X-CC contains abundant, well-preserved radiolarians. The co-occurrence of *Spongaster tetras* and *Spongaster pentas* in this sample suggests assignment to the upper part of the upper Pliocene *Spongaster pentas* Zone of Sanfilippo et al. (1985).

Well-preserved lower Miocene to upper Pliocene radiolarians are common in the upper half of Hole 792E. All samples from below the level of Sample 126-792E-28R-2, 20–21 cm, are devoid of identifiable radiolarians. However, extremely poorly preserved, infilled radiolarians occur in Sample 126-792E-30R-CC and were also observed sporadically below this sample. Samples 126-792E-1R-1, 2–3 cm, through -5R-1, 19–20 cm, contain an assemblage that includes *Druppatractus acquilonius, Amphirhopalum ypsilon, Spongaster tetras, S. pentas, Pterocanium prismatium,* and *Stichocorys peregrina.* The presence of *Amphirhopalum ypsilon* in these samples indicates an age <3.78 Ma (Backman et al., 1988) and that of *Spongaster tetras* an age of <3.8 Ma (Backman et al., 1988). The occurrence of *Spongaster pentas* together with *Didymocyrtis avita* in Sample 126-792E-2R-1, 5–6 cm, suggests assignment to the *Spongaster pentas* Zone of Pliocene age (Sanfilippo et al., 1985). No diagnostic radiolarians were recovered between Sample 126-792E-5R-1, 19–20 cm, and Sample 126-792E-9R-1, 21–22 cm. Sample

Table 1. Radiolarians at Hole 787B.

Epoch	Radiolarian zone	Core, section, interval (cm)	Abundance	Preservation	*Anthocyrtidium angulare*	*Axoprunum angelinum*	*Diartus hughesi*	*Eucyrtidium calvertense*	*Lamprocyclas maritalis maritalis*	*Lithocyclia angusta*	*Theocorythium trachelium dianae*
early Pleistocene	*Anthocyrtidium angulare*	1R-CC	C	G	R				R		F
		2R-CC	C	G		F		F	R		R
		3R-CC	R	C		R					R
		4R-CC	B								
late Miocene	*Didymocyrtis antepenultima*	5R-CC	R	G			R				
		6R-CC	B								
		7R-CC	B								
		8R-CC	B								
		9R-CC	B								
		10R-CC	B								
		11R-CC	B								
late Oligocene	*Dorcadospyris ateuchus*	12R-CC	B								
		13R-CC	C	P						R	

Note: Shaded area represents zone barren of identifiable radiolarians.

Table 2. Radiolarians at Hole 790A.

Core, section, interval (cm)	Abundance	Preservation	*Dictyocoryne profunda*	*Didymocyrtis tetrathalamus*	*Euchitonia furcata*	*Hexacontium enthacanthum*	*Hymeniastrum euclidis*	*Lamprocyclas maritalis maritalis*	*Lamprocyrtis nigriniae*	*Lithopera bacca*	*Pterocanium praetextum eucolpum*	*Spongaster* ?	*Stylochlamydium asteriscus*	*Theocorythium trachelium dianae*
1H-1,12-13	C	G		F	F		F	F	F	R	F		F	F
1H-2,61-62	R	G										R		
1H-CC	R	G				R								
2H-2,90-91	R	G	R											
2H-CC	R	G										R		
3H-CC	R	G							R					
4H-CC	R	G										R		

Table 3. Radiolarians at Hole 790B.

Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Botryostrobus aurita/australis* group	*Carpocanistrum* ?	*Didymocyrtis tetrathalamus*	*Eucyrtidium* ?	*Hexacontium enthacanthum*	*Lamprocyclas maritalis maritalis*	*Lithopera bacca*	*Spongaster tetras*	*Stylatractus* ?	*Stylochlamydium asteriscus*	*Stylodictya validispina*	*Theocorythium trachelium dianae*
1H-CC	R	G									R				
2H-CC	R	G									R				
3H-CC	R	G			R										R
4H-CC	R	G									R				
5H-CC	R	G													R
6H-CC	R	G									R				
7H-CC	C	G	F	F			F		F	R			R	F	F
8H-3,103-104	C	G	F	F		R	F	R	F		R	R	R		R
8H-CC	F	G												R	
9H-CC	R	G									R				
10H-CC	C	G	F	F		F	F				R	R			
11H-CC	R	G									R				
15X-CC	R	G									R				

126-792E-9R-1, 21–22 cm, contains *Stichocorys delmontensis* and is therefore no younger than upper Miocene (6.4 Ma; Backman et al., 1988). This sample was tentatively assigned to the *Didymocyrtis penultima* Zone of Sanfilippo et al. (1985). Samples 126-792E-15R-CC through -22R-CC contain an upper middle Miocene fauna that includes *Stichocorys delmontensis, Cyrtocapsella japonica,* and *Didymocyrtis laticonus.* The presence of *Didymocyrtis laticonus* suggests assignment to the upper middle Miocene *Diartus petterssoni* Zone of Sanfilippo et al. (1985).

Stichocorys wolffii occurs in and below Sample 126-792E-18R-CC. The last occurrence (LO) of this species is in the latest middle Miocene at 11.6 Ma (Nigrini, 1985). Both *Stichocorys wolffii* and *Cyrtocapsella japonica* occur in Sample 126-792E-23R-CC. *Didymocyrtis laticonus,* which is common at levels above this sample, is absent, which suggests assignment to the lower middle Miocene *Dorcadospyris alata* Zone of Sanfilippo et al. (1985).

Samples 126-792E-24R-CC through -27R-CC are barren of radiolarians. Sample 126-792E-28R-2, 20–21 cm, contains one identifiable species, *Cyrtocapsella japonica,* which allows the assignment of a Miocene age. This species is known to occur in the *Cyrtocapsella tetrapera* through *Diartus petterssoni* zones (Nigrini and Lombari, 1984). No identifiable radiolarians were recovered from below Sample 126-792E-28R-2, 20–21 cm.

Table 4. Radiolarians at Hole 790C.

Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Axoprunum angelinum*	*Botryostrobus auritus/australis* group	*Carpocanistrum* ?	*Didymocyrtis tetrathalamus*	*Druppatractus acquilonius*	*Euchitonia elegans*	*Hexacontium laevigatum*	*Lamprocyclas maritalis maritalis*	*Lithopera bacca*	*Peripyramis circumtexta*	*Plectopyramis dodecomma*	*Spongaster* ?	*Spongaster tetras*	*Spongaster tetras irregularis*	*Spongaster tetras tetras*	*Stylochlamydium asteriscus*	*Tetrapyle octacantha*	*Theocorythium trachelium dianae*
2H-CC	R	M													R						
3H-CC	R	G					F									F			F		
4H-CC	B																				
5H-CC	R	G					R												R		
6H-CC	C	G	R		F		R		R		F								F		F
7H-CC	R	G																		R	
8H-CC	B																				
10X-CC	F	G																	F		F
11X-CC	C	G	F																R		R
12X-CC	C	G	F			R		R			F										R
13X-CC	C	G	F		R		F			R	F	R			R				F	R	F
14X-CC	C	M			R	F	F							R					F		
15X-CC	C	M	R	R		F	R				F	R	R				R	F	F		
16X-CC	R	M	R		R		F						R								
17X-CC	R	M									R										
18X-CC	C	G	F	F			R				F										R
19X-CC	R	G													R						
20X-CC	R	P													R						
24X-CC	B																				
27X-CC	B																				

Site 793

All core-catcher samples from Hole 793A were examined. Quaternary radiolarians are present in all samples except Samples 126-793A-2H-CC and -8H-CC (Tables 12 and 13). The occurrence of *Druppatractus aquilonius* in and below Sample 126-793A-3H, 0 cm, indicates an age of >300 k.y. for samples at and below this level (Foreman, 1981).

Rare, moderately preserved radiolarians are present in samples from Hole 793B in Sample 126-793B-2R-CC and Samples 126-793B-4R-CC through -8R-CC. The presence of *Cyrtocapsella tetrapera* and *Stichocorys wolffii* in these samples suggests assignment to the upper lower to lower middle Miocene *Calocycletta costata* or *Didymocyrtis alata* zones. No identifiable faunas were found in, or below, Sample 126-793B-9R-CC. Radiolarians are present in many samples but are typically infilled and have suffered considerable dissolution.

CONCLUSION

Radiolarians were recovered from Miocene to Quaternary sections drilled on Leg 126. They provide important data that will help fill an informational gap in the radiolarian distribution at mid-latitudes in the western Pacific. Radiolarian preservation is discontinuous; and, although present in abundance in some Oligocene sections, specimens are poorly preserved. This is probably a result of partial dissolution of radiolarian tests during diagenesis.

SPECIES LIST

Detailed original descriptions of the radiolarian species identified in samples from various Leg 126 sites have already been presented. Therefore, the following list simply provides a bibliographic reference for the species in this paper. In most cases, only the reference containing the original description is presented, except where this description differs from present consensus or has been revised. The species are listed in alphabetical order.

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

Androcyclas gamphonycha (Jørgensen)
Pterocorys gamphonyxos Jørgensen, 1899, p. 86
P. theoconus Jørgensen, *P. ambycephalis* Jørgensen 1899, p. 86
Androcyclas gamphonycha (Jørgensen, 1905, p. 139, pl. XVIII, figs. 92–97; Hays, 1965, p. 178, pl. III, fig. 2

Anomalacantha dentata (Mast)
Heteracantha dentata Mast, 1910, p. 157; Nigrini, 1970, p. 167, pl. 1, fig. 9
Cladococcus lychnosphaera Hollande and Enjumet, 1960, p. 115, pl. 55, figs. 1–2
Anomalacantha dentata (Mast), in Benson, 1966, p. 170, pl. 5, figs. 10–11

Anthocyrtidium angulare Nigrini
Anthocyrtidium angulare Nigrini, 1971, p. 445, pl. 34.1, figs. 3a–3b

Table 5. Radiolarians at Hole 791A.

Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Carpocanistrum ?*	*Didymocyrtis tetrathalamus*	*Eucyrtidium*	*Lamprocyclas maritalis maritalis*	*Spongaster ?*	*Spongaster tetras*	*Spongaster tetras tetras*	*Spongocore puella*	*Stylochlamydium asteriscus*	*Tetrapyle octacantha*	*Theocorythium trachelium dianae*
2H-CC	R	M						R				R	R	
3H-CC	R	M						R						
4H-CC	R	M								R		F		
5H-CC	R	P						R						
6H-CC	R	P						R						
7H-CC	F	M				F							R	
8H-CC	B													
9H-CC	B													
10H-CC	B													
11H-CC	B													
12H-CC	R	P							R					
14H-CC	B													
15H-CC	R	P						R						
16H-CC	R	P				R	R					F		R
17H-CC	R	P						R						
18H-CC	B													
19H-CC	R	P						R						
20H-CC	B													
21R-CC	R	P						R						
22R-CC	F	M								R				
23H-CC	B													
25X-CC	B													
28X-CC	B													
30X-CC	B													
31X-CC	F	M	R				R				R	F		
32X-CC	C	M	R			R				R	R	R		
33X-CC	B													
34X-CC	B													
35X-CC	F	M				R						R		
38X-CC	C	M	R	R	R	R						R		R
39X-CC	B													
40X-CC	R	P						R						
41X-CC	R	M						R						
42X-CC	B													
46X-CC	R	P							R					

Anthocyrtidium ophirense (Ehrenberg)
Anthocyrtis ophirensis Ehrenberg, 1872, p. 301; Haeckel, 1887, p. 1270
Anthocyrtidium ophirense (Ehrenberg), in Nigrini, 1967, p. 56, pl. 6, fig. 3

Anthocyrtidium zanguebaricum (Ehrenberg)
Anthocyrtis zanguebarica Ehrenberg, 1872, p. 301
Anthocyrtidium zanguebaricum (Ehrenberg), in Nigrini, 1967, p. 58, pl. 6, fig. 4

Axoprunum angelinum (Campbell and Clark)
Stylosphaera angelina Campbell and Clark, 1944, p. 12, pl. 1, figs. 14–20
Axoprunum angelinum (Campbell and Clark), in Kling, 1973, p. 634

Botryostrobus auritus/australis (Ehrenberg) group
Lithocampe aurita Ehrenberg, 1844a, p. 84
Lithocampe australe Ehrenberg, 1844b, p. 187
Lithostrobus seriatus Haeckel, 1887, p. 1474, pl. 79, fig. 15; Petrushevskaya, 1967, p. 145, pl. 82, figs. I–IV; 1971, pl. 24, figs. 6–8
Botryostrobus auritus/australis (Ehrenberg) group Nigrini, 1977, p. 246, pl. 1, figs. 2–5

Carpocanopsis bramlettei Riedel and Sanfilippo
Cycladophora favosa Haeckel, in Riedel, 1954, pl. 1, fig. 3
Carpocanopsis bramlettei Riedel and Sanfilippo, 1971, p. 1597, pl. 2G, figs. 8–14; pl. 8, fig. 7

Carpocanopsis favosa (Haeckel)
Cycladophora favosa Haeckel, 1887, p. 1380, pl. 62, figs. 5–6
Carpocanopsis favosum (Haeckel), in Riedel and Sanfilippo, 1971, p. 1597, pl. 2G, figs. 15–16; pl. 8, figs. 9–10
Carpocanopsis favosa (Haeckel), in Sanfilippo and Riedel, 1973, p. 531

Cenosphaera cristata Haeckel
Cenosphaera cristata Haeckel 1887, p. 66, in Riedel, 1958, p. 223, pl. 1, figs. 1–2
Cenosphaera cristata Haeckel?, in Nigrini and Moore, 1979, p. S41, pl. 4, figs. 2a–2b

Cornutella profunda Ehrenberg
Cornutella clathrata ß *profunda* Ehrenberg, 1854, p. 241
Cornutella profunda Ehrenberg, Riedel, 1958, p. 232, pl. 3, figs. 1–2
Cornutella profunda Ehrenberg, in Nigrini, 1967, p. 60, pl. 6, figs. 5a–5c

Cyrtocapsella japonica (Nakaseko)
Eusyringium japonicum Nakaseko, 1963, p. 193, pl. 4, figs. 1–3
Cyrtocapsella japonica (Nakaseko), in Sanfilippo and Riedel, 1970, p. 452, pl. 1, figs. 13–15

Cyrtocapsella tetrapera (Haeckel)
Cyrtocapsa tetrapera Haeckel, 1887, p. 1512, pl. 78, fig. 5
Cyrtocapsella tetrapera (Haeckel), in Sanfilippo and Riedel, 1970, p. 453, pl. 1, figs. 16–18

Diartus hughesi (Campbell and Clark)
Ommatocampe hughesi Campbell and Clark, 1944, p. 23, pl. 3, fig. 12
Diartus hughesi (Campbell and Clark), in Sanfilippo and Riedel, 1980, p. 1010

Dictyocoryne profunda Ehrenberg
Dictyocoryne profunda Ehrenberg, 1860a, p. 767

Dictyocoryne truncatum (Ehrenberg)
Rhopalodictyum truncatum Ehrenberg, 1860b, p. 301; Haeckel, 1887, p. 589
Dictyocoryne cf. *truncatum* (Ehrenberg), in Benson, 1966, p. 235, pl. 15, fig. 1

Dictyophimus hirundo (Haeckel) group
Pterocorys hirundo Haeckel, 1887, p. 1318, pl. 71, fig. 4; Riedel, 1958, p. 238, pl. 3, fig. 11; pl. 4, fig. 1; text-fig. 9

Didymocyrtis avita (Riedel)
Panartus avitus Riedel, 1953, p. 808, pl. 84, fig. 7
Ommatartus avitus (Riedel), in Riedel and Sanfilippo, 1971, p. 1588
Didymocyrtis avita (Riedel), in Sanfilippo and Riedel, 1980, p. 1010

Didymocyrtis laticonus (Riedel)
Cannartus laticonus Riedel, 1959, pl. 291, pl. 1, fig. 5
Didymocyrtis laticonus (Riedel), in Sanfilippo and Riedel, 1980, p. 1010

Didymocyrtis tetrathalamus (Haeckel)
Panartus tetrathalamus Haeckel, 1887, p. 378, pl. 40, fig. 3
Ommatartus tetrathalamus (Haeckel), in Riedel and Sanfilippo, 1971, p. 1588
Didymocyrtis tetrathalamus (Haeckel), in Sanfilippo and Riedel, 1980, p. 1010

Druppatractus acquilonius Hays
Druppatractus acquilonius Hays, 1970, p. 214, pl. 1, figs. 4 and 5
Stylacontarium acquilonium (Hays), in Kling, 1973, p. 634; Ling, 1973, p. 777, pl. 1, figs. 6 and 7

Euchitonia elegans (Ehrenberg)
Pteractis elegans Ehrenberg, 1872, p. 319
Euchitonia elegans (Ehrenberg), in Nigrini, 1967, p. 39, pl. 4, figs. 2a–2b

Euchitonia furcata Ehrenberg
Euchitonia furcata Ehrenberg, 1872, p. 308

Eucyrtidium acuminatum (Ehrenberg)
Lithocampe acuminatum Ehrenberg, 1844a, p. 84
Eucyrtidium acuminatum (Ehrenberg), Nigrini, 1967, p. 81, pl. 8, figs. 3a–3b

Eucyrtidium calvertense Martin
Eucyrtidium calvertense Martin, in Kling, 1973, pl. 4, figs. 16 and 18–19; pl. 11, figs. 1–5

Eucyrtidium hexagonatum Haeckel
Eucyrtidium hexagonatum Haeckel, 1887, p. 1489, pl. 80, fig. 11

Table 6. Radiolarians at Hole 791B.

Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Axoprunum angelinum*	*Botryostrobus auritus/australis* group	*Carpocanistrum ?*	*Dictyophimus hirundo* group	*Dictyocoryne truncatum*	*Didymocyrtis tetrathalamus*	*Druppatractus acquilonius*	*Euchitonia furcata*	*Eucyrtidium ?*	*Hymeniastrum euclidis*	*Lamprocyclas maritalis maritalis*	*Peripyramis circumtexta*	*Plectopyramis dodecomma*	*Pterocanium praetextum*	*Spongaster ?*	*Spongaster tetras*	*Spongaster tetras tetras*	*Spongocore puella*	*Stylochlamydium asteriscus*	*Tetrapyle octacantha*	*Theocorythium trachelium dianae*
9R-CC	R	M									R	R												
10R-CC	C	M										R			R								R	
11R-CC	B																							
13R-CC	C	M	F						R			R			R							F	R	
15R-CC	B																							
16R-CC	R	P																R						
17R-CC	R	M								R									R					
18R-CC	R	P																R						
20R-CC	C	M	F		R			R		R	R	F								F			F	
21R-CC	C	M	F			F				R		F							F			F	R	
22R-CC	C	M	R		R	F						F												
23R-CC	C	M										R					R		F				R	
24R-CC	F	M	F	R																F				
25R-CC	F	M			R	F						R						F						
26R-CC	F	M																	R					
27R-CC	R	M																	R					
28R-CC	F	G	R		R							F		R		R				F	R		R	
29R-CC	R	M																R						
30R-CC	F	M		F								R	R					F				R		
31R-CC	C	M	R		R			R				R								F			R	R
32R-CC	R	P																						
33R-CC	F	P	R			F												R						
34R-CC	F	M	R		R	F						R												
35R-CC	R	P																						
36R-CC	R	M				F						R		R				F						
37R-CC	C	G	F		R	F	R					F								F				
38R-CC	C	M	F	R		F			R			F		R						F			F	
39R-CC	C	G	F	R		F														F			R	
40R-CC	C	M	R	R		R			R			R								F				
41R-CC	F	M										R								R				
42R-CC	C	M	R	R	F	F														F				
43R-CC	R	M				R												R						
44R-CC	R	M																R						
45R-CC	R	M										R						R						
46R-CC	R	P																						

Heliodiscus asteriscus Haeckel
Heliodiscus asteriscus Haeckel, 1887, p. 445, pl. 33, fig. 8

Hexacontium enthacanthum Jørgensen
Hexacontium enthacanthus Jørgensen, 1899, p. 52, pl. 2, fig. 14; pl. 4, fig. 20
Hexacontium enthacanthum Jørgensen, in Benson, 1966, p. 149, pl. 3, figs. 13–14; pl. 4, figs. 1–3

Hexacontium laevigatum Haeckel
Hexacontium laevigatum Haeckel, 1887 p. 193, pl. 24, fig. 6

Hymeniastrum euclidis Haeckel
Hymeniastrum euclidis Haeckel, 1887, p. 531, pl. 43, fig. 13

Lamprocyclas maritalis maritalis Haeckel
Lamprocyclas maritalis Haeckel, 1887, p. 1390, pl. 74, figs. 13–14
Lamprocyclas maritalis maritalis Haeckel, in Nigrini, 1967, p. 74–76, pl. 7, fig. 5

Lamprocyrtis hannai (Campbell and Clark)
Calocyclas hannai Campbell and Clark, 1944, p. 48, pl. 6, figs. 21–22
Lamprocyrtis (?) *hannai* (Campbell and Clark), in Kling, 1973, p. 638, pl. 5, figs. 12–14; pl. 12, figs. 10–14

Lamprocyrtis heteroporos (Hays)
Lamprocyclas heteroporus Hays, 1965, p. 179, pl. 3, fig. 1
Lamprocyrtis heteroporos (Hays), in Kling, 1973, p. 639, pl. 5, figs. 19–21; pl. 15, fig. 6

Lamprocyrtis nigriniae (Caulet)
Conarachnium nigriniae Caulet, 1971, p. 3, pl. 3, figs. 1–4; pl. 4, figs. 1–4
Lamprocyrtis nigriniae (Caulet), in Kling, 1977, p. 217.

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

Table 7. Radiolarians at Hole 792A.

Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Androcyclas gamphonycha*	*Anthocyrtidium ophirense*	*Axoprunum angelinum*	*Botryostrobus auritus/australis*|group	*Carpocanistrum ?*	*Didymocyrtis tetrathalamus*	*Druppatractus acquilonius*	*Euchitonia furcata*	*Eucyrtidium acuminatum*	*Eucyrtidium calvertense*	*Eucyrtidium hexagonatum*	*Heliodiscus asteriscus*	*Hymeniastrum euclidis*	*Lamprocyclas maritalis maritalis*	*Lithocampe ?*	*Spongaster tetras*	*Spongodiscus ?*	*Stylochlamydium asteriscus*	*Tetrapyle octacantha*
1H-CC	C	G		R	R		R	R	R		R		R	R	R	R	R	R		F	F	
2H-CC	B																					
3H-CC	R	M	R																R			
4H-CC	F	G						R				R		R					F		R	
5H-CC	F	G						F		R					R		R					R
6H-CC	B																					
7H-CC	B																					
8H-CC	B																					
9H-CC	C	G	F			R		F	R	R			R		R	R	R		F		R	R
10H-CC	B																					

Table 8. Radiolarians at Hole 792B.

Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Anomalacantha dentata*	*Anthocyrtidium* sp.	*Carpocanistrum ?*	*Didymocyrtis tetrathalamus*	*Eucyrtidium calvertense*	*Eucyrtidium hexagonatum*	*Heliodiscus asteriscus*	*Hymeniastrum eucladis*	*Lamprocyrtis nigriniae*	*Pterocanium praetextum*	*Siphonosphaera polysiphonia*	*Spongaster tetras*	*Spongaster tetras tetras*	*Stylochlamydium asteriscus*	*Tetrapyle octacantha*
1H-CC	C	G					R	R	R	R	R	R		R	F		R	R
2H-CC	R	M				R												
3H-CC	R	G			R		R								R			
4X-CC	B																	
5X-CC	R	M				R									R			
6X-CC	R	P													R			
7X-CC	R	P				R									R			
8X-CC	B																	
9X-CC	F	M	R								R					F		R
10X-CC	B																	
11X-CC	C	G		R	R	R	R						R		F			R

Table 9. Radiolarians at Hole 792C.

Core, section, interval (cm)	Abundance	Preservation	*Botryostrobus auritus/australis* group	*Carpocanistrum ?*	*Eucyrtidium* sp.	*Lamprocyclas maritalis maritalis*
1X-CC	C	G	R	F	R	R

Liriospyris stauropora (Haeckel)
Trissocyclus stauroporus Haeckel, 1887, p. 987, pl. 83, fig. 5
Liriospyris stauropora (Haeckel), in Goll, 1968, p. 1431, pl. 175, figs. 1–3; text-fig. 9

Lithelius nautiloides Popofsky
Lithelius nautiloides Popofsky, 1908, p. 230, pl. 27, fig. 4

Lithocyclia angusta (Riedel)
Trigonactura angusta Riedel, 1959, p. 292, pl. 1, fig. 6
Lithocyclia angustum (Riedel), in Riedel and Sanfilippo, 1970, p. 522, pl. 13, figs. 1–2

Lithopera bacca Ehrenberg
Lithopera bacca Ehrenberg, 1872, p. 314; Sanfilippo and Riedel, 1970, p. 455

Peripyramis circumtexta Haeckel
Peripyramis circumtexta Haeckel, 1887, p. 1162, pl. 54, fig. 5

Table 10. Radiolarians at Hole 792D.

Epoch	Radiolarian zone	Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Axoprunum angelinum*	*Carpocanistrum ?*	*Didymocyrtis avita*	*Druppatractus acquilonius*	*Eucyrtidium* sp.	*Hymeniastrum euclidis*	*Lamprocyrtis heteroporos*	*Spongaster pentas*	*Spongaster tetras*	*Stylochlamydium asteriscus*
late Pliocene	*Spongaster pentas*	1X-CC	C	G	R	R	F	R	R	R	R	R	F	F	R

Phormostichoartus doliolum (Riedel and Sanfilippo)
Artostrobium doliolum Riedel and Sanfilippo, 1971, p. 1599, pl. 1H, figs. 1–3; pl. 8, figs. 14–15
Phormostichoartus doliolum (Riedel and Sanfilippo), in Nigrini, 1977, p. 252, pl. 1, fig. 14

Plectopyramis dodecomma Haeckel
Plectopyramis dodecomma Haeckel, 1887, p. 1258, pl. 54, fig. 6

Pterocanium prismatium Riedel
Pterocanium prismatium Riedel, 1957, p. 87, pl. 3, figs. 4–5
emend. Riedel and Sanfilippo, 1970, p. 529

Pterocanium praetextum (Ehrenberg) *eucolpum* Haeckel
Pterocanium eucolpum Haeckel, 1887, p. 1322, pl. 73, fig. 4
Pterocanium praetextum (Ehrenberg) *eucolpum* Haeckel, in Nigrini, 1967, p. 70, pl. 7, fig. 2

Pterocanium trilobum (Haeckel)
Dictyopodium trilobum Haeckel, 1860, p. 839
Pterocanium trilobum (Haeckel), in Nigrini, 1967, p. 71, pl. 7, figs. 3a–3b

Siphonosphaera polysiphonia Haeckel
Siphonosphaera polysiphonia Haeckel, 1887, p. 106

Spongaster pentas Riedel and Sanfilippo
Spongaster pentas Riedel and Sanfilippo, 1970, p. 523, pl. 15, fig. 3

Spongaster tetras Ehrenberg
Spongaster tetras Ehrenberg, 1860b, p. 833

Spongaster tetras Ehrenberg *irregularis* Nigrini
Spongaster tetras Ehrenberg *irregularis* Nigrini, 1967, p. 43, pl. 5, fig. 2

Spongaster tetras tetras Ehrenberg
Spongaster tetras tetras Ehrenberg, in Nigrini, 1967, p. 41–43, pl. 5, figs. 1a–1b

Spongocore puella Haeckel
Spongocore puella Haeckel, 1887, p. 347, pl. 48, fig. 6

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

Stichocorys peregrina (Riedel)
Eucyrtidium elongatum peregrinum Riedel, 1953, p. 812, pl. 85, fig. 2
Stichocorys peregrina (Riedel), in Sanfilippo and Riedel, 1970, p. 451, pl. 1, fig. 10

Stichocorys wolffii Haeckel
Stichocorys wolffii Haeckel, 1887, p. 1479.

Stylochlamydium asteriscus Haeckel
Stylochlamydium asteriscus Haeckel, 1887, p. 514, pl. 41, fig. 10

Stylodictya validispina Jørgensen
Stylodictya validispina Jørgensen, 1905, p. 119, pl. 10, fig. 40

Tetrapyle octacantha Müller
Tetrapyle octacantha Müller, 1858, p. 33, pl. 2, figs. 12 and 13; pl. 3, figs. 1–12

Theocorythium trachelium (Ehrenberg) *dianae* (Haeckel)
Theocorys dianae Haeckel, 1887, p. 1416, pl. 69, fig. 11
Theocorythium trachelium (Ehrenberg) *dianae* (Haeckel), in Nigrini, 1967, p. 77, pl. 8, figs. 1a–1b; pl. 9, figs. 1a–1b

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Table 11. Radiolarians at Hole 792E.

Epoch	Radiolarian zone	Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Anthocyrtidium zanguebaricum*	*Botryostrobus auritus/australis* group	*Carpocanistrum ?*	*Carpocanopsis ?*	*Cornutella profunda*	*Cyrtocapsella japonica*	*Dictyocoryne profunda*	*Dictyophimus hirundo* group	*Didymocyrtis avita*	*Didymocyrtis laticonus*	*Didymocyrtis tetrathalamus*	*Druppatractus acquilonius*	*Eucyrtidium acuminatum*	*Eucyrtidium hexagonatum*	*Heliodiscus asteriscus*	*Hymeniastrum euclidis*	*Lamprocyclas maritalis maritalis*	*Lithelius nautiloides*	*Phormostichoartus doliolum*	*Pterocanium praetextum*	*Pterocanium prismatium*	*Spongaster pentas*	*Spongaster tetras*	*Spongocore puella*	*Stichocorys delmontensis*	*Stichocorys peregrina*	*Stichocorys wolffii*	*Stylatractus* sp.	*Stylochlamydium asteriscus*	*Tetrapyle octacantha*
		1R-1, 2-3	C	G	R	R		R		R						R	R		R	R	R	R			R	R	R	R					R	
		2R-1, 5-6	R	P	R									R												R	R								
		2R-CC	C	G	R			R																R		R	F					R		R
late Pliocene	*Spongaster pentas*	3R-1, 8-9	C	G	F	R	F	R	R	R			R			R	R	R	R	R	R	R	R	R	R		R			R		R	R	R
		3R-CC	C	G													R									R								
		4R-1, 44-45	F	G	F			R								R		R		R	R	R				F	R			R		R	R	
		4R-CC	B																															
		5R-1, 19-20	F	G								R					R													R				
		5R-CC	R	P																														
		6R-CC	B																															
		7R-CC	B																															
		8R-CC	B																															
late Miocene	*Didymocyrtis penultima*	9R-1, 21-22	R	P															R										F					
		9R-CC	B																															
		10R-2,92-93	R	P																			R											
		10R-CC	B																															
		11R-CC	R	P																											R			
		12R-CC	B																															
		13R-1, 58-59	R	P																									R		R			
		13R-CC	B																															
		14R-CC	R	P				R																							R			
		15R-1, 0-1	R	P				R																										
		15R-CC	F	M				R							R								R									R	R	
		16R-CC	C	M						R					R														F					
late middle Miocene	*Diartus petterssoni*	17R-CC	C	M				R			F				F								R						F					
		18R-CC	C	G				R			R				F														F		R			
		19R-CC	C	M							R				R														R					
		20R-CC	C	M							R				R														R					
		21R-CC	F	P							R				R																			
		22R-CC	F	P											R														R					
early middle Miocene	*Dorcadospyris alata*	23R-CC	F	P				R			R																					R	R	
		24R-CC	B																															
early Miocene		28R-2, 20-21	F	P							R																							

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Table 12. Radiolarians at Hole 793A.

Core, section, interval (cm)	Abundance	Preservation	*Amphirhopalum ypsilon*	*Carpocanistrum ?*	*Druppatractus acquilonius*	*Euchitonia furcata*	*Hymeniastrum eucladis*	*Lamprocyrtis nigriniae*	*Spongaster tetras*	*Spongocore puella*	*Stylochlamydium asteriscus*	*Tetrapyle octacantha*
1H,CC	R	G							C		F	
2H-CC	B											
3H-4, TOP	A	G	F		R							
3H-CC	R	G									F	
4H-CC	F	G	F		R			R				R
5H-CC	C	G			R		F		C			
6H-CC	R	M				R						
7H-CC	F	M	F	F			R		C			R
8H-CC	B											
9H-CC	C	G			R				C	R		
10H-CC	R	G							C		F	
11H,CC	R	P			R							

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Table 13. Radiolarians at Hole 793B.

Epoch	Radiolarian zone	Core, section, interval (cm)	Abundance	Preservation	*Carpocanistrum ?*	*Carpocanopsis bramlettei*	*Carpocanopsis ?*	*Carpocanopsis favosa*	*Cenosphaera cristata*	*Cyrtocapsella japonica*	*Cyrtocapsella tetrapera*	*Didymocyrtis ?*	*Liriospyris ?*	*Liriospyris multuaria*	*Liriospyris stauropora*	*Stichocorys wolffii*
early middle-late early Miocene	*D. alata - C. costata*	2R-CC	R	P	F				F					R		
		3R-CC	B													
		4R-CC	R	M	F						R					
		5R-CC	R	M				F		F			R			F
		6R-CC	R	P												F
		7R-CC	R	M		R									R	
		8R-CC	R	M			R					R		R		
		9R-CC	B													