11. ANTARCTIC RADIOLARIA[1]

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INTRODUCTION

Radiolaria, as planktonic animals, have widespread distribution. Previous investigations indicate that Radiolaria-rich sediments occur in the equatorial and polar regions. The study of antarctic Radiolaria began with Ehrenberg (1844), who studied the Radiolaria collected during the voyage of Sir James Clark Ross in 1841-1843. Later Haeckel (1887) described 25 species collected by *Challenger* from the Indian sector of the Antarctic. Haecker (1908) studied some Radiolaria collected by *Valdivia* of the Deutsche Tiefsee Expedition from the south of Africa. Popofsky (1908) described some of the Radiolaria collected by *Gauss* during the Deutsche Sudpolar Expedition. Riedel (1958) described the Radiolaria from sediment samples collected during the B.A.N.Z. Antarctic Research Expedition. Nakaseko (1959) worked on species of the superfamily Liosphaericae from sediments collected near Antarctic by the Japanese Antarctic Research Expedition. Petrushevskaya (1968) studied plankton and bathymetric samples collected by *Ob* during the Soviet Antarctic Expedition in 1955-1958. However, the first study of antarctic Radiolaria from a biostratigraphic point of view was that of Hays (1965). Four faunal zones were recognized on the basis of an upward sequential disappearance of several radiolarian species. Later contributions include correlation to paleomagnetic stratigraphy, other microfossil assemblages, and biostratigraphic units. Finally this informal biostratigraphic zonation was put into a time-stratigraphic framework (Opdyke et al., 1966), and was extended back to lower Pliocene sediments (Hays and Opdyke, 1967). However, the synchroneity of radiolarian biostratigraphic levels used in Hays' zonations was questioned by Weaver (1973). He demonstrated that the last common occurrences and extinctions of some Pliocene index Radiolaria are diachronous within the Southern Ocean, based on the study of 14 piston cores collected from the Antarctic region south of Australia. This discrepancy may result from the fact that piston cores reaching the Pliocene sediments commonly have low sedimentation rates and/or disconformities, therefore greater possibility of mixing.

Leg 28 provided the first opportunity to examine the pre-Pliocene antarctic Radiolaria and their environment. Because of time limitations, the major emphasis of the present contribution is to establish a southern high-latitude radiolarian biostratigraphy. It is hoped this biostratigraphic framework will be useful for analysis of noncalcareous Antarctic sediments recovered on succeeding DSDP legs. In addition, systematic descriptions are presented for approximately 85% of the Radiolaria observed in the course of this study. A more detailed presentation of these results will form the subject of my doctoral dissertation.

Radiolaria occur at all of the drilling sites of Leg 28, but their abundance and preservation vary with the geological setting of each drilling locality (Table 1). Holes drilled on or close to the Antarctic continental rise (Holes 268, 269, and 269A) and on the Ross Sea shelf contain sparse or no Radiolaria, making dating of the sediments difficult or impossible. In Holes 264 and 264A, located on the Naturaliste Plateau where calcareous sediments dominate, moderately preserved Radiolaria were found only at restricted levels. In holes drilled on the flank of the mid-ocean ridge or in the deep basin far from the continent (Holes 265, 266, 267, 267A, and 267B) substantial numbers of well-preserved Radiolaria were generally found.

NEOGENE RADIOLARIAN BIOSTRATIGRAPHY

Stratigraphic correlation of post-Miocene sediments collected from deep basins south of the Antarctic Polar Front by means of foraminifera and calcareous nannoplankton proved difficult because of the noncalcareous nature of the sediments. They were successfully dated by the use of radiolarian and diatom biostratigraphies, both based on a paleomagnetically dated piston core (E13-17) (Hays and Opdyke, 1967; McCollum, 1972). The proposed radiolarian biostratigraphy in this report is adapted and modified from Hays' radiolarian zonations (Figure 1).

Leg 28 provides a good composite sequence of sediments for constructing a Neogene radiolarian biostratigraphy. Radiolarian-bearing Neogene sediments were cored at all sites except Site 264. The longest Neogene sections were obtained at Site 265 (upper/middle Miocene to Pleistocene) and Site 266 (lower Miocene to Pleistocene), and the composite radiolarian biostratigraphy is based on the study of these two holes. Other sites contain either long uncored intervals or sparse radiolarian fauna. An attempt to core the Miocene/Pliocene boundary was made at Site 266, but the uppermost Miocene and/or lowermost Pliocene were not obtained, as indicated by the absence of the evolutionarily younger form of *Antarctissa conradae* that was found in Hole 267B. Radiolarian biostratigraphy near the Oligocene/Miocene boundary is uncertain due either to intermittent coring or lack of radiolarian-rich sediments in this section. Table 2 shows the ranges of some radiolarian taxa with their extinction or appearance levels within the Neogene.

[1]Lamont-Doherty Geological Observatory Contribution No. 2095.

TABLE 1
Coring Summary

Hole	Dates (1972 and 1973)	Latitude	Longitude	Water Depth (m)	Penetration (m)	Cores (No.)	Cores (m)	Recovery (m)	Recovery (%)
264	22-23 Dec.	34°58.13'S	112°02.68'E	2,873	215.5	15	142.5	65.2	46
264A	23 Dec.	34°58.13'S	112°02.68'E	2,873	158.5	4	38.0	33.2	87
265	30-31 Dec.	53°32.45'S	109°56.74'E	3,582	462.0	18	169.0	108.0	64
266	2-4 Jan.	56°24.13'S	110°06.70'E	4,173	384.0	24	219.5	145.2	66
267	6 Jan.	59°15.74'S	104°29.30'E	4,564	219.5	7	58.0	25.9	45
267A	7 Jan.	59°15.74'S	104°29.30'E	4,564	70.5	3	28.5	11.6	41
267B	7-8 Jan.	59°14.55'S	104°29.94'E	4,539	323.0	10	95.0	53.5	56
268	10-12 Jan.	63°56.99'S	105°09.34'E	3,544	474.5	20	189.5	65.5	35
269	18 Jan.	61°40.57'S	140°04.21'E	4,285	397.5	11	103.0	38.8	38
269A	19-21 Jan.	61°40.57'S	140°04.21'E	4,285	958.0	13	123.5	55.4	45
270	30 Jan./2 Feb.	77°26.48'S	178°30.19'W	634	422.5	49	422.5	263.7	62
271	3-5 Feb.	76°43.27'S	175°02.86'W	554	265.0	24	233.0	15.3	7
272	6-8 Feb.	77°07.62'S	176°45.61'W	629	433.0	48	439.0	162.0	37
273	10 Feb.	74°32.29'S	174°37.57'E	495	76.0	9	76.0	27.9	37
273A	11-13 Feb.	74°32.29'S	174°37.57'E	495	346.5	29	256.5	55.5	22
274	16-19 Feb.	68°59.81'S	173°25.64'E	3,326	421.0	45	421.0	279.1	66
Total						329	3013.5	1404.9	47

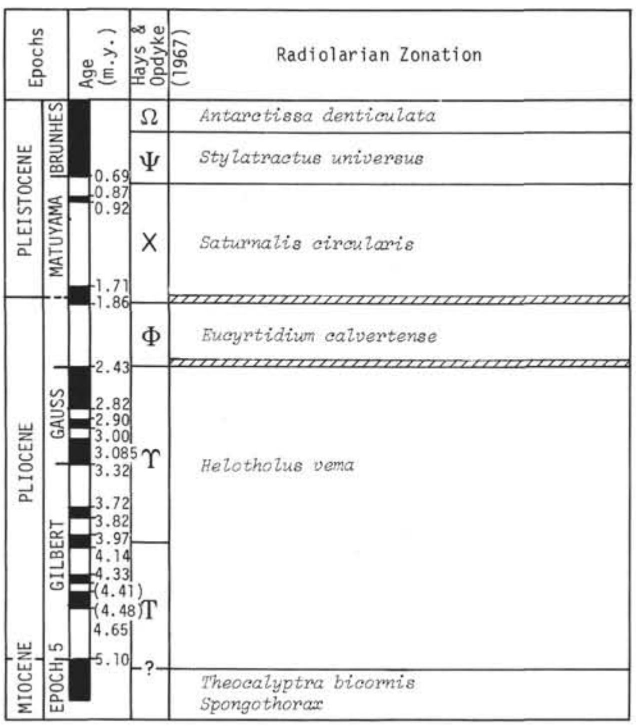


Figure 1. *Correlation between radiolarian zonation and paleomagnetic stratigraphy.*

Definition of Neogene Radiolarian Zones

Cyrtocapsella tetrapera Zone

Base: Earliest appearance of *Cyrtocapsella tetrapera.*
Top: Coincident with the base of the *Lophocyrtis regipileus* Zone.

The radiolarian taxa present near the Oligocene/Miocene boundary are unknown because of coring gaps or the lack of Radiolaria in the sediments. Some Radiolaria possibly having their earliest appearances in this zone are *Stylacantarium bispiculum*, *Eucyrtidium cienkowskii*, *Dendrospyris haysi*, and *Lophocyrtis golli.*

Lophocyrtis regipileus Zone

Base: Earliest appearance of *Lophocyrtis regipileus.*
Top: Coincident with the base of the *Eucyrtidium punctatum* Zone.

Eucyrtidium punctatum Zone

Base: Earliest appearance of *Eucyrtidium punctatum.*
Top: Coincident with the base of the *Spongomelissa dilli* Zone.

Calocyclas disparidens Zone

Base: Earliest appearance of *Calocyclas disparidens.*
Top: Coincident with the base of the *Actinomma tanyacantha* Zone.

Latest occurrences include *Cyrtocapsella isopera.*

Actinomma tanyacantha Zone

Base: Earliest appearance of *Actinomma tanyacantha.*
Top: Coincident with the base of the *Antarctissa conradae* Zone.

Latest occurrences include *Lophocyrtis regipileus*, *Eucyrtidium punctatum*, *Calocyclas disparidens*, and *Thyrsocyrtis clausa.* Earliest appearances include *Dendrospyris megalocephalis* and *Thyrsocyrtis clausa.*

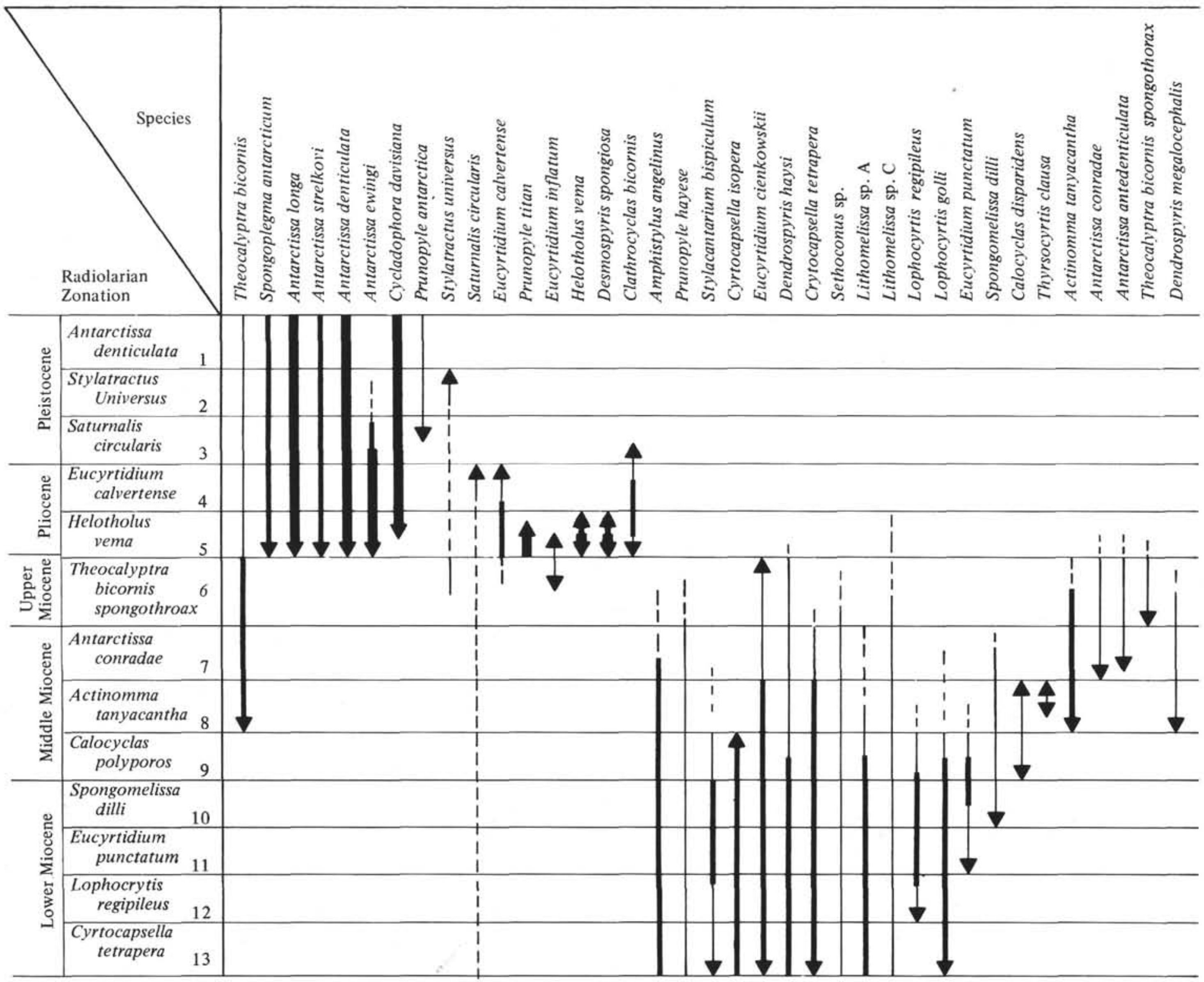
Antarctissa conradae Zone

Base: Earliest appearance of *Antarctissa conradae.*
Top: Coincident with the base of the *Theocalyptra bicornis spongothorax* Zone.

Latest occurrences include *Stylacantarium bispiculum*, *Lithomelissa ehrenbergi*(?), *Lophocyrtis golli*, and *Spongomelissa dilli.*

Earliest appearances include *Antarctissa antedenticulata.*

TABLE 2
Neogene Radiolarian Zonation



—— Present; ▬ Common; ██ Abundant; – – – – Few to Rare.

Theocalyptra bicornis spongothorax Zone

Base: Earliest appearance of *Theocalyptra bicornis spongothorax.*

Top: Coincident with the base of the *Helotholus vema* Zone.

Latest occurrences include *Amphistylus angelinus, Eucyrtidium cienkowskii, Cyrtocapsella tetrapera, Sethoconus* sp., *Actinomma tanyacantha, Dendrospyris megalocephalis* and *Prunopyle hayesi.* Earliest appearances include *Eucyrtidium calvertense, Stylatractus universus* (first evolutionary appearance), and *Eucyrtidium inflatum.*

Helotholus vema Zone

Base: Earliest concurrence of *Antarctissa longa* and *Antarctissa ewingi.*

Top: Latest concurrence of *Helotholus vema* and *Desmospyris spongiosa.*

Latest occurrences include *Eucyrtidium inflatum, Dendrospyris haysi, Lithomelissa* sp. *Antarctissa conradae, Antarctissa antedenticulata, Theocalyptra bicornis spongothorax,* and *Prunopyle titan.* Earliest appearances include *Spongoplegma antarcticum, Cycladophora davisiana, Desmospyris spongiosa, Helotholus vema, Clathrocyclas bicornis, Antarctissa denticulata, Prunopyle titan,* and *Antarctissa strelkovi.*

Eucyrtidium calvertense Zone

Base: Coincident with the top of the *Helotholus vema* Zone.

Top: Latest occurrence of *Eucyrtidium calvertense.*

Saturnalis circularis Zone

Base: Coincident with the top of the *Eucyrtidium calvertense* Zone.

Top: Latest occurrence of *Saturnalis circularis.*

Latest occurrences include *Clathrocyclas bicornis.* Earliest appearances include *Prunopyle antarctica.*

Stylatractus universus Zone

Base: Coincident with the top of the *Saturnalis circularis* Zone.

Top: Latest occurrence of *Stylatractus universus.*

Latest occurrences include *Antarctissa ewingi.*

Antarctissa denticulata Zone

Base: Coincident with the top of the *Stylatractus universus* Zone.

Top: Recent.

The Pliocene/Pleistocene boundary in deep-sea cores were discussed by Hays and Berggren (1971), and Bandy et al. (1971). Based on the correlation with the type section of the Calabrian in southern Italy and paleomagnetic data, the ϕ/χ boundary or the last occurrence of *Eucyrtidium calvertense* in Antarctic sediments represents a close approximation of the Pliocene/Pleistocene boundary. The ϕ/χ boundary is equivalent to the *Saturnalis circularis* Zone/*Eucyrtidium calvertense* Zone boundary in this report.

A Miocene/Pliocene boundary in antarctic regions was proposed by Bandy et al. (1971). The presences of *Prunopyle titan* and *Lychnocanium grande* (described by Campbell and Clark [1944] from the Miocene sediments of southern California) suggested to the authors that the *Prunopyle titan* extinction datum plane within the Gauss normal magnetic epoch corresponds to the Miocene/Pliocene boundary. However, the Gilbert/Epoch 5 boundary is accepted by others as the Miocene/Pliocene boundary (Berggren, 1972; Opdyke, 1972; Saito and Burckle, in press). Only one deep-sea core (E13-17) which reaches to Epoch 5 in the antarctic region has been reported (Hays and Opdyke, 1967). Though the Radiolaria in sediments close to the Gilbert/Epoch 5 boundary in this core are rare and poorly preserved, the assemblage shows a remarkable resemblance to the assemblage close to the *Helotholus vema*/*Theocalyptra bicornis spongothorax* Zone in sediments collected by Leg 28. Therefore the *Helotholus vema*/*Theocalyptra bicornis spongothorax* boundary corresponds to or represents a close approximation of the Miocene/Pliocene boundary.

Problems remain with regard to the exact placements of the Miocene subseries boundaries within the present radiolarian zonation. The position of the upper/middle Miocene boundary has not been consistently established in two holes which have concurrent calcareous and siliceous microfossils. This boundary is found within the *Antarctissa conradae* Zone at Site 266, but it lies within the *Theocalyptra bicornis spongothorax* Zone at Site 265. Because the upper/middle Miocene boundary is located within the *Antarctissa conradae* Zone at Site 278 of Leg 29 (samples supplied by J.P. Kennett), it is unlikely that the boundary between the *Theocalyptra bicornis spongothorax* Zone and the *Antarctissa conradae* Zone is time-transgressive. If this boundary were time-transgressive, the upper/middle Miocene boundary at Site 278 would be located at a biostratigraphic position higher than that at Site 265. It is possible that this discrepancy is due to different calcareous nannofossils being used to define the upper/middle boundary at Sites 265 and 266. The middle/lower Miocene boundary was only recovered at Site 266 and is based on calcareous nannofossils (*Sphenolithus heteromorphus*/*Sphenolithus dissimilis*).

PALEOGENE RADIOLARIA

Previous reports on pre-Pliocene radiolarian taxa and biostratigraphy in antarctic sediments are unknown to the author. Most of the radiolarian assemblages in pre-Pliocene sediments were, as expected, found to be different from low-latitude faunas, and shipboard dating of Leg 28 sediments by the use of the low-latitude radiolarian biostratigraphy was unsuccessful.

Oligocene radiolarian-bearing sediments were cored in Holes 267 and 274. In Hole 274, Oligocene Radiolaria occur in Cores 20-35. Within this interval, no changes in radiolarian assemblages were observed. The assemblages resemble those in Sample 29-277-18-1, 140-141 cm (supplied by J.P. Kennett) which has been dated as lower Oligocene by calcareous nannoplankton. In

Hole 267, two cores (4, 5) contain Oligocene Radiolaria and have been dated by calcareous nannoplankton as upper and middle Oligocene, respectively. To verify the ages of these two cores, the author has examined the radiolarian assemblages in Leg 29 Samples 277-11-5, 140-141 cm (middle Oligocene); 278-25-1, 135-136 cm (lower Miocene); and 278-33-2, 90-91 cm (upper Oligocene) (supplied by J.P. Kennett), and has found that Cores 267-4 and -5 show closely similar Radiolaria to Samples 278-33-2, 90-91 cm; and 277-11-5, 140-141 cm; respectively.

Establishing an Oligocene radiolarian zonation based on Leg 28 materials has not been attempted, and only a tabulation of the radiolarian taxa is presented here (see also the radiolarian report in each site chapter).

Eocene Radiolaria occur at Site 264, which is located about 20° north of the Antarctic Convergence. The assemblage is similar to but less diverse than the upper middle Eocene to upper Eocene low-latitude assemblages previously described by Riedel and Sanfilippo (1971) and Foreman (1973).

RADIOLARIA AT EACH SITE

The occurrences of Radiolaria are tabulated here for all the samples studied from each site except for Sites 270-273 where Radiolaria are rare or absent. Figure 2 shows the correlation of Neogene radiolarian zones for Leg 28 sites. A strewn-slide was prepared for each sample using 20 cc of sediment. Radiolarian abundances were roughly estimated from the density of radiolarian distribution on the slide; **A**, abundant; **C**, common; **F**, few; **R**, rare; and **T**, trace. **G**, **M**, and **P** indicate that radiolarian preservation is good, moderate, or poor, respectively.

In the body of the tables, rough estimates of relative abundance of each species are **A**, abundant; **C**, common; **P**, present; **F**, few, and **R**, rare. Since every slide studied was completely examined, no entry in the tables indicates absence.

Site 264 (Table 3)

Site 264, near the southern edge of the Naturaliste Plateau, contains a thin Neogene and a well-developed Paleogene sequence of carbonate oozes and chalks. Small numbers of moderately preserved Eocene Radiolaria are present between Core 2, Section 5, and Core 3, CC. Radiolaria are absent or occur only in trace amounts throughout the remainder of the cores.

The radiolarian zonation is difficult to determine, because low-latitude index species are absent. However, on the basis of overall occurrences of several species (*Lychnocanoma amphitrite*, *Eusyringium fistuligerum*, *Lithochytris vespertilio*, *Theocampe amphora*, *Calocyclas hispida*, *Theocampe urceolus*, *Lophocyrtis biaurita*, *Lychnocanoma babylonis*, and *Phormocyrtis striata striata*), it appears that the interval from Core 3, CC to Core 2, Section 5 is within the *Podocyrtis mitra* Zone to *Thyrsocyrtis bromia* Zone interval (upper middle Eocene to upper Eocene).

Site 265 (Table 4)

Site 265 lies about 500 km south of the Southeast Indian Ridge crest. About 75 meters of nannofossil ooze and chalk of late/middle Miocene age underlies about 370 meters of recent to early Pliocene predominantly diatom oozes. Cores were not taken continuously but were spaced at 2-core-length intervals. Common, well to moderately preserved Radiolaria were recovered from the post-Miocene sediments (Cores 1-14), whereas few to common, moderately preserved Radiolaria occurred in the upper/middle Miocene sediments (Cores 15, 16).

The Miocene/Pliocene boundary is located at the coring gap between Cores 14 and 15. Radiolarian zones represented are: Cores 1 to 3, the *Antarctissa denticulata* Zone; Core 4, the *Stylatractus universus* Zone; Core 5 to Core-Section 10-3, the *Saturnalis circularis* Zone; Core 10, CC to Core 11, the *Eucyrtidium calvertense* Zone; Cores 12 to 14, the *Helotholus vema* Zone.

Some reworked *Helotholus vema* and *Desmospyris spongiosa* were observed in Cores 10 and 11.

Site 266 (Table 5)

Site 266 lies about 800 km south of the ridge crest, in 4173 meters of water. About 150 meters of Quaternary to late Miocene diatom ooze grades down to 105 meters of late to early Miocene mixed nanno and diatom oozes. Sediments were continuously cored near the Pliocene/Miocene (Cores 7-11) and middle/upper Miocene (Cores 15-17) boundaries. Radiolaria are common to abundant and well preserved in all of the post-Miocene sediments, and few to common, and well preserved in the Miocene sediments.

The Miocene/Pliocene boundary lies between Cores 9 and 10. Radiolarian zones represented are Cores 1-3, the *Saturnalis circularis* Zone; Core 4, the *Eucyrtidium calvertense* Zone; Cores 5-9, the *Helotholus vema* Zone; Core 10, the *Theocalyptra bicornis spongothorax* Zone; Core 11 to Core 12, Section 3, the *Antarctissa conradae* Zone; Core 12, Section 4 to Core 12, CC, the *Actinomma tanyacantha* Zone; Cores 13-16, the *Calocyclas disparidens* Zone; Core 17, the *Spongomelissa dilli* Zone; Core 18, Sections 1-3, the *Eucyrtidium punctatum* Zone; Core 18, Section 4 to Core 20, Section 2, the *Lophocyrtis regipileus* Zone; and Core 20, Section 3 to Core 23, Section 1, the *Cyrtocapsella tetrapera* Zone.

Core 23, Section 1 and Core 22, Section 3 contain some downward contaminated upper Miocene Radiolaria. Other cores show no sign of contamination or reworking. A small hiatus or a condensed interval, indicated by the lack of transitional forms of an evolutionary lineage between *Antarctissa conradae* and *Antarctissa strelkovi*, may be present between Cores 9 and 10. The *Antarctissa denticulata* and *Stylatractus universus* zones are not present at the top of this hole.

Site 267 (Tables 6A, 6B)

Site 267 is in the deep basin south of the Southeast Indian Ridge and about 600 km north of the Wilkes Land continental shelf. Holes 267 and 267A include about 100 meters of Quaternary and Pliocene silty clay overlying early Miocene to middle Oligocene nanno ooze and chalk. Radiolaria are present in all of the samples studied. Neogene sediments contain common, moderately to well preserved Radiolaria, whereas Paleogene sediments contain few, moderately to poorly preserved Radiolaria.

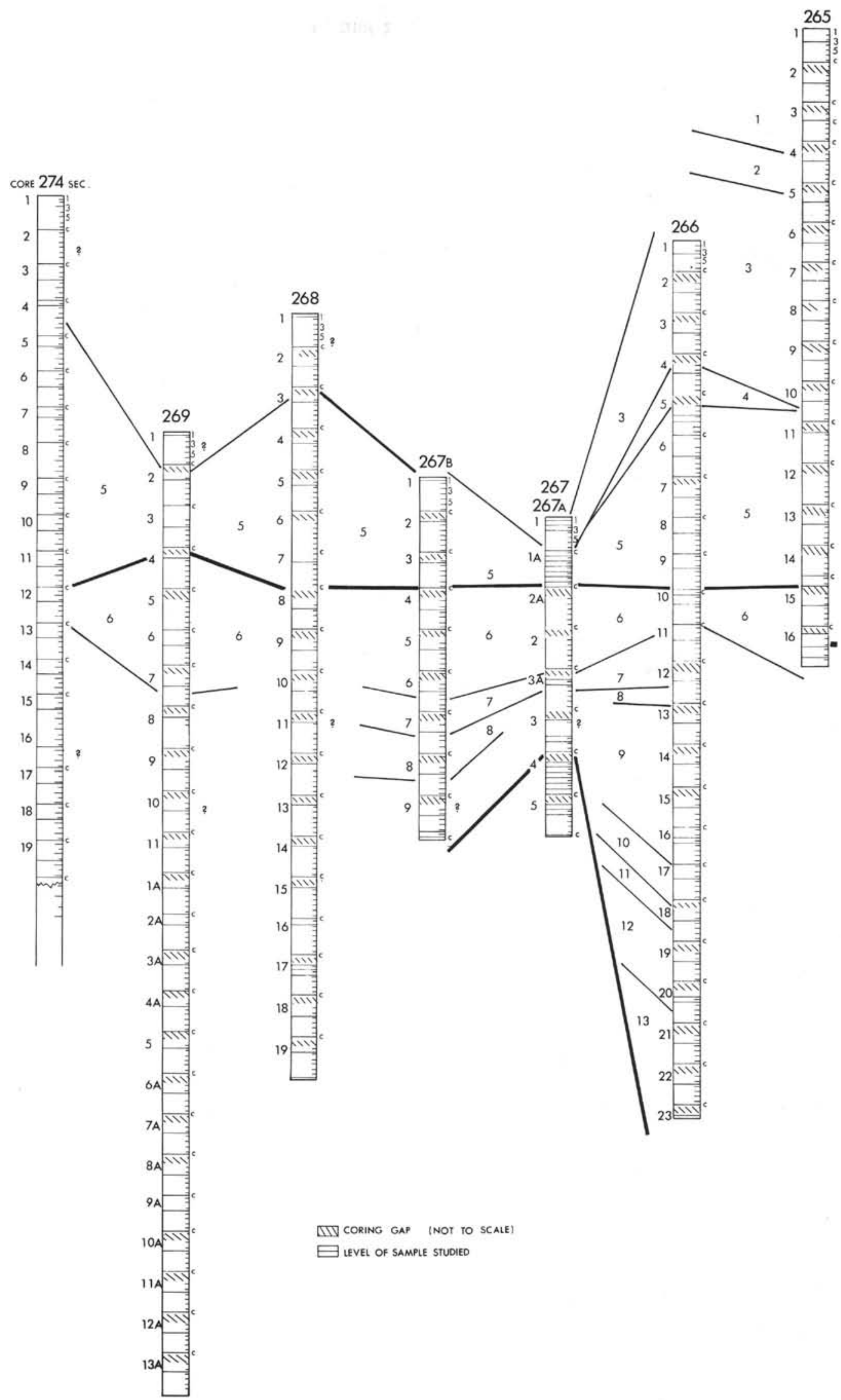


Figure 2. *Correlation of Neogene radiolarian zones for holes drilled in Leg 28. (See Table 2 for the radiolarian zones corresponding to the numbered zones above).*

TABLE 3
Radiolaria from Hole 264

Sample (Interval in cm) \ Species	Abundance	Preservation	*Amphisphaera minor*	*Calocyclas hispida*	*Clathrocyclas universa*	*Dictyopodium* sp. aff. *D. oxylophus*	*Dorcadospyris argisca*	*Eusyringium fistuligerum*	*Eusyringium lagena*	*Giraffospyris didiceros*	*Lophoconus titanothericeraos*	*Lophocyrtis biaurita*	*Lychnocanoma amphitrite*	*Lychnocanoma babylonis*	*Lychnocanoma* sp.	*Lychnocanium* sp. aff. *L. grande*	*Phormocyrtis proxima*	*Phormocyrtis striata striata*	*Prunopyle spiropyrinus*	*Sethocyrtis* sp.	*Stylosphaera coronata coronata*	*Stylosphaera coronata laevis*	*Theocampe amphora*	*Theocampe urceolus*	*Cyclampterium* (?) *milowi*	*Theocyrtis diabloensis*	*Lophocyrtis* (?) *jacchia*
2-5, 90-92	F	P	P				F	P	P	F	P	P	C	P	P	P		F				F			P		
2-6, 105-107	C	M	P	F	F	P	F	P	P	P	C	P	C	P		C	R	F	P	P	F	C	P		P	F	F
3-1, 105-107	F	M	P	F	F		P	P	F		P	E	C	P	P	C			P	F		C	C	F	F	F	
3-2, 105-107	C	P	R		R					F	P	P	P	C	P	C		R		F		P	P	P	F	F	F
3-4, 90-92	T	P											R									R					
3-5, 90-92	T	P											R									R					
3-6, 90-92	T	P											R									R					
3, CC	F	M	F							F	F	P	C	P	R	F						C	R				

Note: See text for explanation of entries.

Radiolarian zones represented in these two holes are Core 1, Sections 1-3, the *Saturnalis circularis* Zone; Core 1, CC to Core 1A, CC, the *Helotholus vema* Zone; Core 2, the *Theocalyptra bicornis spongothorax* Zone; and Core 3A, the *Antarctissa conradae* Zone. Core 3 is early Miocene, probably in the *Cyrtocapsella tetrapera* Zone. Cores 4 and 5 are believed to be late and middle Oligocene, respectively, on the basis of the correlation of radiolarian assemblages with Sites 277 and 278 of Leg 29. The Miocene/Pliocene boundary is located at the coring gap between Cores 1A and 2. The Oligocene/Miocene boundary lies between Cores 4 and 5.

The *Antarctissa denticulata* Zone, *Stylatractus universus* Zone and *Eucyrtidium calvertense* Zone were not encountered at the top of these two holes. The *Actinomma tanyacantha* Zone may be present in the coring gap between Cores 3A and 3. No reworked older Radiolaria were found in any samples examined from these two holes.

Hole 267B is offset about 2 km from Holes 267 and 267A. About 300 meters of Neogene diatomaceous silty clays overlie middle to early Oligocene chalk. Thus, an unconformity is present near the base of the clay sequence, in which parts of the Miocene and Oligocene are missing. Radiolaria are common and well preserved in the post-Miocene sediments, and few to common and moderately preserved in the Miocene sediments. Oligocene sediments are barren of Radiolaria.

Radiolarian zones represented are: Cores 1-3, the *Helotholus vema* Zone; Core 4 to Core 6, Section 3, the *Theocalyptra bicornis spongothorax* Zone; Core 6, Section 4 to Core 7, Section 3, the *Antarctissa conradae* Zone; and Core 7, Section 4 to Core 8, Section 3, the *Actinomma tanyacantha* Zone. Core 8, Section 4 to Core 9, CC is middle to early Miocene. No reworked older Radiolaria were observed.

Site 268 (Table 7)

Site 268 is on the lower continental rise just north of the Knox Coast of Antarctica. About 474 meters of clayey sediments ranging in age from Quaternary to late Oligocene were cored. Radiolaria are rare and moderately to poorly preserved in most of the Neogene sediments (Cores 1-12), and very scarce to absent in older sediments.

The only radiolarian zone recognized is the *Helotholus vema* Zone (Core 3, Section 2 to Core 7). The overall assemblages in Cores 8-13 indicate Miocene age, but further subdivision of this interval is impossible. From Core 14 downward, sediments are barren of Radiolaria except in Core 17, Section 1, where specimens of *Stylosphaera coronata coronata* were observed.

Site 269 (Table 8)

Site 269 is near the southeastern edge of the South Indian abyssal plain. About 958 meters of Quaternary to early Miocene silty turbidites were cored. Radiolaria are few to common and well preserved in post-Miocene sediments, and sparse, moderately preserved in upper Miocene sediments. Pre-upper Miocene sediments contain no Radiolaria.

The Miocene/Pliocene boundary is located in the coring gap between Cores 3 and 4. Two radiolarian zones were recognized at this site: the *Helotholus vema* Zone (Cores 2-3), and the *Theocalyptra bicornis spongothorax* Zone (Cores 3-7). Based on a few Radiolaria that occur at several horizons, Cores 8 to 1A are Miocene. No Radiolaria were seen below Core 1A. No reworked older Radiolaria are encountered in any of the samples studied.

TABLE 4
Radiolaria from Hole 265

Sample (Interval in cm)	Abundance	Preservation	Acanthosphaera sp.	Actinomma tanyacantha	Antarctissa antedenticulata	Antarctissa conradae	Antarctissa denticulata	Antarctissa ewingi	Antarctissa longa	Antarctissa strelkovi	Amphistylus angelinus	Calocyclas disparidens	Cannartus prismaticus	Clathrocyclas bicornis	Cornutella profunda	Cycladophora davisiana	Crytocapsella isopera	Cyrtopera laguncula	Desmospyris spongiosa	Dendrospyris megalocephalis	Dendrospyris haysi	Dictyocephalus papillosus	Dictyophimus mawsoni	Druppatractus sp.	Echinomma delicatulum	Echinomma popofskii	Eucyrtidium calvertense	Eucyrtidium cienkowskii Group	Eucyrtidium inflatum	Eucyrtidium punctatum	Haliommetta miocenica	Helotholus vema	Lithelius nautiloides	Lithomelissa sp. A	Lithomelissa sp. C	Lophocyrtis golli	Lophocyrtis regipileus	Mitrocalpis araneafera	Ommatartus antepenultimus	Peripyramis circumtexta	Prunopyle antarctica	Prunopyle tetrapila	Prunopyle titan	Pterocorys hirundo	Saturnalis circularis	Sethoconus (?) dogieli	Spongodiscus osculosus	Spongomelissa dilli	Spongoplegma antarcticum	Spongoplegma sp.	Spongotrochus glacialis	Stichocorys delmontensis	Stichophormis sp.	Stylatractus neptunus	Stylatractus universus	Theocalyptra bicornis	Theocalyptra bicornis spongothorax	Theocorys redondoensis	Thyrsocyrtis clausa	Triceraspyris antarctica
1-3, 110-112	F	G					C	F	C	C					F	C		R						R							R		R					R		R	F	R		R		F	R		F		P			F		F				F
1, CC	F	G					C	F	C	C					P	P		R					R		F	R					R		F							R	R	R									P			F		F				P
2-3, 100-102	C	G					C		C	P					R	C		R						R	R								F					R		P	R	P		R		R	F		R		P			R		F				
2, CC	C	G					C		A	C					F	A		R						R		R												R		R		R		F		R	R				P			P		R				C
3-3, 30-32	C	G					C		C	C					F	P																	P								C					R			P		C			P		F				C
3, CC	F	G					C		A	P					P	C		R															P					R		R	P					R	F		P		P					R				P
4-3, 110-112	C	G	R				C		C	P					P	C								R	F								R							F	P					R	F		C		C				P	F				P
4 CC	C	G	P				C		A	C					F	C		R							F								P								P			R			F		C		C			F	P	R				P
5-3, 120-122	F	G	P				A		A	C					F	C		R							F								P					R		R	P	F		R	R		P		C		P			R	R	F				P
5, CC	C	G	R				A		A	C					F	C								R	P	R							R					R		F	P	R		F			F		P		P			F	R					P
6-3, 101-103	C	M	R				C	R	C	C					P	A		R					R		R	R							P					F			P			R	R	R	P		P		P				P	R				P
6, CC	C	G					C	P	P	C					P	C							R			R							P					F			F			R	R		F		A		C			P	P	F				P
7-3, 112-114	C	M					C	A	C	P					F	C		R								R							R					P		P	P	P		F	F	R	P		C		F					R				P
7, CC	C	M					A	C	C	P					F	C									P													F			F			R	F	R	P		C		C					F				F
8-3, 80-82	C	G					C	C	C	P					F	P		R							P								P					F		P	F	P			F				C		P			F		F				C
8, CC	C	G					C	C	C	C					P	C		R															R							P	F	F		R	R				C		F									P
9-3, 90-92	C	M					C	C	C	P					F	C									F															F	F	F		R	R	R	F		P		C			R		R				P
9, CC	C	G					C	C	C	P					F	P		R						C									P									F			R		F		P		C			F						F
10-3, 102-104	F	G					C	A	C	P					F	P									F								R							R									C		P			R		F				
10-5, 70-72	C	M					C	A	C	P					F	P								R	P								R							R					R				C		F			F		R				
10, CC	C	G					C	A	C	P				P	F	C								F	P	R	R					R	P							R					F		F		P		F			F		R				
11-1, 136-138	C	G					C	A	A	C				P	R	P		R						R			R					R	F							P	R		R		F		F		P		F			F		R				F
11-3, 105-107	C	M					C	A	A	P				F	P	C		F	R					F			R						P							F	P				R	R	F		F		F			P						P
11, CC	C	G					P	C	C	P				P		P			F					F	F		R					F	P										R	F		R	F		P		P			F						P
12, CC	C	G					P	A	A	C				F		P		R	F					P			P					F								R					R	R			C		F			F		P		R		F
13-3, 105-107	C	G					P	A	P	P				C	F	C		R	F					R	F		C					P									R				R	R			C		P			F		F				P
13, CC	C	G					P	A	F	P				F	P	P		R	P					R			P					P								R	F		P		R		F		F		R			P		P				P
14-3, 20-22	C	G					F	A	P	R				P	F			R	P						F		P					C									F		F	R	R		F		F		F			P	R	P		R		
14, CC	C	G					R	A	F	P	R			C				R	C					F			C		R			C								F	R			F	F		F		P		P			P	R	F				
15-1, 40-42	C	M			R						R				P												C		R					R	P						R			R	R		P			P	R			P	A	P	C	F		C
15-3, 10-12	F	M			R	R					R				P			R		R				F			R	P	P					P	C				F		P		C	R	R					F	F			P	C	F	C	F		C
15, CC	C	G			F	R					R				F						P			P				P	R					P	C						F		C	R	R		F			F	P			P	C	F	F	P		C
16-3, 5-7	F	M		P	R	R					C				P			F			C							P							C					F	F						P			F	R			P		P	F	F		P
16-5, 130-132	F	M		C	F	P					C				P			R			C			P				C						C	P					F	P						P			F				P		P	R	F		P

Note: See text for explanation of entries.

TABLE 5
Radiolaria from Hole 266

Sample (Interval in cm)	Abundance	Preservation	*Acanthosphaera* sp.	*Actinomma tanyacantha*	*Antarctissa antedenticulata*	*Antarctissa conradae*	*Antarctissa denticulata*	*Antarctissa ewingi*	*Antarctissa longa*	*Antarctissa strelkovi*	*Amphistylus angelinus*	*Calocyclas disparidens*	*Cannartus prismaticus*	*Clathrocyclas bicornis*	*Cornutella profunda*	*Cycladophora davisiana*	*Cyrtocapsella isopera*	*Cyrtopera laguncula*	*Desmospyris spongiosa*	*Dendrospyris megalocephalis*	*Dendrospyris haysi*	*Dictyocephalus papillosus*	*Dictyophimus mawsoni*	*Druppatractus* sp.	*Echinomma delicatulum*	*Echinomma popofskii*	*Eucyrtidium calvertense*	*Eucyrtidium cienkowskii* Group	*Eucyrtidium inflatum*	*Eucyrtidium punctatum*	*Haliommetta miocenica*	*Helotholus vema*	*Lithelius nautiloides*	*Lithomelissa* sp. A	*Lithomelissa* sp. C	*Lophocyrtis golli*	*Lophocyrtis regipileus*	*Mitrocalpis araneafera*	*Ommatartus antepenultimus*	*Peripyramis circumtexta*	*Prunopyle antarctica*	*Prunopyle tetrapila*	*Prunopyle titan*	*Pterocorys hirundo*	*Saturnalis circularis*	*Sethoconus* (?) *dogieli*	*Spongodiscus osculosus*	*Spongomelissa dilli*	*Spongoplegma antarcticum*	*Spongoplegma* sp.	*Spongotrochus glacialis*	*Stichocorys delmontensis*	*Stichophormis* sp.	*Stylatractus neptunus*	*Stylatractus universus*	*Theocalyptra bicornis*	*Theocalyptra bicornis spongothorax*	*Theocorys redondoensis*	*Thyrsocyrtis clausa*	*Triceraspyris antarctica*	*Cyrtocapsella tetrapera*	*Prunopyle hayesi*	*Sethoconus* sp.	*Stylacontarium bispiculum*
1-3, 80-82	C	G	C				A		P	C						C		R					R	R	F	R							C					R		R	P			R	R	R	F		C		C			F	F	P				C				
1, CC	C	G	P				A		P	C					P	P							R	F	R	R							P					F		P	F			R	F	R			A		P			F	P	P				C				
2-3, 80-82	C	G					C	C	P	C						P		R					R	P	F						P		P							F	F	P		F	F	R			P		C			P	F	R				P				
2, CC	F	G					C	C	P	C					F	C		R							R						F										F			R	F	R	P		C		P			R						P				
3, CC	C	G					C	A	C	C					P	C		F					R	R	P						F		C							R		R		F	P	F			C		C			P		R				C				
4-3, 90-92	C	G					C	A	R	C				P	F	C		R					R	R	C		R						P							R		P		F	P	R	R		C		P			F		F				P				
4, CC	C	G					P	A	C	C				F				R							P		F						P					R		R	R	F			R	R			P		C			F		P								
5-3, 120-122	C	G					C	C	C	C	R			P	P			R	A					R	P		P					A								P		C	F	P	F	R			P		P			P		P				F				
5, CC	F	G					P	C	C	P					F	R		R	R								R					C													R				P		P			F		F								
6-3, 110-112	C	G					P	A	C	P				P				R	C				R		P		C					C										P	C				R		P		P			P	P	P								
6, CC	C	G					P	A	C	P				P	R				C				R	R	C		C		R			C										P	P		R		C		F		P			P		P								
7-3, 45-47	C	G					P	A	F	P				P	F			R	A					R	P		C		R			C										C	A						P		C			F	R									
7, CC	F	G					P	A	C	P				C	F				C					R	P		C		R			C										P	C						P		F			P		R				P				
8-3, 40-42	C	G					F	A	A	F				R	P			R	A					R	F		C		P			C								F		P	C				P		P		P			P	R	R				F				
8, CC	C	G					F	C	A	F				F	F			R	P				R	R	F		C		P			P								F		P	C		R	R	F		C		P				R	P								
9-3, 52-54	C	G					P	A	A	F				P	R			R	C					P	P		P		F			P										P	A		R				A		C			P		P				C				
9, CC	C	G						C	A	R				P	R				C		P			P			C		P			C										F	C		F		R		C		C			P	P					C				
10-1, 101-103	C	G		F	P	R															C							F	R						P								R				P				P				R		P	R			R			
10-3, 51-53	C	G		C	F	P									R			R		R	C			P			R	F							C							C			R		F				R				P	C	R	F		P	F	P		
10, CC	F	M		P	R	P					R				F		R	R		R	C			P				C						R	P				R	F		R			R									F		C	F			P		P	R	
11-1, 51-53	C	G		P		P									F					F	C			R				P							P				P								R				F	R				P		R			F	P	R	
11-3, 51-53	C	G		C		C							R					R		P	C			P	P		R	C		R					R	R				R		P			R					R				P		C		R			P	P	R	R
11, CC	F	G		C		F					C		F				R				R			P				P		R				R	R	R			P									C		P		F		F		C		R		C	P	C	F	P
12-3, 80-82	F	M		C		F					C		R				R	R		P	C			P			R	C						R	P	F			P			R			R		R	R		R	F	P		P		C		R			P	C	F	
12, CC	F	M		P							C		R				R			P	F			P				C						F	P	P			P						R		F	F		R		F		P		C		F		P	C	C	F	P
13-1, 51-53	F	M									P						P				P			R				P						R	R	F	R														F							P			C			P
13-3, 51-53	C	G									C				R		P	R			P			F	P			C						R	P	R	P					F			F					P				F				P	R	C	C	C	F	C
13, CC	F	M									C				P		C	R			F			C				C		R				R	P	P	P			P					R		R			P	R			F				P		C	C	C	F	P
14-3, 51-53	C	G									C				P		C	R			P			C				C		C				P	F	R	P					P			R		F	R		P	R		R	P				R	P	F	A	C	R	C
14, CC	F	G									C				F		P	R			C			P				C		R				C	P	P	P			P		R			R								R	P				F	R	P	A	P	F	F
15-1, 45-47	F	G									P	R					P	R						F																		F			R									F				R		P	A	P	R	
15-3, 50-52	C	G									C	C			R		C	R			P			R				A		C				C	F	C	P			R		P			R		F	P			R		P	P				R	P	C	A	C	P	C
15, CC	C	G									P	F					P				C			F				C		P				C	F	C	C					R			R					P			R	F				R		F	C	C	F	P
16-2, 100-102	F	G									C	C			F		P	R			P			P				C		C				C	C	C	P			F		F			P		R	P		C	F		P	F				R		F	A	C	R	C
16, CC	C	G									C	P					R				P			F				C		C				C	P	P	R					F			P			R		C			P	F				R		F	C	F	R	C
17-3, 50-52	C	G									C				R		P	R			R			P	P			C		F				P	C	C	C			F		R			F			R			R		F	P				P			P	P	P	P
17, CC	F	G									C				P		P	F			C			R	R			C		F					P	F	C					R			P		F	R		P			F	F						R	C	C	F	P
18-3, 51-53	C	G									C				P		C	P			F							P		P				C	C	C	C			F		P			R		R			C	P			C				P	R		A	P	F	P
18, CC	F	G									P				F		C				C			P	P			P						P	C	C	C			F					R					R				P				R		R	A	C	P	R
19-3, 50-52	C	M									C				P		C	R			P			P	F			P						P	P	C	F			R		P			R					P	R			P				R		P	C	C	P	F
19, CC	F	M									C				F		C	R			C			P	P			F						P	R	C	P			R		R								P				F				R		P	C	C	P	
20-2, 50-52	F	M									F						P							R				P						F	F	P	F										R			P	R							F			C			
20-3, 50-52	C	G									C				F		C	F			F			P				C						P	P	P	F					F			F		R	R		F	R			R						P	C		R	F
20, CC	F	G									C						P	R			C			P				C						P	R	C				F		R			R					C				R				R	R		C	C	R	
21-3, 50-52	C	G									C				F		C	R			P			R	F			C						P	R	C				F							R			P	C			F				P		P	A	P	P	
21, CC	C	G									C				R		P							F										R	P	P				P		R			R		R			F				P				F			A	C		R
22-3, 50-52	C	M									P				F		P	F			P			P										P	P	R				F		R			R			P		F	F			F				R			A	P		P
22, CC	T	P									P						R				F													R	P							R					F			P				P						P		F		C
23-1, 36-35	F	M									C				F		C	F			C			R	R			C						C	P	C				R		R			R						P							R			C	P	R	C

Note: See text for explanation of entries.

TABLE 6A
Radiolaria from Holes 267 and 267A

Sample (Interval in cm) \ Species	Abundance	Preservation	*Acanthosphaera* sp.	*Actinomma tanyacantha*	*Antarctissa antedenticulata*	*Antarctissa conradae*	*Antarctissa denticulata*	*Antarctissa ewingi*	*Antarctissa longa*	*Antarctissa strelkovi*	*Amphistylus angelinus*	*Calocyclas disparidens*	*Cannartus prismaticus*	*Clathrocyclas bicornis*	*Cornutella profunda*	*Cycladophora davisiana*	*Cyrtocapsella isopara*	*Cyrtopera laguncula*	*Desmospyris spongiosa*	*Dendrospyris megalocephalis*	*Dendrospyris haysi*	*Dictyocephalus papillosus*	*Dictyophimus mawsoni*	*Druppatractus* sp.	*Echinomma delicatulum*	*Echinomma popofskii*	*Eucyrtidium calvertense*	*Eucyrtidium cienkowskii* Group	*Eucyrtidium inflatum*	*Eucyrtidium punctatum*	*Haliometta miocenica*	*Helotholus vema*
1-1, 120-122	C	G	R				C	P	A	C						A		F						F	P							
1-2, 110-112	F	G					P	C	C	P					F	C		R					R	F	F							
1-3, 110-112	C	G					P	A	C	C					F	A		R						F								
1, CC	C	G					P	C	C	C				C	R	P		R	P					R			P					C
1A-1, 70-72	C	G					C	C	C	P					F	C		F						P	P	R						
1A-2, 82-84	F	M					C	A	C	C				P		C			P				R		F		P					C
1A-3, 75-77	C	M					P	C	P	F				R	F	C			C					R			P					A
1A-4, 75-77	C	G			R	R	R	C						f	P				C					F	P		P		R			C
1A-5, 75-77	C	G			R	R	F	C						P	P				C					F	P		P		R			C
1A-6, 75-77	C	G			F		P	A	A					P				R	C					R	F		C		F			C
1A, CC	F	M			F			C	C					F	F				P					F			F		R			F
2, CC	F	G																R			C			P			F					
3A-1, 103-107	C	G		P		C							R		R			R		R	C			P				C				
3A-2, 40-44	C	G		P		C					F									F	P			P				C				
3A, CC	F	M		F		P					R										P			R				P				
3-1, 145-147	F	G									P						P				F			F				F				
3-2, 40-44	F	M									P										P			F								
3-3, 110-114	F	G									P						R				P			F	P			R				
3-4, 110-114	R	M									C										F											
3-5, 120-124	C	M									C													F	P			F				
3, CC	F	M									F						R				F							P				

Sample (Interval in cm) \ Species	*Lithelius nautiloides*	*Lithomelissa* sp. A	*Lithomelissa* sp. C	*Lophocyrtis golli*	*Lophocyrtis regipileus*	*Mitrocalpis araeafera*	*Ommatartus antepenultimus*	*Peripyramis circumtexta*	*Prunopyle antarctica*	*Prunopyle tetrapila*	*Prunopyle titan*	*Pterocorys hirundo*	*Saturnalis circularis*	*Sethocornus (?) dogieli*	*Spongodiscus osculosus*	*Spongomelissa dilli*	*Spongoplegma antarcticum*	*Spongoplegma* sp.	*Spongotrochus glacialis*	*Stichocorys delmontensis*	*Stichophormis* sp.	*Stylatractus neptunus*	*Stylatractus universus*	*Theocalyptra bicornis*	*Theocalpytra bicornis spongothorax*	*Theocorys redondoensis*	*Thyrsocyrtis clausa*	*Triceraspyris antarctica*	*Cyrtocapsella tetrapera*	*Prunopyle hayesi*	*Sethoconus* sp.	*Stylacontraium bispiculum*
1-1, 120-122	P					F		F	P	F			F		P		C		C			R						P				
1-2, 110-112	F							F		F					F		P		C				R	F				P				
1-3, 110-112	P							R		P		R	R		F		C		C									P				
1, CC										F					R		P		P			R						F				
1A-1, 70-72	P					R		F		F			P				C		C					F								
1A-2, 82-84										P			R				P		P			F		F				P				
1A-3, 75-77								P		F							P		P					P				P				
1A-4, 75-77								P		P	C	R			P		C		C					P								
1A-5, 75-77								P		P	C	R			P		C		C					P								
1A-6, 75-77										P	C	F			P		P		C					C								
1A, CC						R				F	C				P		C		C					R				P				
2, CC			C							P					F				P						P			P		P		
3A-1, 103-107										F					P				P					C		F				P	R	
3A-2, 40-44										F									F					P					R	C	R	
3A, CC			R	R						R									R					F						P		
3-1, 145-147			F	F						F					F	R										R		F	P	C	F	R
3-2, 40-44			F							F																		P		C		
3-3, 110-114			F	F											F				R									F	R	C		R
3-4, 110-114				F																								F	C	C		
3-5, 120-124		F		F						R									R		R			P		R		P	R	C		P
3, CC		R	R	R																								R	P	P		R

Note: See text for explanation of entries.

TABLE 6B
Radiolaria from Hole 267B

Sample (Interval in cm)	Abundance	Preservation	*Acanthospaera* sp.	*Actinomma tanyacantha*	*Antarctissa antedenticulata*	*Antarctissa conradae*	*Antarctissa denticulata*	*Antarctissa ewingi*	*Antarctissa longa*	*Antarctissa strelkovi*	*Amphistylus angelinus*	*Calocyclas disparidens*	*Cannartus prismaticus*	*Clathrocyclas bicornis*	*Cornutella profunda*	*Cycladophora davisiana*	*Crytocapsella isopera*
1-1, 75-77	F	G					P	F	A	C				R	F		
1, CC	F	G					P	C	A	C							
2-1, 132-134	C	G					C	C	C	P					R		
2, CC	F	G					C	C	P	F							
3-2, 120-122	F	G					P	C	P	P					R		
3 CC	C	G					C	A	P	F							
4-1, 100-106	F	M			F	P											
4-3, 100-104	C	G			P	C									P		
4, CC	F	M			P	P									P		
5-3, 80-84	C	G				F									F		
5, CC	F	G				R									P		
6-3, 110-114	C	G		C	R	P									F		
6, CC	C	G		C		F					F				R		
7-3, 110-114	F	M		P		F					F				F		
7, CC	R	P		F							P						
8-3, 110-114	F	M		F							P						
8, CC	F	M									P						
9-3, 110-114	C	M									P						
9-6, 10-114	R	M									R						
9, CC	F	R															

Sample (Interval in cm)	*Cyrtopera laguncula*	*Desmospyris spongiosa*	*Dendrospyris megalocephalis*	*Dendrospyris haysi*	*Dictyocephalus papillosus*	*Dictyophimus mawsoni*	*Druppatractus* sp.	*Echinomma delicatulum*	*Echinomma popofskii*	*Eucyrtidium calvertense*	*Eucyrtidium cienkowskii* Group	*Eucyrtidium inflatum*	*Eucyrtidium punctatum*	*Haliometta miocenica*	*Helotholus vema*	*Lithelius nautiloides*	*Lithomelissa* sp. A	*Lithomelissa* sp. C	*Lophocyrtis golli*	*Lophocyrtis regipileus*	*Mitrocalpis araneafera*	*Ommatartus antepenultimus*
1-1, 75-77	R									P		R										
1, CC	R	F								F												
2-1, 132-134						R	R			F												
2, CC										P		R						R				
3-2, 120-122							F					R			R							
3 CC															R							
4-1, 100-106				P						P		F										
4-3, 100-104				P			R			C		P										
4, CC		F		C						F								F				
5-3, 80-84				C							P							P				
5, CC	R			C			P											C				
6-3, 110-114				C			P	F			C							P				
6, CC				A			P				C							R				
7-3, 110-114				C			P				C							R				F
7, CC				F			P				P								F			P
8-3, 110-114			R				F				P						C	F				
8, CC			F	P			P				F								R			
9-3, 110-114				P			R				F							R				
9-6, 10-114							R				F								R			
9, CC																						

Sample (Interval in cm)	*Peripyramis circumtexta*	*Prunopyle antarctica*	*Prunopyle tetrapila*	*Prunopyle titan*	*Pterocorys hirundo*	*Saturnalis circularis*	*Sethoconus* (?) *dogieli*	*Spongodiscus osculosus*	*Spongomelossa dilla*	*Spongoplegma antarcticum*	*Spongoplegma* sp.	*Spongotrochus glacialis*	*Stichocorys delmontensis*	*Stichophormis* sp.	*Stylatractus neptunus*	*Stylatractus universus*	*Theocalyptra bicornis*	*Theocalpytra bicornis spongothorax*	*Theocorys redondoensis*	*Thyrsocyrtis clausa*	*Triceraspyris antarctica*	*Cyrtocapsella tetrapera*	*Prunopyle hayesi*	*Sethoconus* sp.	*Stylacontraium bispiculum*
1-1, 75-77	F		F			R		F				C			R	F	F				F				
1, CC								F				F				R									
2-1, 132-134	R							P				P				C	P		R		P				
2, CC			F					F				F				P					P				
3-2, 120-122								R							R		P								
3 CC	R		R	R								R				R	F								
4-1, 100-106				F				F										P							
4-3, 100-104	F		P									P				P	P	C	R		P		P		
4, CC	F		F									P				C	P	P					P	R	
5-3, 80-84			R					F				F				A	R	C					F		
5, CC			F					P				F					F	P			P		F		
6-3, 110-114			F					P				C					C	C	R				P		
6, CC			F					P				P					C		R				C		
7-3, 110-114	R		R					P				F					R		R				C		
7, CC																							P		
8-3, 110-114			R						P						F		R		R				C		
8, CC			R					P			P						P		P				P		
9-3, 110-114			R					F			R											R	P		P
9-6, 10-114								R				R									R		F		C
9, CC																							F		C

Note: See text for explanation of entries.

TABLE 7
Radiolaria from Hole 268

Sample (Interval in cm)	Abundance	Preservation	Acanthosphaera ap.	Actinomma tanyacantha	Antarctissa antedenticulata	Antarctissa conradae	Antarctissa denticulata	Antarctissa ewingi	Antarctissa longa	Antarctissa strelkovi	Amphistylus angelinus	Calocyclas disparidens	Cannartus prismaticus	Clathrocyclas bicornis	Cornutella profunda	Cycladophora davisiana	Cyrtocapsella isopera	Cytopera laguncula	Desmospyris spongiosa	Dendrospyris megalocephalis	Dendrospyris haysi	Distyocephalus papillosus
1-3, 110-114	F	G	F				C		F	R						P						
1, CC	T	P																				
2-3, 40-44	R	G						P		R												
2, CC	B																					
3-2, 50-54	F	G					F	C	R	R				C					C			
3, CC	T	G						P														
4-2, 40-44	C	G					P	A	P	P				C	P			R	C			
4, CC	R	G					P	C	P	F				C					P			
5-2, 40-44	C	G					F	C	A	C				P	P			R			F	
5, CC	F	G						C	P	P				F							R	
7-2, 40-44	C	G					P	A	A	C												
8-3, 40-44	C	G									C				F		F	R				
8, CC	R	M															F					
9-3, 50-54	F	M																			F	
9, CC	R	G													R						P	
10-3, 42-46	T	G																			P	
10, CC	B																					
11-1, 127-130	T	M																			P	
11, CC	R	P																				
12-1, 50-54	R	P									F											
12, CC	F	M									P							R			F	
13-1, 99-101	F	M									C											

Sample (Interval in cm)	Dictyophimus mawsoni	Druppatractus sp.	Echinomma delicatulum	Echinomma popofskii	Eucyrtidium calvertense	Eucyrtidium cienkowskii Group	Eucyrtidium inflatum	Eucyrtidium punctatum	Haliommetta miocenica	Helotholus vema	Lithelius nautiloides	Lithomelissa sp. A.	Lithomelissa sp. C.	Lophocyrtis golli	Lophocyrtis regipileus	Mitrocalpis araneafera	Ommatartus antepenultimus	Peripyramis circumtexta	Prunopyle antarctica	Prunopyle tetrapila	Prunopyle titan	Pterocorys hirundo
1-3, 110-114											P					R		R	F	R		
1, CC																						
2-3, 40-44																				F		
2, CC																						
3-2, 50-54					P					C										F		
3, CC																						
4-2, 40-44	R				C					C										P		
4, CC					P					P												
5-2, 40-44		R	F		P		R													F	C	
5, CC					F		R												R		P	
7-2, 40-44							F			R	P									F	F	
8-3, 40-44		F				F						F	F	C								
8, CC		R										F		R								
9-3, 50-54														P								
9, CC		F										P		F								
10-3, 42-46												P		P								
10, CC																						
11-1, 127-130														F								
11, CC		P												R						R		
12-1, 50-54																						
12, CC																						
13-1, 99-101		R																				

Sample (Interval in cm)	Saturnalis circularis	Sethoconus (?) dogieli	Spongodiscus osculosus	Spongomelissa dilli	Spongoplegma antarcticum	Spongoplegma sp.	Spongotrochus glacialis	Stichocorys delmontensis	Stichophormis sp.	Stylatractus neptunus	Stylatractus universus	Theocalyptra bicornis	Theocalpyptra bicornis spongothorax	Theocorys redondoensis	Thyrsocyrtis clausa	Triceraspyris antarctica	Cyrtocapsella tetrapera	Prunopyle hayesi	Sethoconus sp.	Stylacontraium bispiculum
1-3, 110-114					R		P					F								
1, CC																				
2-3, 40-44							P													
2, CC		R	P		P		C													
3-2, 50-54																				
3, CC																				
4-2, 40-44		R	F				P													
4, CC			R				F													
5-2, 40-44			C				C				P	P				R				
5, CC			F				F													
7-2, 40-44			P				C				C	P		R						
8-3, 40-44	R		F	F		F	P									C		C	R	
8, CC							P							R						
9-3, 50-54			R				F									F	F	F		
9, CC			F				R											P		
10-3, 42-46			F																	
10, CC							F													
11-1, 127-130																				
11, CC							P					R		R		F		P		
12-1, 50-54							P							R						
12, CC			F				F											C		F
13-1, 99-101			F															C		F

Core 14 and below are barren of Radiolaria

Note: See text for explanation of entries.

TABLE 8
Radiolaria from Holes 269 and 269A

Samples (Interval in cm) \ Species	Abundance	Preservation	*Acanthosphaera* sp.	*Actinomma tanyacantha*	*Antarctissa antedenticulata*	*Antarctissa conradae*	*Antarctissa denticulata*	*Antarctissa ewingi*	*Antarctissa longa*	*Antarctissa strelkovi*	*Amphistylus angelinus*	*Calocyclas disparidens*	*Cannartus prismaticus*	*Clathrocyclas bicornis*	*Cornutella profunda*	*Cycladophora davisiana*	*Cyrtocapsella isopera*	*Cyrtopera laguncula*	*Desmospyris spongiosa*	*Dendrospyris megalocephalis*	*Dendrospyris haysi*	*Dictyocephalus papillosus*
1-3, 50-54	C	G					C		P	P					P	F		F				
1, CC	F	G					P			F												
2-2, 60-64	C	G					C	A	C	C				P	F				C			
2, CC	C	G					P	A	F	R				P					C			
3-3, 67-71	F	G					P	P	P	P				P	F				P			
3, CC							P	P	P	P				F								
4-1, 134-138	F	G			P	C									F				F			
5, CC	F	G																			P	
6-3, 14-18	F	M													F						R	
6, CC	F	M			F																	
7-3, 90-94	C	G		C	P	F					F				R						C	
7, CC	T	M																				
8-1, 134-138	F	M		F																R	P	
8, CC	B																					
9-3, 90-94	T	P																			R	
9, CC	F	M									P											
10-3, 90-94	B																					
11-2. 41-45	T	P																				
11A-2, 113-117	F	M																				

Samples (Interval in cm) \ Species	*Dictyophimus mawsoni*	*Druppatractus* sp.	*Echinomma delicatulum*	*Echinomma popofskii*	*Eucyrtidium calvertense*	*Eucyrtidium cienkowskii* Group	*Eucyrtidium inflatum*	*Eucyrtidium punctatum*	*Haliommetta miocenica*	*Helotholus vema*	*Lithelius nautiloides*	*Lithomelissa* sp. A	*Lithomelissa* sp. C	*Lophocyrtis golli*	*Lophocyrtis regipileus*	*Mitrocalpis araneafera*	*Ommatartus antepenultimus*	*Peripyramis circumtexta*	*Prunopyle antarctica*	*Prunopyle tetrapila*
1-3, 50-54											P					R				R
1, CC																				
2-2, 60-64					P					C								F		
2, CC		R	P		C					C						P	C			
3-3, 67-71					P					F							P			
3, CC		R			F					R						F	F			
4-1, 134-138										R										
5, CC							R						F							
6-3, 14-18		R			R		F													F
6, CC							R													
7-3, 90-94		R				C							C				R			F
7, CC																				F
8-1, 134-138						P														
8, CC																				
9-3, 90-94																				
9, CC		F																		R
10-3, 90-94																				
11-2. 41-45						R														
11A-2, 113-117		R				R														

Samples (Interval in cm) \ Species	*Prunopyle titan*	*Pterocorys hirundo*	*Saturnalis circularis*	*Sethoconus* (?) *dogieli*	*Spongodiscus osculosus*	*Spongomelissa dilli*	*Spongoplegma antarcticum*	*Spongoplegma* sp.	*Spongotrochus glacialis*	*Stichocorys delmontensis*	*Stichophormis* sp.	*Stylatractus neptunus*	*Stylatractus universus*	*Theocalyptra bicornis*	*Theocalyptra bicornis spongothorax*	*Theocorys redondoensis*	*Thyrsocyrtis clausa*	*Triceraspyris antarctica*	*Cyrtocapsella tetrapera*	*Prunopyle hayesi*	*Sethoconus* sp.	*Stylacontraium bispiculum*
1-3, 50-54				R	P		P		P					P				P				
1, CC							F															
2-2, 60-64		R	R	R					P					F								
2, CC	P		P		P		P		P									F				
3-3, 67-71	F				F				P				P					P				
3, CC													C	F				P				
4-1, 134-138					P								P							F		
5, CC					R			R	P				C	F	P					P		
6-3, 14-18					R			F	R				C	F	C			P		P		
6, CC													C					P		P		
7-3, 90-94					P									P	P	R				C		
7, CC																				P		
8-1, 134-138						F		P	P					P						C		
8, CC																						
9-3, 90-94																						
9, CC																			P	F		
10-3, 90-94									R													
11-2. 41-45																						
11A-2, 113-117						F												F	P	P		

Cores 2A to 13A are barren of Radiolaria.

Note: See text for explanation of entries.

Site 270

Site 270 is in the southern part of the Ross Sea. About 412 meters of silty clay, silty claystone, calcareous greensand, and silty sand were penetrated. Except for the following, Radiolaria are generally absent or occur only as unidentifiable fragments in most of the samples studied. Core 1: a few well-preserved Radiolaria (*Antarctissa strelkovi*, *Antarctissa denticulata*, and *Triceraspyris antarctica*); post-Miocene. Sample 3-1, 105-107 cm: fragments of Spumellaria. Sample 15, CC: fragments of Spumellaria.

Site 271

Site 271 lies about 80 km northeast of Site 270. Some 15 meters of silty clay and clayey silt were recovered from 265 meters of hole. Except for the following, Radiolaria are generally absent in most of the samples studied. Sample 1-1, 15-17 cm: a few moderately preserved Radiolaria (*Antarctissa denticulata*, *Antarctissa strelkovi*, *Triceraspyris antarctica* and *Spongotrochus glacialis*); post-Miocene. Sample 2-1, 132-136 cm: traces of moderately preserved Radiolaria (*Antarctissa denticulata*, *Antarctissa ewingi*, *Spongotrochus glacialis*, and *Antarctissa strelkovi*); Pliocene. Sample 9-1, 74-78 cm: a few moderately preserved Radiolaria (*Antarctissa denticulata*, *Antarctissa ewingi Desmospyris spongiosa*, and *Helotholus vema*); the *Helotholus vema* Zone. Sample 24, CC: rare and poorly preserved Radiolaria (*Spongotrochus glacialis*, and *Dendrospyris haysi*); Miocene?

Site 272

Site 272 is located about halfway between Sites 270 and 271. About 440 meters of diatomaceous silty clay and silty claystone were penetrated. Radiolaria are generally absent or occur only in trace amounts. The following were observed. Sample 11-3, 41-44 cm: traces of poorly preserved Radiolaria (*Helotholus vema*, and *Prunopyle titan*); the *Helotholus vema* Zone? Sample 16-2, 67-71 cm: traces of poorly preserved Radiolaria (*Helotholus vema*, and *Prunopyle titan*); the *Helotholus vema* Zone? The zonal assignments are tenuous because of the absence of *Antarctissa strelkovi*, *Antarctissa denticulata* and *Antarctissa ewingi*, which are generally the most abundant species in post-Miocene sediments.

Site 273

Site 273 is in the west-central part of the Ross Sea on the flank of an apparent erosional valley that bounds the western edge of Pennell Bank. About 346 meters of diatomaceous silty clay were penetrated, with a recovery of 83 meters. Sediments similar to the sediments at Sites 270-272 generally contain no Radiolaria, or only traces of unidentifiable forms. However, the following were identified at certain levels. Core 1: common and well-preserved Radiolaria (*Antarctissa denticulata*, *Antarctissa strelkovi*, *Theocalyptra bicornis*, and *Lithelius nautiloides*); the *Antarctissa denticulata* Zone. Sample 3-1, 120-124 cm: rare and well-preserved Radiolaria (*Antarctissa denticulata*, *Antarctissa strelkovi*, and *Spongotrochus glacialis*); post-Miocene. Sample 5-1, 78-81 cm: rare and well-preserved Radiolaria (*Antarctissa ewingi*, *Lithelius nautiloides*, and *Antarctissa denticulata*); Pliocene?

Site 274 (Tables 9A, 9B)

Site 274 lies on the continental rise northeast of Cape Adare. A largely terrigenous clay-rich sedimentary sequence about 415 meters thick overlies basalt at this site. Radiolaria are few and well preserved in Cores 1-4; common and well preserved in Cores 5-11, and 20-34, and rare and moderately preserved in Cores 12-19, and 35-42.

Radiolarian zones represented are: Cores 7-11, the *Helotholus vema* Zone; Core 12, the *Theocalyptra bicornis spongothorax* Zone. Cores 13-19 contain low abundance of radiolarian assemblages which indicate Miocene age. On the basis of presence of *Cyrtocapsella isopera*, Cores 15-19 are early to middle Miocene. In Cores 20-34, radiolarian assemblages are of uniform species composition throughout the entire section. A comparison of the radiolarian assemblages of Core 20 from this site and Core 18 of Site 277 suggests that Core 20 is early Oligocene. There may therefore be a hiatus between Cores 19 and 20 with late or middle to late Oligocene sediments missing. Cores 35-42 have the same, but less diverse radiolarian assemblages. The age of this interval is uncertain. No reworked older Radiolaria were observed in this site.

SYSTEMATICS

The classification proposed by Riedel (1967a,b, 1971) is followed wherever applicable. Synonymies of taxa presented here are kept to a minimum and restricted to the original description and those which reflect the current concept or latest usage. Species are arranged alphabetically by family. Species abundances and ranges are indicated. For those species which have uncertain ranges as a result of intermittent coring, barren sediments, or scarcity, occurrences rather than specific ranges are given. Type specimens will be deposited in the U.S. National Museum, Washington, D.C.

Order POLYCYSTINA Ehrenberg

Polycystina Ehrenberg, 1838, emend. Riedel, 1967b, p. 291.

Suborder SPUMELLARIA Ehrenberg, 1875

Family ACTINOMMIDAE Haeckel, emend. Riedel

Actinommidae Haeckel, 1862, emend. Riedel, 1967b.

Genus ACANTHOSPHAERA Ehrenberg

Acanthosphaera Ehrenberg, 1858, p. 12.

Acanthosphaera sp.
(Plate 22, Figure 5)

Acanthosphaera sp. Hays, 1965, p. 169, pl. II, fig. 8.
Abundance: Rare to few.
Occurrence: Lower Pleistocene.

Genus ACTINOMMA Haeckel

Actinomma Haeckel, 1862, p. 440.

Actinomma tanyacantha, n. sp.
(Plate 11, Figures 5, 6)

Description: Shell composed of two medullary shells and one cortical shell. Inner medullary shell approximately spherical. Outer medullary shell polygonal with small circular pores, connected to cortical shell by six 3-bladed spines aligned in three perpendicular axes,

TABLE 9A
Radiolaria from Hole 274

Samples (Interval in cm) \ Species	Abundance	Preservation	*Acanthosphaera* sp.	*Actinomma tanyacantha*	*Antarctissa antedenticulata*	*Antarctissa conradae*	*Antarctissa denticulata*	*Antarctissa ewingi*	*Antarctissa longa*	*Antarctissa strelkovi*	*Amphistylus angelinus*	*Calocyclas disparidens*	*Cannartus prismaticus*	*Clathrocyclas bicornis*	*Cornutella profunda*	*Cycladophora davisiana*	*Cyrtocapsella isopera*	*Cyrtopera laguncula*	*Desmospyris spongiosa*	*Dendrospyris megalocephalis*	*Dendrospyris haysi*	*Dictyocephalus papillosus*	*Dictyophimus mawsoni*	*Druppatractus* sp.	*Echinomma delicatulum*	*Echinomma popofskii*	*Eucyrtidium calvertense*	*Eucrtidium cienkowskii* Group	*Eucyrtidium inflatum*	*Eucyrtidium punctatum*	*Haliommetta miocenica*	*Helotholus vema*	*Lithelius nautiloides*	*Lithomelissa* sp. A	*Lithomelissa* sp. C	*Lophocyrtis golli*	*Lophocyrtis regipileus*	*Mitrocalpis araneafera*	*Ommatartus antepenultimus*	*Peripyramis circumtexta*	*Prunopyle antarctica*	*Prunopyle tetrapila*	*Prunopyle titan*	*Pterocorys hirundo*	*Saturnalis circularis*	*Sethoconus (?) dogieli*	*Spongodiscus osculosus*	*Spongomelissa dilli*	*Spongoplegma antarcticum*	*Spongoplegma* sp.	*Spongotrochus glacialis*	*Stichocorys delmontensis*	*Stichophormis* sp.	*Stylatractus neptunus*	*Stylatractus universus*	*Theocalyptra bicornis*	*Theocalyptra bicornis spongothorax*	*Theocorys redondoensis*	*Thyrsocyrtis clausa*	*Triceraspyris antarctica*	*Cyrtocapsella tetrapera*	*Prunopyle hayesi*	*Sethoconus* sp.	*Stylacontraium bispiculum*
1-3, 87-90	F	G					C	A	P	P					F	P																								F	P			R		R	R		F		P			F		P				F				
1, CC	T	G					P	P	P	P								R															R									R									F													
2, CC	T	M						P		R																																R					R				F			F										
3-3, 71-73	R	M						P		R						R																								F	F								R															
3, CC	F	G					P	C	C	C														R									F									F				R					P			R						P				
4-1, 60-62	R	G					P	C	C	C														F																R		R		R							F			F						R				
4, CC	F	M					P	C	C	P						P			P								R				R	P	P							F				R		R	F		F		P									F				
5-2, 60-62	C	G					C	A	P	P				P	F	P			C					R	F		R				R	P								F		R				R	F		P		C			R		F								
5, CC	C	G					C	A	P	P				P		C			C					F			P					C								R		P		F	R	R	R				P			F										
6-3, 110-114	C	G					C	A	C	C				P	F	P		R															F							F		P		R	R	R	F				C					R								
6, CC	C	G					P	A	P	P					R			R						R			R													R		P			R	F			F		C			R		C								
7-2, 110-114	F	G					F	C	F	F				P	F				R					R			R						P							R		P		R	R	R	R				F			R										
7, CC	F	P					R	C	P	P				P										R	R							P										F									P			F		P								
8, CC	C	G					F	A	P	C				P	F	P			C								P					A								F		F				R	P		P		P					F								
9-3, 112-116	F	G					P	A	C	C				P					A					R	R		P					P								R		R				R			P		P			R		F		R						
9, CC	F	G					P	A	C	C				P	P				C					F			P		R			P								R		P		R		R	P		F		P			P		F								
10-3, 142-146	C	G					P	C	A	C				P	P				A					R			F		F			F								P		P	C			R			P		C			F		F								
10, CC	C	G					C	P	A	P				P					P					R			F		F			F								R		F	F								C			P										
11-3, 136-140	C	G					F	C	A	P				P	F				F					P	R		P		P													P	R				P		P		P			F	F									
11, CC	C	M					P	C	A	P				F					R					R					F											F		R	R								F			F	C	F				F				
12-3, 142-146	R	M			R	P									C						C			R					C													R									R						P					C		
12, CC	F	G		C	F	F									P						P			R											R	R						R													C		P	R				P	R	R
13-3, 142-146	T	M																																																												R		
13, CC	T	G																																																					R						P		
14-4, 60-64	F	M				F									R		R	R						F																											P					P						R		
14, CC	T	P																R																																						R						C		
15-3, 50-54	T	G															P																																	R						C								
15, CC	T	M																																																						R								
16-3, 60-64	R	M															R											R							R						R																					P		
16, CC	T	M															F																		R																													
17-3, 80-90	T	M															C							R											R															R						R						P		
17, CC	T	M															P											R																												R						C		
18-3, 60-70	T	M															P																																							R						C		
18, CC	T	P																																						R																						F		
19-4, 90-100	T	P															P																																													P		

Note: See text for explanation of entries.

TABLE 9B
Radiolaria from Hole 274

Samples (Interval in cm) \ Species	Abundance	Preservation	*Amphisphaera* sp.	*Amphistylus angelinus*	*Calocyclas semipolita* (?)	*Carpocanarium* (?) sp.	*Cenosphaera* sp.	*Dendrospyris stabilis*	*Diplocyclas* sp. A Group	*Eucyrtidium* sp.	*Lithomelissa challengerae*	*Lithomelissa* sp. B	*Lithomelissa robusta*	*Lithomelissa sphaerocephalis*	*Lithomelissa tricornis*	*Lithomelissa* sp. C	*Prunopyle hayesi*	*Prunopyle frakesi*	*Sethoconus* sp.	*Spongomelissa* sp.	*Cyclampterium* (?) *longiventer*
20-3, 40-50	F	G	C	R	P	C	C	C		C	R	R	P	C	F	P	C	C	C	R	R
20, CC	F	G	C	F	P	C	C	P		C	F	F	P	P	F	P	C	C	C	F	F
21-3, 54-64	C	G	C	P	F	P	C	P	F	C	P	P	F	C	P	C	P	C	C	R	P
21, CC	F	G	P	P	F	P	C	C	R	C	R			C	R	R	C	C	P	R	R
22-3, 60-70	F	G	C	P	F	C	C	P	F	C	P	R	P	P	C	P	C	C	C		R
22, CC	F	G	C	P	C	P	C	P	P	C	F	P	P	C	P	C	C	C	C	R	F
23-3, 60-70	F	G	C	P	C	C	C	C	R	C	P	P	P	C	P	C	C	C	P	R	P
24-3, 60-70	C	M	C	R	C	F	C	P	R	C	P	R	R	P	P	C	C	C	P	F	R
24, CC	F	M	C	R	P	P	C	P	F	C	F	R	F	P	R	C	C	C	P	F	R
25-3, 60-70	C	M	C	F	P	C	C	P		C	R	P	R	C	P	C	C	C	P	R	R
25, CC	C	M	C	P	P	P	C	P	F	C	F	P	F	P	R	P	C	C	P		P
26-3, 50-70	F	M	C		P	C	C	F		C	P	P	P	F	P	C	C	C	C	R	P
26, CC	F	M	C		P	P	C	R	F	C			F	P		C	C	C	P		
27-3, 50-70	F	M	C	R	C	F	C	P	R	C	P	F	R	C	P	P	P	P	P	R	F
27, CC	R	M	C	R	F	R	C	P	R	P	R	R	R	R	P	C	P	R	R	R	R
28-3, 50-70	R	M	C		P	P	C	F		C	P	R	R	F	P	C	C	C	P		R
28, CC	F	M	C	R	R	P	C		F	C	R	R	R	R	P	F	C	C	P		
29-3, 50-70	C	M	C	P	P	R	C	P		C	P	F	F	C	F	R	C	C	C		R
29, CC	R	M	C	P	R	P	C	R	R	C	R	R	R		R	P	C	P	C	R	R
30-3, 50-70	F	M	C	R	P	R	C	R		C	R	R	R	P	P	F	C	C	C	R	R
30, CC	F	M	C	P	P	F	P	F		P	R	R	R	P	F	F	P	P	F	R	R
31-3, 50-70	F	M	C	R	F	F	P	F	R	P	F	R		P		F	P	P	C	R	F
31, CC	C	M	C	P	P	P	P	P		C	P	F		F		P	P	C	F		R
32-3, 50-70	F	M	C		P	F	C	F		C	R		P	C	R	C	P	P	P	R	R
32, CC	F	M	P	R	P	P	C	P	R	P	R		R	P	R	P	P	C	P		P
33-3, 55-75	C	G	P	P	C	P	C	P		C	P		F	P	R	F	C	P	C	R	P
33, CC	C	M	C	F	C	C	C	R		C	R		F	C	R	C	C	C	P	R	F
34-3, 24-44	F	M	C	P	P		C	P	R	C	R	R	P	C	R	P	C	C			R
34, CC	R	M	C	F	P	P	P	F		P	R	R	F	P	R	P	C	C	P	F	F
36-1, 108-118	R	P	C	P	P			R		P	F			C		P	P		P	R	P
36, CC	R	P	C		P									P			C				
37-1, 73-77	R	P	C	F	P					P	R	R		P			P			R	F
38, CC	R	P	P		P					P				P			P	F			F
38-2, 35-45	R	M	C		P						R			F			P	R			F
39-2, 60-70	F	P	C	R	P		F			R	F			F			C	R			R
40-1, 75-85	R	P	P		C					R		R	R	P			P			R	R
40, CC	R	P	P		P									P			P				
41-3, 40-50	R	P	R	R	F									R			P				R
42-3, 50-60	R	P	P		P							R		P			P				

Note: See text for explanation of entries.

and extending outside as large 3-bladed primary spines. Cortical shell spherical or somewhat subcubical when viewed along one of the primary spines, with large (27μ-36μ) circular pores of uniform size. Additional 8 large 3-bladed secondary spines arising from the cortical shell.

Measurements based on 25 specimens from Samples 266-17, CC; 266-12-3, 80-83 cm; 266-12, CC; and 266-11, CC: length of the spine, 45μ-90μ; diameter of the cortical shell, 125μ-153μ; of the outer medullary shell, 45μ-63μ; of the inner medullary shell, 18μ-27μ.

Remarks: This species differs from other members of this genus in having large 3-bladed primary and secondary spines.

Abundance: Common.
Range: Middle to upper Miocene.

Genus AMPHISPHAERA Haeckel

Amphisphaera Haeckel, 1881, p. 452.

Amphisphaera minor (Clark and Campbell)
(Plate 3, Figure 1)

Stylosphaera minor Clark and Campbell, 1942, p. 27, pl. 5, fig. 1, 2, 2a, 12.

Amphisphaera minor (Clark and Campbell), Sanfilippo and Riedel, 1973, p. 486, pl. 1, fig. 1-5; pl. 22, fig. 4.

Abundance: Present.

Occurrence: Eocene (upper Eocene?).

Amphisphaera sp.
(Plate 6, Figures 1, 2)

Description: Shell consisting of two medullary shells and one cortical shell. Inner medullary shell a loose meshwork. Outer medullary shell spherical to ellipsoidal with small circular pores connecting to cortical shell by 6-8 radiating bars. Cortical shell spherical, of variable thickness; 12-14 circular to subcircular pores of equal dimension, evenly distributed across a diameter. Polar spines slenderly conical, weakly bladed at the base.

Measurements based on 35 specimens from Samples 274-21-3, 54-64 cm; 274-21, CC; 274-22, CC; 274-23, CC; and 274-34, CC: diameter of the cortical shell, 99μ-137μ; of the outer medullary shell, 37μ-47μ; length of the polar spines, 84μ-109μ.

Abundance: Common.

Occurrence: Oligocene.

Genus AMPHISTYLUS Haeckel

Amphistylus Haeckel, 1881, p. 452.

Amphistylus angelinus (Campbell and Clark)
(Plate 21, Figures 3, 4)

Stylosphaera angelina Campbell and Clark, 1944, p. 12, pl. 1, fig. 14-20.

Axoprunum angelinum (Campbell and Clark) Kling, 1973, p. 634, pl. 6, fig. 18.

Description: Shell composed of two medullary shells and one cortical shell. Inner medullary shell irregular with 3-4 polygonal pores across a diameter. Outer medullary shell approximately spherical, with 7-9 circular pores of equal dimensions across a diameter, connected to cortical shell by two bars collinear with the polar spines, and by 6-11 randomly distributed bars.Cortical shell spherical or slightly ellipsoidal, medium to thick-walled, covered by small conical spines of variable length, with small circular, regularly disposed pores of uniform size. Polar spines slenderly conical, unequal in length, commonly not aligned along the polar axis.

Measurements based on 40 specimens from Samples 274-21, CC; 266-16-2, 100-102 cm; 266-15, CC; 266-14 CC; and 266-14-1, 51-53 cm: diameter of the cortical shell, 117μ-154μ; of the outer medullary shell, 30μ-37μ; and of the inner medullary shell, 25μ-30μ; length of the polar spine, 145μ-171μ.

Remarks: This species differs from *Stylatractus universus* Hays in having conical spines which are not extensions of radial spines, and in having a more spherical cortical shell. These differences are conspicuous enough to separate them even though transitional forms have been observed in the upper Miocene and lower Pliocene sediments. Kling included *S. universus* (1973, pl. 1, fig. 14-17; pl. 6, fig. 14-17) and this form (pl. 6, fig. 18) as *Axoprunum angelinum*. The specimens in antarctic sediments have three concentric shells and polar spines of unequal lengths; thus they belong to genus *Amphistylus*.

Abundance: Present to common.

Range: Oligocene to upper Miocene.

Genus CANNARTUS Haeckel

Cannartus Haeckel, 1881, p. 462, emend. Riedel, 1971, p. 652.

Cannartus sp. aff. C. prismaticus (Haeckel)
(Plate 20, Figure 7)

Remarks: This species occurs in Core 12 of Site 266 (middle Miocene) and is very similar to *Cannartus prismaticus* (Haeckel) which has been found in lower Miocene sediments in low latitudes (Goll, 1972). Its taxonomy is not clear at present.

Abundance: Rare.

Occurrence: Middle Miocene.

Genus CENOSPHAERA Ehrenberg

Cenosphaera Ehrenberg, 1854, p. 237.

Cenosphaera sp.
(Plate 6, Figure 9; Plate 7, Figures 1, 2)

Description: Specimens composed of single spherical shell; 17-20 circular pores of uniform size, hexagonally framed across a diameter, and regularly disposed. Surface covered with thorn-like spines arising from each node, and sometimes covered with a hexagonal framework (Plate 7, Figure 1) formed by developing cross-pieces between the adjacent spines.

Measurements based on 40 specimens from Samples 274-20, CC; 274-22, CC; and 274-23, CC: diameter of the shell, 189μ-252μ.

Abundance: Common.

Occurrence: Oligocene.

Genus DRUPPATRACTUS Haeckel

Druppatractus Haeckel, 1887, p. 324.

Druppatractus sp.
(Plate 20, Figures 11, 12)

Description: Shell composed of two shells. Medullary shell consisting of a loose meshwork of irregular shape, about one half as broad as the cortical shell. Cortical shell ellipsoidal with 9-11 circular pores of uniform size a half equator, connected to the medullary shell by 6-8 radiating bars and by 2 bars collinear with polar spines. Polar spines slenderly cylindrical, equal in length.

Measurements based on 30 specimens from Samples 266-1, CC; 266-2, CC; 266-3, CC; and 266-4, CC: major axis of the cortical shell, 70μ-75μ; minor axis of the cortical shell, 57μ-61μ; length of the polar spines, 38μ-53μ.

Abundance: Few to present.

Occurrence: Neogene (and Oligocene?).

Genus ECHINOMMA

Echinomma Haeckel, 1881, p. 453.

Echinomma delicatulum (Dogiel)
(Plate 24, Figure 1)

Heliosoma delicatulum Dogiel and Reshetnyak, 1952, p. 7-8, fig. 2.

Echinomma sp., Riedel, 1958, p. 225, pl. 1, fig. 6.

Echinomma delicatulum (Dogiel), Petrushevskaya, 1968, p. 18-20, fig. 11.

Abundance: Few to present.

Occurrence: Neogene.

Echinomma popofskii Petrushevskaya
(Plate 20, Figure 13)

Echinomma popofskii Petrushevskaya, 1968, p. 20-22, fig. 12,I-III.

Abundance: Rare.

Range: Pleistocene to Recent.

Genus HALIOMETTA

Haliometta Haeckel, 1887, p. 233.

Haliommetta miocenica (Campbell and Clark)
(Plate 20, Figures 14, 15)

Heliosphaera miocenica Campbell and Clark, 1944, p. 16, pl. 16, fig. 10-14.

Haliommetta miocenica (Campbell and Clark) group, Petrushevskaya and Kozlova, 1972, p. 517-519, pl. 9, fig. 8, 9.

Remarks: Petrushevskaya and Kozlova (1972) did not differentiate between *Echinomma popofskii* Petrushevskaya, *Acanthosphaera* sp. Hays, and *Echinomma quadrisphaera* Dogiel. Only the forms which have three concentric shells and thin cortical shell are included in *Haliommetta miocenica* by the author.

Abundance: Rare.

Occurrence: Pleistocene.

Genus OMMATARTUS Haeckel

Ommatartus Haeckel, 1881, p. 463.

Ommatartus sp. aff. O. antepenultimus Riedel and Sanfilippo
(Plate 20, Figures 8, 9)

Remarks: This species is similar to *Ommatartus antepenultimus* Riedel and Sanfilippo, but has a thicker cortical shell and wider spongy polar columns.
Abundance: Few.
Occurrence: Middle Miocene.

Genus PRUNOPYLE Dreyer

Prunopyle Dreyer, 1889, p. 3.

Prunopyle antarctica
(Plate 23, Figures 5, 6)

Prunopyle antarctica Dreyer, 1889, p. 24-25, fig. 75; Riedel, 1958, p. 225, pl. 1, fig. 7, 8.
Cromyechinus antarctica (Dreyer), Petrushevskaya, 1968, p. 22-27, fig. 13,I-VI; 14,I-VII.
Abundance: Few to present.
Range: Pleistocene to Recent.

Prunopyle frakesi n. sp.
(Plate 10, Figures 1-3)

Description: Cortical shell prune-shaped, thick-walled; pores small circular, tube-like, of uniform size, and evenly disposed. Medullary shell consisting of a spiral, dense, spongy disk (Plate 10, Figure 2) at the center and a loose meshwork at the margin (Plate 10, Figure 3). Pylome small, circular, and surrounded by 7-12 conical spines of variable length.

Measurements based on 35 specimens from Samples 274-21-3, 54-64 cm; 274-21, CC; 274-22, CC; and 274-23, CC: major axis of the shell, 270μ-342μ; minor axis of the shell, 198μ-297μ; ratio of the major to minor axes, 1.12-1.30.

Remarks: This species differs from other species of this genus in having a spongy core and small tube-like pores. The species is named after Lawrence A. Frakes, one of the co-chief scientists of Leg 28.
Abundance: Common.
Occurrence: Oligocene.

Prunopyle hayesi n. sp.
(Plate 9, Figures 3-5)

Description: Shell prune-shaped, consisting of radiating spines and densely spiral shell. Pylome circular, large, and surrounded by 12-19 conical spines. Pores framed by hexagonal bars and aligned with the radiating spines through each layer of the spiral shell (Plate 9, Figure 5).

Measurements based on 35 specimens from Samples 274-21-3, 54-64 cm; 274-21, CC; 274-22, CC; and 274-23, CC: major axis of the shell, 270μ-315μ; minor axis of the shell, 207μ-252μ; diameter of pylome, 89μ-101μ.

Remarks: This species is characterized by its hexagonally framed pores, and densely spiral shell. This species is named after Dennis E. Hayes, one of the co-chief scientists of Leg 28.
Abundance: Common.
Range: Lower Oligocene to Miocene.

Prunopyle tetrapila Hays
(Plate 23, Figures 3, 4)

Prunopyle tetrapila Hays, 1965, p. 172, pl. II, fig. 5.
Abundance: Few to present.
Occurrence: Neogene (and Oligocene?).

Prunopyle titan Campbell and Clark
(Plate 23, Figures 1, 2)

Prunopyle titan Campbell and Clark, 1944, p. 20, pl. 3, fig. 1-3; Hays, 1965, p. 173, pl. II, fig. 4.
Abundance: Common.
Range: Pliocene.

Genus SATURNALIS Haeckel

Saturnalis Haeckel, 1881, p. 450.

Saturnalis circularis Haeckel
(Plate 24, Figure 2)

Saturnalis circularis Haeckel, 1887, p. 131; Nigrini, 1967, p. 25, pl. 1, fig. 9; Kling, 1973, p. 635, pl. 1, fig. 21-25; pl. 7, fig. 1-5; Ling, 1973, p. 777, pl. 1, fig. 5.
Saturnalis planetes Haeckel, 1887, p. 142, pl. 16, fig. 7; Hays, 1965, p. 167, pl. 1, fig. 5.
Abundance: Rare.
Occurrence: Oligocene to lower Pleistocene.

Genus SPONGOPLEGMA Haeckel

Spongoplegma Haeckel, 1881, p. 455.

Spongoplegma antarcticum Haeckel
(Plate 22, Figures 3, 4)

Spongoplegma antarcticum Haeckel, 1887, p. 90; Hays, 1965, p. 165-167, pl. 1, fig. 1.
Diploplegma banzare Riedel, 1958, p. 223, pl. 1, fig. 3, 4.
Theocosphaera antarctica Nakaseko, 1959, p. 8, pl. II, fig. 7; 10a, b.
Cenosphaera antarctica Nakaseko, 1959, p. 5, pl. 1, fig. 3-6.
Cladococcus aquaticus Popofsky, 1908, p. 214, pl. XXIII, fig. 3, 4.
Diploplegma aquatica (Popofsky) Petrushevskaya, 1968, p. 14-18, fig. 9I-III; 10,I-VI.
Abundance: Present to common.
Range: Pliocene to Recent.

Spongoplegma sp.
(Plate 22, Figures 1, 2)

Description: Species consisting of two shells. Cortical shell spherical with evenly disposed, circular to ovate pores of various dimensions. Medullary shell consisting a loose meshwork about half the diameter of the cortical shell, and irregularly radiating spines.

Measurements based on 20 specimens from Samples 266-22, CC; 266-19-3, 50-52 cm; 266-17-3, 50-52 cm; and 265-15-3, 10-12 cm: diameter of the cortical shell, 195μ-213μ; diameter of the medullary shell, 83μ-113μ.

Remarks: This species may have evolved to *Spongoplegma antarcticum* in the early Pliocene, though the transitional form has not been observed. This species differs from *Spongoplegma antarcticum* in having a smaller cortical shell, and more regular pores on the cortical shell.
Abundance: Present.
Range: Miocene.

Genus STYLACONTARIUM Popofsky

Stylacontarium Popofsky, 1912, p. 90.

Stylacontarium bispiculum Popofsky
(Plate 21, Figures 1, 2)

Stylacontarium bispiculum Popofsky, 1912, p. 91, pl. 2, fig. 2
Description: Cortical shell ellipsoidal (ratio of polar to equatorial axes about 1.09-1.12), thick-walled, thorny, with 10-12 circular to subcircular pores of equal dimensions on a half-equator. Polar spines conical of variable length, generally shorter than the polar axis of the cortical shell. Outer medullary shell spherical or ellipsoidal with polygonal pores framed by very thin bars, connected to the cortical shell by two bars collinear with the polar spines, and by 6-8 bars in the equatorial plane. Inner medullary shell a loose meshwork.

Measurements based on 30 specimens from Samples 266-13, CC; 266-15, CC; and 266-13-1, 51-53 cm: length of the polar spines, 45μ-72μ; of the polar axis, 135μ-180μ; and of the equatorial axis, 126μ-171μ; maximum diameter of the outer medullary shell, 36μ-45μ.

Remarks: This species is similar to *Druppatractus acquilonius* Hays, but differs in having smaller and more numerous pores on the cortical shell, and in having two medullary shells.
Abundance: Common.
Range: Miocene.

Genus STYLATRACTUS Haeckel

Stylatractus Haeckel, 1887, p. 328.

Stylatractus neptunus (?) Haeckel
(Plate 24, Figure 3)

Stylatractus neptunus Haeckel, 1887, p. 328, pl. 17, fig. 6.
Stylatractus neptunus Haeckel (?), Riedel, 1958, p. 226, pl. 1, fig. 9.
Stylatractus sp. Petrushevskaya, 1968, p. 27-28, fig. 15,I-IV; 32,III.
Abundance: Few.
Occurrence: Neogene.

Stylatractus universus Hays
(Plate 21, Figures 5-9)

Stylatractus sp. Hays, 1965, p. 167, pl. 1, fig. 6.
Stylatractus universus Hays, 1970, p. 215, pl. 1, fig. 1, 2; Kling, 1971, p. 1086, pl. 1, fig. 6.
Axoprunum angelinum (Campbell and Clark), Kling, 1973, p. 634, pl. 1, fig. 13-15; pl. 6, fig. 14-17; Ling, 1973, p. 777, pl. 1, fig. 2-4.
Remarks: The younger form of this species has stouter polar spines and thicker cortical shell. The older form is very similar to *Amphistylus angelinus* (Campbell and Clark), but differs in having a more prolate cortical shell.
Abundance: Few.
Range: Upper Miocene to lower Pleistocene.

Genus STYLOSPHAERA Ehrenberg

Stylosphaera Ehrenberg, 1847a, chart, p. 385; Sanfilippo and Riedel, 1973, p. 519.

Stylosphaera coronata coronata Ehrenberg
(Plate 5, Figures 1, 2)

Stylosphaera coronata coronata Ehrenberg, 1873, p. 258; 1875, pl. 25, fig. 4; Sanfilippo and Riedel, 1973, p. 520, pl. 1, fig. 13-17; pl. 25, fig. 4
Druppatractus trichopterus Clark and Campbell, 1942, p. 35, pl. 5, fig. 4.
Abundance: Common to present.
Occurrence: Oligocene and Eocene.

Stylosphaera coronata laevis Ehrenberg
(Plate 5, Figure 3)

Stylosphaera laevis Ehrenberg, 1873, p. 259; 1875, pl. 25, fig. 6; Sanfilippo and Riedel, 1973, p. 520-521, pl. 1, fig. 19; pl. 25; fig. 5, 6.
Abundance: Present.
Occurrence: Oligocene and Eocene.

Family LITHELIIDAE Haeckel

Litheliidae Haeckel, 1862, p. 515.

Genus LITHELIUS Haeckel

Lithelius Haeckel, 1860, p. 843; Sanfilippo and Riedel, 1973, p. 522.

Lithelius nautiloides Popofsky
(Plate 24, Figure 7)

Lithelius nautiloides Popofsky, 1908, p. 230-231, pl. XXVII, fig. 4; Riedel, 1958, p. 228-229, pl. 2, fig. 3; Petrushevskaya, 1968, p. 50-52, fig. 27; 28,I; 29,I.
Abundance: Present.
Range: Pliocene to Recent.

Family SPONGODISCIDAE Haeckel, emend. Riedel

Spongodiscidae Haeckel, 1862, emend. Riedel, 1967b, p. 295.

Genus SPONGODISCUS Ehrenberg

Spongodiscus Ehrenberg, 1854, p. 237; Sanfilippo and Riedel, 1973, p. 524.

Spongodiscus osculosus (Dreyer)
(Plate 24, Figure 4)

Spongopyle osculosa Dreyer, 1889, p. 42-43, pl. VI, fig. 99, 100; Riedel, 1958, p. 226-227, pl. I, fig. 12.
Spongodiscus osculosus (Dreyer), Petrushevskaya, 1968, p. 19-40, fig. 20,I,II.
Abundance: Present.
Occurrence: Neogene.

Genus SPONGOTROCHUS Haeckel

Spongotrochus Haeckel, 1860, p. 844.

Spongotrochus glacialis Popofsky
(Plate 24, Figures 5, 6)

Spongotrochus glacialis Popofsky, 1908, p. 228-229, pl. 26, fig. 7, 8; pl. 27, fig. 1; Petrushevskaya, 1968, p. 40-50, fig. 21,I-VII; fig. 22,I-VII; fig. 26,II.
Spongotrochus (?) *glacialis* Popofsky, Riedel, 1958, p. 227-228, pl. 2, fig. 1, 2.
Abundance: Present to common.
Occurrence: Neogene (and Oligocene?).

Suborder NASSELLARIA Ehrenberg, 1875

Family ACANTHODESMIIDAE Haeckel

Acanthodesmiidae Haeckel, 1862; Riedel, 1967b, p. 296.

Genus DENDROSPYRIS Haeckel

Dendrospyris Haeckel, 1881, p. 44; emend. Goll, 1968, p. 1417

Dendrospyris haysi n. sp.
(Plate 15, Figures 3-5)

Description: Saggital ring D-shaped; joined to the back and apex of lattice shell. Apical spine very short and conical. Six basal pores separated by two primary and two secondary lateral spines. Lattice shell thick, constricted at saggital and basal rings, and extending below the basal ring as thorax. Pores subcircular to polygonal and of variable dimensions; slightly larger in the thorax of some specimens. Shell generally terminated by lattice bars or terminated smoothly.

Measurements based on 30 specimens from Samples 266-19-3, 50-52 cm; 266-12-3, 80-82 cm; and 266-11, CC. Width of the cephalis 99μ-144μ, and of the thorax 90μ-126μ. Length of the cephalis 80μ-103μ, of the thorax 65μ-180μ.

Remarks: This species differs from *Desmospyris spongiosa* Hays in the lack of a spongy shell, and from *Dendrospyris stabilis* Goll in having larger dimensions of the shell and less densely spaced and larger pores. These three species have similar internal structures, and belong to an evolutionary lineage, *Dendrospyris stabilis*→*Dendrospyris haysi*→*Desmospyris spongiosa.*

This species is named after James D. Hays in recognition of his valuable contributions in the field of radiolarian studies.
Abundance: Present to common.
Range: Miocene.

Genus DENDROSPYRIS Haeckel

Dendrospyris Haeckel, 1881, p. 44, emend. Goll, 1968, p. 1417.

Dendrospyris megalocephalis n. sp.
(Plate 14, Figures 3-5)

Description: Saggital ring D-shaped; joined directly to back of lattice shell. Basal and saggital rings constricted indistinctly. Thorax subcylindrical with a slight constriction at mouth. Six basal pores separated by two primary and two secondary lateral spines. Pores circular to subcircular, small, and densely spaced in the cephalis, large and scattered in the thorax. Shell has small conical spines at the apex in some specimens, and is terminated by teeth of irregular size.

Measurements based on 10 specimens from Samples 266-12, CC, and 266-12-3, 80-82 cm: width of the cephalis, 126μ-153μ; width of the thorax, 108μ-150μ; length of the cephalis, 90μ-118μ; length of the thorax, 54μ-92μ.

Remarks: This species differs from other members of this genus in having small, densely spaced pores, and a flatter and wider shell.
Abundance: Present.
Range: Upper to middle Miocene.

Dendrospyris stabilis Goll
(Plate 7, Figure 3)

Dendrospyris stabilis Goll, 1968, p. 1422-1423, pl. 173, fig. 16-18.
Abundance: Few to present.
Occurrence: Oligocene.

Genus DESMOSPYRIS Haeckel

Desmospyris Haeckel, 1881, p. 443; 1887, p. 1089.

Desmospyris spongiosa Hays
(Plate 15, Figures 1, 2)

Desmospyris spongiosa Hays, 1965, p. 173-175, pl. II, fig. 1.
Abundance: Present to common.
Range: Pliocene.

Genus DORCADOSPYRIS Haeckel, 1881, emend. Goll, 1969.

Dorcadospyris Haeckel, 1881, p. 44, emend. Goll, 1969, p. 335.

Dorcadospyris argisca (Ehrenberg)
(Plate 3, Figure 9)

Petalospyris argiscus Ehrenberg, 1873, p. 246; 1875, pl. 22, fig. 1, 2; Bütschli, 1882, p. 539, pl. 32, fig. 17a,b.
Petalospyris (Petalospyromma) *argiscus* Haeckel, 1887, p. 1062-1063.
?*Petalospyris platycantha* Riedel, 1957, p. 259, pl. 63, fig. 3.
Dorcadospyris argisca (Ehrenberg), Goll, 1969, p. 336, pl. 56, fig. 9-11.
Abundance: Rare.
Occurrence: Eocene (upper Eocene?)

Genus GIRAFFOSPYRIS Haeckel

Giraffospyris Haeckel, 1881, p. 442, emend. Goll, 1969, p. 329.

Giraffospyris didiceros (Ehrenberg) group
(Plate 3, Figure 4)

Ceratospyris didiceros Ehrenberg, 1873, p. 228; 1875, pl. 21, fig. 6.
Ceratospyris longibarba Ehrenberg, 1873, p. 219; 1875, pl. 21, fig. 2.
Ceratospyris heptaceros Ehrenberg, 1873, p. 219, pl. 20, fig. 2.
Giraffospyris didiceros (Ehrenberg), Goll, 1969, p. 332, pl. 60, fig. 5-7, 9; Riedel and Sanfilippo, 1970, pl. 5, fig. 5.
Dendrospyris didiceros (Ehrenberg) group, Petrushevskaya and Kozlova, 1972, p. 532, pl. 40, fig. 12.
Abundance: Present.
Occurrence: Eocene (upper Eocene?).

Genus TRICERASPYRIS Haeckel

Triceraspyris Haeckel, 1881, p. 441.

Triceraspyris antarctica (Haecker)
(Plate 15, Figure 6)

Phormospyris antarctica Haecker, 1907, p. 124, fig. 9.
Triceraspyris antarctica (Haecker), Haecker, 1908, p. 445-446, pl. 84, fig. 586; Riedel, 1958, p. 230, pl. 2, fig. 6, 7; Petrushevskaya, 1964, p. 1121-1123, fig. 1.
Tripospyris bicornis Popofsky, 1908, p. 269-270, pl. XXX, fig. 6.
Tripospyris biloculata Popofsky, 1908, p. 269, pl. XXX, fig. 7.
Triceraspyris (?) *antarctica* (Haecker), Petrushevskaya, 1968, p. 62-64, fig. 37,I-III.
Abundance: Few to present.
Occurrence: Neogene.

Family ARTOSTROBIIDAE

Artostrobiidae Riedel, 1967a, p. 149.

Genus CARPOCANARIUM Haeckel

Carpocanarium Haeckel, 1887, p. 1279.

Carpocanarium (?) sp.
(Plate 6, Figures 7, 8)

Description: Cephalis hemispherical with very few small subcircular pores, separated from thorax by an indistinct change in contour. Thorax thick-walled; ovate with irregular constrictions and bulges in some specimens; pores subcircular, of approximately uniform size, and randomly disposed; terminated by a constricted mouth surrounded by a poreless peristome.

Measurements based on 30 specimens from Samples 274-21-3, 54-64 cm; 274-21, CC; 274-22, CC: length of the shell, 72μ-108μ; maximum width of the thorax, 63μ-72μ.

Remarks: This species differs from *Carpocanarium* sp. Riedel and Sanfilippo (1971, pl. II. fig. 17-25; pl. 2J, fig. 8, 9) in having more abundant pores and a less conspicuous collar constriction.
Abundance: Present.
Occurrence: Lower Oligocene.

Genus PHORMOCYRTIS Haeckel

Phormocyrtis Haeckel, 1887, p. 1368.

Phormocyrtis proxima (?) Clark and Campbell
(Plate 2, Figure 6)

Phormocyrtis proxima Clark and Campbell, 1942, p. 82, pl. 7, fig. 24, 26.
Remarks: This form is tentatively assigned to this species due to its more cylindrical abdomen and longer portion of poreless abdomen.
Abundance: Few.
Occurrence: Eocene (upper Eocene?).

Phormocyrtis striata striata Brandt
(Plate 3, Figure 8)

Phormocyrtis striata Brandt, 1935, p. 55, pl. 9, fig. 12; Riedel and Sanfilippo, 1970, p. 532, pl. 10, fig. 7.
Phormocyrtis striata striata Foreman, 1973, p. 438, pl. 7, fig. 5, 6, 9.
Abundance: Rare.
Occurrence: Eocene (upper Eocene?).

Genus THEOCAMPE Haeckel

Theocampe Haeckel, 1887, p. 1422; Burma, 1959, p. 328.

Theocampe amphora (Haeckel) group
(Plate 2, Figures 2, 3)

Dictyocephalus amphora Haeckel, 1887, p. 1305, pl. 62, fig. 4.
Theocampe amphora (Haeckel) group, Foreman, 1973, p. 431, pl. 8, fig. 7, 9-13; pl. 9, fig. 8, 9.
Abundance: Present.
Occurrence: Eocene (upper Eocene?).

Theocampe urceolus (Haeckel)
(Plate 3, Figure 7)

Dictyocephalus urceolus Haeckel, 1887, p. 1305.
(?)*Dictyocephalus* (*Dicteyprora*) *pulcherrimus* Clark and Campbell, 1942, p. 78, pl. 8, fig. 2, 3, 6, 7.
Theocampe urceolus (Haeckel), Foreman, 1973, p. 432, pl. 8, fig. 14-17; pl. 9, fig. 6, 7.
Abundance: Few.
Occurrence: Eocene (upper Eocene?).

Family PLAGONIIDAE Haeckel, emend. Riedel

Plagoniidae Haeckel, 1881, emend. Riedel, 1967b.

Genus ANTARCTISSA Petrushevskaya

Antarctissa Petrushevskaya, 1968, p. 83.

Antarctissa antedenticulata n. sp.
(Plate 18, Figures 1, 2)

Description: Cephalis spherical with randomly distributed, small, subcircular pores. Collar stricture variable depending on thickness of the shell but generally marked by a change in contour. Thorax cylindrical or inflated cylindrical, about the same width as the cephalis or slightly wider, with subcircular pores of various dimensions. Mouth wide open in most specimens, closed by a sieve plate on rare specimens.

Measurements based on 20 specimens from Samples 267B-6, CC; 267B-6-3, 100-104 cm; and 266-10-3, 51-53 cm: length of the cephalis, 27μ-45μ; length of the thorax, 36μ-54μ; width of the cephalis, 36μ-45μ; and of the thorax, 54μ-63μ.

Remarks: This species evolved to *Antarctissa denticulata* in the early Pliocene and differs in having a cephalis and thorax of almost equal width.
Abundance: Few to present.
Range: Upper to middle Miocene.

Antarctissa conradae n. sp.
(Plate 17, Figures 1-5)

Description: Cephalis thick-walled, ovate, with scattered, small, subcircular pores. Specimens from younger sediments have conical spines on the apex of cephalis and cephalic pores become progressively larger and more irregular. Thorax cylindrical, slightly tapering at the base in some specimens, separated from the cephalis by a distinct collar constriction. Thoracic pores circular to subcircular, scattered, and about the same size as those of the cephalis. In specimens from younger sediments, dorsal and two lateral spines constrict wall of thorax and form longitudinal furrows; thoracic pores become larger and more abundant.

Measurements based on 35 specimens from Samples 266-11, CC; 266-10, CC; 267B-4, CC: length of the cephalis, 27μ-36μ; of the thorax 45μ-63μ; width of the cephalis, 25μ-32μ; of the thorax 35μ-54μ.

Remarks: This species evolved to *Antarctissa longa* in the early Pliocene. The distinction between these two species is made on an arbitrary size limit of the thorax; i.e., specimens having a thorax less than 54μ in width are assigned to *Antarctissa conradae*, otherwise to *Antarctissa longa.*

Abundance: Few to present.

Range: Upper to middle Miocene.

Antarctissa denticulata (Ehrenberg)
(Plate 18, Figures 3-8)

Lithobotrys denticulata Ehrenberg, 1844, p. 203.
Lithopera denticulata (Ehrenberg), Ehrenberg, 1873, pl. 12, fig. 7; Haeckel, 1887, p. 1083; Haecker, 1907, p. 123-124, fig. 8.
Peromelissa denticulata (Ehrenberg), Haecker, 1908, p. 448-452, pl. 84, fig. 582, 583, 591; Riedel, 1958, p. 236, pl. 3, fig. 9.
Helotholus histricosa var. *clausa* Popofsky, 1908, p. 281-282, pl. XXXIII, fig. 1.
Antarctissa denticulata (Ehrenberg), Petrushevskaya, 1968, p. 84-86, fig. 49,I-IV.

Abundance: Common to abundant.

Range: Pliocene to Pleistocene.

Antarctissa ewingi n. sp.
(Plate 16, Figures 5-9)

Description: Shell cylindrical, rough-surfaced, of variable thickness. Cephalis spherical, half sunken into thorax, bearing external 3-4 conical spines of variable lengths, with small subcircular pores. Thorax cylindrical with subcircular to ovate pores of various sizes. Internal skeleton similar to that of *Helotholus vema* Hays, but with 6-9 (instead of 6) "horizontal beams" and thinner skeletal structure. Where "horizontal beams" join the wall of the thorax, a distinct constriction forms. Shell closed by a sieve plate in complete specimens.

Measurements based on 35 specimens from Samples 266-9, CC; 266-9-3, 52-54 cm; and 266-6, CC: length of the shell, 85μ-108μ; width of the cephalis, 44μ-65μ, of the thorax, 72μ-83μ.

Remarks: This species is very similar to *Antarctissa denticulata* Petrushevskaya, but differs from the latter in its cylindrical form and the presence of "horizontal beams." This species is named for Maurice Ewing in recognition of his outstanding achievements in the field of marine science.

Abundance: Abundant.

Range: Pliocene to lower Pleistocene.

Antarctissa longa (Popofsky)
(Plate 17, Figures 6-8)

Helotholus longus Popofsky, 1908, p. 282-283, pl. XXXIV, fig. 2
Antarctissa longa (Popofsky), Petrushevskaya, 1968, p. 90, fig. 51,I.

Abundance: Common to abundant.

Range: Pliocene to Recent.

Antarctissa strelkovi Petrushevskaya
(Plate 17, Figure 9)

Helotholus histricosa Jorgensen, Popofsky, 1908, p. 279-281, pl. XXXII, fig. 1-5, pl. XXXVI, fig. 2; Riedel, 1958, p. 234-235, pl. 3, fig. 8.
Antarctissa strelkovi Petrushevskaya, 1968, p. 88-90, fig. 51, III-VI.

Abundance: Common to abundant.

Range: Pliocene to Recent.

Genus HELOTHOLUS Jörgensen

Helotholus Jörgensen, 1905, p. 137.

Helotholus vema Hays
(Plate 16, Figures 1-4)

Helotholus vema Hays, 1965, p. 176, pl. II, fig. 3.

Abundance: Common.

Range: Pliocene.

Genus LITHOMELISSA Ehrenberg

Lithomelissa Ehrenberg, 1847b, p. 54.

Lithomelissa challengerae n. sp.
(Plate 8, Figure 3)

Description: Shell subcylindrical, spongy-walled. Cephalis hemispherical, bearing a sharp 3-bladed apical spine about the same length as the cephalis; pores small and subcircular, separated from thorax by a change in contour. Thorax subcylindrical with a constriction below the level where three straight sharp 3-bladed wings extend beyond the wall. Mouth open. Vertical spine branching into four bars at the top of the cephalic chamber, one bar extending vertically as an apical spine, the other three bars lying on a horizontal plane and fusing to the wall of the cephalis.

Measurements based on 25 specimens from Samples 274-21-3, 54-64 cm; 274-21, CC; 274-22-3, 50-60 cm; 274-22, CC; and 274-23, CC: length of the cephalis, 56μ-72μ; of the thorax, 270μ-342μ; maximum width of the thorax, 162μ-194μ.

Remarks: This species differs from other members of this genus in having a spongy wall, and from *Lithomelissa spongiosa* Bütschli in having a longer thorax and unbranched external spines.

Abundance: Present to common.

Occurrence: Oligocene.

Lithomelissa robusta n. sp.
(Plate 9, Figures 1,2)

Description: Cephalis spherical, thick-walled, bearing a 3-bladed apical spine about half the length of the cephalis. Cephalic pores subcircular, of regular size, and hexagonally framed. Thorax robust and subcylindrical with a constriction below the level where three straight, 3-bladed wings extend out. Thoracic pores subcircular, more irregular in size and shape than those of the cephalis. Mouth open. Internal skeletal structure similar to that of *Lithomelissa mitra* Bütschli.

Measurements based on 15 specimens from Samples 274-34, CC; 274-30, CC; 274-28, CC; and 274-21-3, 54-64 cm: width of the cephalis, 72μ-90μ; maximum width of the thorax, 98μ-136μ; length of the thorax, 126μ-135μ.

Remarks: On all antarctic Oligocene lithomelissids, except for *Lithomelissa robusta*, the cephalis is about the same width as the thorax. The relatively small cephalis, as compared with the thorax, makes *Lithomelissa robusta* easily distinguishable from other species of *Lithomelissa.*

Abundance: Few.

Occurrence: Oligocene.

Lithomelissa sphaerocephalis n. sp.
(Plate 8, Figures 1, 2)

Description: Cephalis spherical, poreless, rough-surfaced, bearing a conical or weakly bladed apical spine about half the length of the cephalis, separated from thorax by a distinct constriction. Thorax conical with subcircular to irregular pores, commonly covered with spongy meshwork. Internal skeletal structure similar to that of *Lithomelissa mitra* Bütschli.

Measurements based on 30 specimens from Samples 274-21-3, 54-64 cm; 274-21, CC; 274-22, CC; 274-23, CC; and 274-24, CC: width of the thorax, 108μ-135μ; of the cephalis, 53μ-89μ; total length of the shell (excluding spine), 135μ-207μ; length of the thorax, 98μ-126μ.

Remarks: This species is distinguished from other members of this genus by its large, poreless, and spherical cephalis.

Abundance: Common to present.

Occurrence: Lower Oligocene.

Lithomelissa tricornis n. sp.
(Plate 8, Figures 6, 7)

Description: Cephalis hemispherical, poreless, bearing three sharp, 3-bladed spines. Thorax conical with scattered pores of irregular size and shape, bearing three straight, sharp, 3-bladed wings. Apical spine branching into four bars at the top of the cephalic chamber; one bar extending vertically as an apical spine; the other three bars extending horizontally, fusing to, and then extending downward as ribs on the wall of the cephalis, two of them following individually the directions of two lateral spines and each branching out as a 3-bladed spine which extends out of the cephalic wall, the other following the direction of the dorsal spine. Shell closed by a sieve or poreless plate.

Measurements based on 20 specimens from Samples 274-21-3, 54-64 cm; 274-21, CC; 274-22, CC; and 274-23-3, 60-70 cm: length of the cephalis, 40μ-51μ; of the thorax, 90μ-126μ; width of the cephalis, 43μ-65μ; of the thorax, 54μ-107μ.

Remarks: This species is very similar to *Lithomelissa hertwigi* Bütschli (Eocene, Barbados) but differs in having three spines on the cephalis.

Abundance: Present to common.

Occurrence: Oligocene.

Lithomelissa sp. A aff. L. ehrenbergi Bütschli
(Plate 11, Figures 1, 2)

Description: Cephalis spherical, bearing a conical or weakly 3-bladed apical spine of variable length with regularly disposed subcircular pores of uniform size, separated from thorax by a distinct neck region where a short 3-bladed vertical spine extends beyond the wall. Thorax of variable shape, conical cylindrical, or inflated cylindrical, slightly wider than the cephalis. Thoracic pores ovate to subcircular, regularly disposed, about the same size as those on the cephalis.

Measurements based on 30 specimens from Sample 266-23-1, 36-38 cm; 266-12-2, 100-102 cm; 266-16, CC; and 266-15, CC: width of the cephalis, 36μ-54μ; of the thorax, 54μ-72μ; length of the thorax, 53μ-71μ.

Remarks: This species is similar to *L. ehrenbergi* Bütschli (Eocene sediments in Barbados), but differs in having a longer thorax and in the absence of exposed dorsal and two lateral spines.

Abundance: Common to present.

Range: Lower to upper Miocene.

Lithomelissa sp. B aff. L. mitra Bütschli
(Plate 8, Figures 4, 5)

Description: Cephalis spherical, thick-walled with few small subcircular pores of uniform size, bearing two short conical spines, one apical and the other vertical, separated from the thorax by a distinct change in contour. Thorax cylindrical, about the same width as the cephalis, thick-walled, with scattered pores of more irregular size and shape. Dorsal and two lateral spines extending beyond the wall of thorax as three short, conical wings. Apical spine branching at the base of the cephalic chamber into four bars, one extending vertically as an apical spine, the others lying on a horizontal plane, and extending individually along the directions of dorsal and two lateral spines, and fusing to the wall of the cephalis.

Measurements based on 30 specimens from Samples 274-20, CC; 274-22, CC; 274-23, CC; and 274-24, CC: length of the shell, 90μ-101μ; width of the cephalis, 54μ-72μ.

Remarks: This species is similar to *Lithomelissa mitra* Bütschli (Eocene, Barbados), but differs in having a thicker shell and more irregular pores.

Abundance: Few.

Occurrence: Oligocene.

Lithomelissa sp. C
(Plate 11, Figures 3, 4)

Description: Cephalis hemispherical, sunken into expanded thorax, thin-walled, bearing two 3-bladed or conical spines; apical spine of variable lengths, vertical spine short; pores subcircular to ovate, of variable dimensions; thorax subconical with subcircular to ovate pores of variable dimensions. Dorsal and two lateral spines fusing to the wall in three longitudinal furrows and extending beyond the wall as short conical wings.

Measurements based on 35 specimens from Samples 266-19-3, 50-52 cm; 266-18, CC; 266-17, CC; and 266-10-3, 50-52 cm: width of the cephalis, 18μ-27μ; of the thorax, 54μ-81μ; length of the thorax, 54μ-94μ.

Remarks: This species is characterized by its sunken cephalis and unbranched apical spine.

Abundance: Few to present.

Range: Miocene and Oligocene.

Genus MITROCALPIS Haeckel

Mitrocalpis Haeckel, 1881, p. 427.

Mitrocalpis araneafera Popofsky

Mitrocalpis araneafera Popofsky, 1908, p. 273-274. pl. 30, fig. 30; Riedel, 1958, p. 232-233, pl. 3, fig. 3, 4.

Abundance: Rare to few.

Range: Pliocene to Recent.

Genus SPONGOMELISSA Haeckel

Spongomelissa Haeckel, 1887, p. 1209.

Spongomelissa dilli n. sp.
(Plate 13, Figures 6, 7)

Description: Cephalis hemispherical; bearing two 3-bladed spines; one apical, short and strongly faceted, the other vertical and emerging from the collar stricture. Collar stricture marked by a change in contour. Thorax short, broad, and conical with an indistinct constricted peristome, dorsal and two lateral spines fusing to and extending beyond the wall of the thorax as three short, 3-bladed wings. Both segments rough-walled with randomly disposed circular to ovate pores of various dimensions.

Measurements based on 25 specimens from Samples 266-16-2, 100-102 cm; 266-15-3, 50-52 cm; 266-12, CC; and 266-11, CC: length of the shell (excluding apical horn), 135μ-153μ; maximum width of the thorax, 171μ-189μ.

Remarks: This species is distinguished by its broad and compressed thorax. This species is named after Lloyd E. Dill, captain of *Glomar Challenger* during Leg 28.

Abundance: Few to present.

Range: Middle to upper Miocene.

Spongomelissa sp.
(Plate 10, Figure 4)

Description: Shell flattened subcylindrical. Cephalis hemispherical, large, and two-lobed; bearing two 3-bladed spines, one apical about the same length as the cephalis and extending out at the junction of the two lobes, the other vertical, short, and extending out at collar stricture; pores subcircular, approximately of uniform size, and evenly distributed. Thorax subcylindrical and slightly wider than the cephalis, bearing three curved 3-bladed wings; pores circular to ovate, evenly distributed, and larger than those on the cephalis. Shell terminated by a wide, open mouth.

Measurements based on 15 specimens from Samples 274-21, CC; 274-22, CC; 274-23, CC; and 274-24, CC: width of the cephalis, 54μ-90μ; of the thorax, 64μ-108μ; length of the cephalis, 33μ-64μ; of the thorax, 45μ-90μ.

Remarks: This form is similar to *Spongomelissa* sp. Sanfilippo and Riedel (1973, pl. 34, fig. 11) but has longer and curved wings.

Abundance: Few.

Occurrence: Oligocene.

Family PTEROCORYIDAE Haeckel

Pterocoryidae Haeckel 1881, emend. Riedel, 1967b.

Genus PTEROCORYS Haeckel

Pterocorys Haeckel, 1881, p. 435.

Pterocorys hirundo Haeckel
(Plate 19, Figure 3)

Pterocorys hirundo Haeckel, 1887, p. 1318, pl. 71, fig. 4; Riedel, 1958, p. 238, pl. 4, fig. 1.

Pterocorys (?) *hirundo* Haeckel, Petrushevskaya, 1968, p. 114-116, fig. 67, I-V.

Abundance: Few.

Range: Pliocene to Recent.

Genus SETHOCYRTIS Haeckel

Sethocyrtis Haeckel, 1887, p. 1298.

Sethocyrtis sp.
(Plate 1, Figures 4, 5)

Description: Cephalis ball-shaped, bearing a slenderly conical horn, poreless or with few scattered small pores, separated from thorax by a distinct stricture. Thorax mostly conical in the upper part and cylindrical in the lower part; pores circular, of uniform size, and arranged in longitudinal rows. Shell terminated by a slightly constricted mouth with a distinct peristome.

Measurements based on 20 specimens from Samples 264-2-6, 105-107 cm, and 264-3-2, 105-107 cm: length of the horn, 63μ-70μ; of the cephalis, 18μ-23μ; of the thorax, 126μ-144μ; maximum width of the thorax, 108μ-126μ; width of the mouth, 54μ-60μ.

Abundance: Present.

Occurrence: Eocene (upper Eocene?).

Genus THEOCYRTIS Haeckel

Theocyrtis Haeckel, 1887, p. 1405.

Theocyrtis (Theocorypha) diabloensis Clark and Campbell
(Plate 5, Figures 4-7)

Theocyrtis (Theocorypha) diabloensis Clark and Campbell, 1942, p. 90, fig. 13.

Abundance: Few to present.

Occurrence: Eocene (upper Eocene?).

Family THEOPERIDAE Haeckel

Theoperidae Haeckel, 1881, emend. Riedel, 1967b, p. 296.

Genus CALOCYCLAS Ehrenberg

Calocyclas Ehrenberg, 1847b, table opposite p. 54.

Calocyclas hispida (Ehrenberg)
(Plate 3, Figure 10)

Anthocyrtis hispida Ehrenberg, 1873, p. 216; 1875, pl. 8, fig. 2.
Cycladophora hispida (Ehrenberg) Riedel and Sanfilippo, 1970, p. 529, pl. 10, fig. 9; 1971, pl. 3b, fig. 10, 11; Moore, 1971, pl. 4, fig. 6, 7.
Calicyclas hispida (Ehrenberg) Foreman, 1973, p. 434, pl. 1, fig. 12-15; pl. 9, fig. 18.

Abundance: Rare to few.

Occurrence: Eocene (upper Eocene?).

Calocyclas disparidens n. sp.
(Plate 13, Figures 4, 5)

Description: Cephalis spherical, poreless, bearing two tiny conical spines, one apical and the other vertical. Collar stricture distinct. Thorax conical or conical in the upper part and cylindrical in the lower part, with small, circular, longitudinally disposed pores of regular size; wall of medium thickness, covered by tiny spines in some specimens. Lumbar stricture marked by a distinct change in contour. Abdomen short, cylindrical, with subcircular to ovate pores of various dimensions. Shell terminated by 5-8 teeth of irregular size.

Measurements based on 20 specimens from Samples 266-12-2, 100-102 cm; and 266-15-3, 50-52 cm: length of the cephalis, 18μ-27μ; of the thorax, 80μ-95μ; width of the thorax, 117μ-125μ.

Remarks: This species is characterized by its abundant and delicate pores in the thorax and its teeth. The specific name is a combination of the Latin *dispar* (different) and *dens* (tooth), and is used as a noun in apposition.

Abundance: Few.

Occurrence: Lower to middle Miocene.

Calocyclas semipolita (?) Clark and Campbell
(Plate 6, Figures 3-6)

Calocyclas semipolita Clark and Campbell, 1942, p. 83, pl. 8 , fig. 12, 14, 17-19, 21-23.

Description: Shell cylindrical to subcylindrical, robust and thick-walled. Cephalis hemispherical, poreless, bearing a small apical horn, separated from thorax by a distinct change in contour. Thorax inflated conical, with circular to subcircular pores of uniform size arranged in longitudinal rows, separated from abdomen by a distinct constriction. Abdomen variable, cylindrical, inflated cylindrical, or conical, some with irregular constriction and bulge. Abdominal pores subcircular to polygonal, of uniform size or slightly increasing in size distally, arranged in longitudinal rows. Shell closed by a sieve plate with a small tube-like mouth or wide open and terminated smoothly.

Measurements based on 20 specimens from Samples 274-21, CC; 274-22, CC; 274-23, CC; 274-24, CC; and 274-34, CC: length of the cephalis, 16μ-18μ; of the thorax, 47μ-65μ; of the abdomen, 92μ-154μ; width of the abdomen, 87μ-135μ.

Remarks: This form is tentatively assigned to *C. semipolita* Clark and Campbell (Eocene, California) because it has a smaller apical horn and a longer abdomen.

Abundance: Common.

Occurrence: Oligocene.

Genus CLATHROCYCLAS Haeckel

Clathrocyclas Haeckel, 1882, p. 434.

Clathrocyclas bicornis Hays
(Plate 12, Figures 8, 9)

Clathrocyclas bicornis Hays, 1965, p. 179, pl. III, fig. 3.

Abundance: Present to common.

Range: Pliocene.

Clathrocyclas universa Clark and Campbell
(Plate 1, Figures 2, 3)

Clathrocyclas universa Clark and Campbell, 1942, p. 86, pl. 7, fig. 8-12, 14-21, 25.

Abundance: Few.

Occurrence: Eocene (upper Eocene?).

Genus CORNUTELLA Ehrenberg

Cornutella Ehrenberg, 1838, p. 128.

Cornutella profunda Ehrenberg

Cornutella clathrata β profunda Ehrenberg, 1856, pl. 35b, fig. 21; Bailey, 1856, p. 2, pl. 1, fig. 23; Riedel, 1958, p. 232, pl. 3, fig. 1, 2.
Cornutella profunda Ehrenberg, 1858, p. 31.
Sethoconus profundus (Ehrenberg), Haeckel, 1887, p. 1294.
Cornutella hexagona Haeckel, 1887, p. 1180, pl. 54, fig. 9.

Abundance: Few to present.

Range: Oligocene to Recent.

Genus CYCLADOPHORA Ehrenberg

Cycladophora Ehrenberg, 1847b, p. 54.

Cycladophora davisiana Ehrenberg
(Plate 13, Figure 3)

Cycladophora (?) *davisiana* Ehrenberg, 1862, p. 297; 1873, pl. 2, fig. 11.
Eucyrtidium davisianum (Ehrenberg), Haeckel, 1862, p. 328-329.
Pterocodon davisianus Ehrenberg, 1862, p. 300-301; 1873, pl. 11, fig. 10.
Pterocanium davisianus (Ehrenberg), Haeckel, 1862, p. 332.
Stichopilium davisianum (Ehrenberg), Haeckel, 1887, p. 1437-1438; Cleve, 1899, p. 33, pl. IV, fig. 6.
Theocalyptra davisiana (Ehrenberg), Riedel, 1958, p. 239, pl. 4, fig. 2, 3.
Cycladophora davisiana, Petrushevskaya, 1968, p. 120-122, fig. 69,I-VII.

Abundance: Present to common.

Range: Pliocene to Recent.

Genus CYCLAMPTERIUM Haeckel

Cyclampterium Haeckel, 1887, p. 1379.

Cyclampterium (?) longiventer n. sp.
(Plate 10, Figure 7)

Description: Shell subconical and thick-walled. Cephalis hemispherical with small circular pores, bearing a conical horn as long as the cephalis, separated from thorax by a distinct change in contour. Thorax inflated conical, thick-walled, separated from abdomen by a distinct constriction. Thoracic pores small, circular, sometimes hexagonally framed, and arranged in longitudinal rows. Abdomen inflated conical, ovate in cross-section, thick walled and robust. Abdominal pores subcircular to polygonal, larger than those on the thorax, slightly increasing in size distally, and arranged in longitudinal rows. Shell terminated by a wide open mouth surrounded by 3-6 irregular teeth.

Measurements based on 15 specimens from Samples 274-33-3, 55-75 cm; 274-31, CC; 274-28, CC; 274-27, CC; 274-25, CC; 274-24, CC; and 274-23, CC: length of the cephalis, 25μ-29μ; of the thorax, 44μ-55μ; of the abdomen, 180μ-218μ; maximum width of the thorax, 72μ-93μ; of the abdomen, 172μ-202μ.

Remarks: This species is closely related and similar to *Cyclampterium* (?) *milowi*, but differs from the latter in having an abdomen terminated by irregular teeth. The specific name is derived from the Latin *longus* (long) and *venter* (belly), and is used as a noun in apposition.

Abundance: Few.
Range: Oligocene.
Occurrence: Lower Oligocene.

Cyclampterium (?) milowi Riedel and Sanfilippo
(Plate 2, Figures 4, 5)

Cyclampterium (?) *milowi* Riedel and Sanfilippo, 1971, p. 1593, pl. 3B, fig. 3; pl. 7, fig. 8, 9.
Abundance: Rare.
Occurrence: Eocene (upper Eocene?).

Genus CYRTOCAPSELLA Haeckel

Cyrtocapsella Haeckel, 1887; Sanfilippo and Riedel, 1970, p. 451; Riedel and Sanfilippo, 1970, p. 530.

Cyrtocapsella isopera n. sp.
(Plate 11, Figures 7-9)

Description: Cephalis spherical, bearing one short conical apical horn, with very few small, circular pores. Collar stricture marked by a distinct change in contour. Thorax campanulate, smooth-walled, with longitudinally disposed circular pores of uniform size. Lumbar constriction distinct. Abdomen cylindrical, inflated cylindrical, or inflated inverted conical, with a constriction at about the middle in some specimens. Abdominal pores similar in size and arrangement to those in the thorax. Shell closed by a sieve plate with a small circular mouth.

Measurements based on 30 specimens from Sample 266-21-3, 50-52 cm; 266-20, CC; 266-19, CC; and 266-18, CC: length of the cephalis, 18μ-20μ; of the thorax, 36μ-54μ; of the abdomen, 36μ-80μ; width of the thorax, 54μ-83μ; of the abdomen 50μ-93μ.

Remarks: This species is characterized by its small, circular uniform pores in both thorax and abdomen.
Abundance: Present to common.
Range: Lower to middle Miocene.

Cyrtocapsella tetrapera Haeckel
(Plate 20, Figure 1)

Cyrtocapsa (Cyrtocapsella) tetrapera Haeckel, 1887, p. 1512, pl. 78, fig. 5.
Cyrtocapsella tetrapera Haeckel, Riedel and Sanfilippo, 1970, p. 453, pl. 1, fig. 16-18.
Abundance: Common to present.
Range: Miocene.

Genus CYRTOPERA Haeckel

Cyrtopera Haeckel, 1881, p. 439.

Cyrtopera laguncula Haeckel
(Plate 18, Figure 9)

Cyrtopera laguncula Haeckel, 1887, p. 1451, pl. 75, fig. 10; Benson, 1966, p. 510-513, pl. 35, fig. 3, 4.
Cyrtocapsa sp. Riedel, 1958, p. 244, pl. 4, fig. 11.
Abundance: Rare.
Range: Neogene.

Genus DICTYOCEPHALUS Ehrenberg

Dictyocephalus Ehrenberg, 1860, p. 830.

Dictyocephalus papillosus (Ehrenberg)

Eucyrtidium papillosum Ehrenberg, 1872, p. 310-311, pl. VII, fig. 10.
Dictyocephalus papillosus (Ehrenberg), Haeckel, 1887, p. 1307; Riedel, 1958, p. 235-238, pl. 3, fig. 10; (?) Petrushevskaya, 1968, p. 112-113, fig. 66,I-III.
Abundance: Rare.
Range: Pliocene to Recent.

Genus DICTYOPHIMUS Ehrenberg

Dictyophimus Ehrenberg, 1847b, p. 53.

Dictyophimus mawsoni Riedel
(Plate 19, Figures 1, 2)

Dictyophimus mawsoni Riedel, 1958, p. 234, pl. 3, fig. 6, 7.
Dictyophimus (?) *mawsoni* Riedel, Petrushevskaya, 1968, p. 73-74, fig. 43.
Abundance: Rare.
Range: Pliocene to Recent.

Genus DICTYOPODIUM Ehrenberg

Dictyopodium Ehrenberg, 1847b, p. 54.

Dictyopodium sp. aff. D. oxylophus Ehrenberg
(Plate 4, Figures 1, 2)

Remarks: This form differs from *D. oxylophus* in having a generally broader shell and less developed spongy legs. It may be the cold-water form of the *D. oxylophus*.
Abundance: Rare to few.
Occurrence: Eocene (upper Eocene?).

Genus DIPLOCYCLAS Haeckel

Diplocyclas Haeckel, 1881, p. 434.

Diplocyclas sp. A group Petrushevskaya and Kozlova
(Plate 7, Figures 4, 5)

Diplocyclas sp. A group Petrushevskaya and Kozlova, 1972, p. 541, pl. 33, fig. 14-16.
Abundance: Few.
Occurrence: Oligocene.

Genus EUCYRTIDIUM Ehrenberg

Eucyrtidium Ehrenberg, 1847b, p. 43.

Eucyrtidium calvertense Martin
(Plate 15, Figure 9)

Eucyrtidium calvertense Martin, 1904, p. 450, pl. 130, fig. 5; Hays, 1965, p. 181, pl. III, fig. 4; 1970, p. 213, pl. i. fig. 6; Kling, 1973, p. 636, pl. 4, fig. 16, 18, 19; pl. 11, fig. 1-15.
Abundance: Present to common.
Range: Pliocene.

Eucyrtidium cienkowskii Haeckel group
(Plate 15, Figure 7)

Cf. *Eucyrtidium cienkowskii* Haeckel, 1887, p. 1493, pl. 80, fig. 9.
Cf. *Dictyomitra multicostata* (sic!) Luchese, 1927, p. 106, pl. 8, fig. 8.
Eucyrtidium cienkowskii Haeckel group, Sanfilippo et al., 1973, p. 221, pl. 5, fig. 7-11.
Abundance: Present to common.
Range: Miocene.

Eucyrtidium inflatum Kling
(Plate 20, Figure 5)

Eucyrtidium inflatum Kling, 1973, p. 636, pl. 11, fig. 7, 8; pl. 15, fig. 7-10.
Abundance: Rare.
Range: Upper Miocene to lower Pliocene.

Eucyrtidium punctatum (Ehrenberg) group
(Plate 15, Figure 8)

Lithocampe punctata Ehrenberg, 1844, p. 84.
Eucyrtidium punctatum (Ehrenberg), Ehrenberg, 1857, p. 43; 1854, pl.

22, fig. 24; Sanfilippo et al., 1973, p. 221, pl. 5, fig. 15, 16.
Abundance: Present.
Range: Lower to middle Miocene

Eucyrtidium sp.
(Plate 7, Figures 6-8)

Description: Shell consisting of 6-8 segments, conical in the upper part and subcylindrical in the lower part, thick-walled, and rough-surfaced. Cephalis hemispherical and small bearing two conical spines of variable length but generally shorter than the cephalis, one apical and the other vertical; separated from thorax by an indistinct change in contour; pores subcircular, small, and scattered. Thorax conical with subcircular pores of uniform size, arranged in longitudinal rows, separated from abdomen by a distinct stricture. Abdomen inflated conical; pores subcircular, of uniform size, hexagonally framed, arranged in longitudinal rows, and 3-4 pores in each row. From the fourth to the sixth segment, shell subcylindrical; segments separated from one another by distinct strictures; pores subcircular, of uniform size, and arranged in longitudinal rows or randomly disposed. Maximum width of the shell occurs at the fourth or fifth segment. Shell tapering at the fifth or sixth segment, and pores becoming more irregular in size, form, and arrangement. Mouth open.

Measurements based on 30 specimens from Samples 274-21-2, 54-64 cm; 274-21, CC; 274-22, CC; 274-23, CC; and 274-24, CC: maximum width of the shell, 90μ-135μ; length of the shell, 198μ-315μ.
Abundance: Common.
Occurrence: Oligocene.

Genus EUSYRINGIUM Haeckel

Eusyringium Haeckel, 1881, p. 437.

Eusyringium fistuligerum (Ehrenberg)
(Plate 3, Figure 3)

Eucyrtidium fistuligerum Ehrenberg, 1873, p. 229; 1875, p. 70, pl. 9, fig. 3.
Eusyringium fistuligerum (Ehrenberg) Riedel, 1957, p. 94, pl. 4, fig. 8; Riedel and Sanfilippo, 1970, p. 527, pl. 8, fig. 8, 9; Moore, 1971, pl. 4, fig. 10, 11; Foreman, 1973, p. 435, pl. 11, fig. 6.
Abundance: Common.
Occurrence: Eocene (upper Eocene?).

Eusyringium lagena (Ehrenberg) (?)

(?)*Lithopera lagena* Ehrenberg, 1873, p. 241; 1875, p. 78, pl. 3, fig. 4.
(?)*Sethopera lagena* (Ehrenberg) Haeckel, 1887, p. 1233.
(?)*Sethocapsa pyriformis* Haeckel, 1887, p. 1310, pl. 57, fig. 2.
Eusyringium lagena (Ehrenberg) (?) Riedel and Sanfilippo, 1970, p. 527, pl. 8, fig. 5-7; Foreman, 1973, p. 435, pl. 11, fig. 4, 5.
Abundance: Few.
Occurrence: Eocene (upper Eocene?).

Genus LITHOCHYTRIS Ehrenberg

Lithochytris Ehrenberg, 1847a, chart p. 385.

Lithochytris vespertilio Ehrenberg
(Plate 1, Figure 1)

Lithochytris vespertilio Ehrenberg, 1873, p. 239; 1875, pl. 4, fig. 10; Riedel and Sanfilippo, 1970, p. 528, pl. 9, fig. 8, 9.
Lithochytris lucerna Haeckel, 1887, p. 1364, pl. 67, fig. 14.
Lithochytris cheopsis Clark and Campbell, 1942, p. 81, pl. 9, fig. 37.
Abundance: Rare.
Occurrence: Eocene (upper Eocene?).

Genus LOPHOCONUS Haeckel

Lophoconus Haeckel, 1887, p. 1403.

Lophoconus titanothericeraos Clark and Campbell
(Plate 2, Figure 9)

Lophoconus titanothericeraos Clark and Campbell, 1942, p. 89, pl. 8, fig. 24-26, 28, 30-37.
Abundance: Common.
Occurrence: Eocene (upper Eocene?).

Genus LOPHOCYRTIS Haeckel

Lophocyrtis Haeckel, 1887, p. 1410.

Lophocyrtis biaurita (Ehrenberg)
(Plate 3, Figure 2)

Eucyrtidium biauritum Ehrenberg, 1873, p. 226; 1875, p. 70, pl. 10, fig. 8, 9; Bütschli, 1881, p. 530, pl. 33, fig. 38a-f.
Lophocyrtis biaurita (Ehrenberg), Haeckel, 1887, p. 1411; Cita, Nigrini, and Gartner, 1970, p. 404, pl. 2, fig. I-K; Foreman, 1973, p. 442, pl. 8, fig. 23-26.
Abundance: Common.
Occurrence: Eocene (upper Eocene?).

Lophocyrtis golli n. sp.
(Plate 12, Figures 4, 5)

Description: Cephalis cap-shaped with small circular pores arranged in transverse rows, bearing two 3-bladed spines, one apical about twice the length of the cephalis, the other lateral oblique. Thorax conical in the upper part, inflated conical or conical in the lower part, with a distinct change in contour between. Thoracic pores circular to subcircular, small in the upper part and large in the lower part, arranged in transvere rows. Abdomen cylindrical or slightly dilated cylindrical, wider than the thorax, separated from the thorax by a distinct change in contour, with 2-3 rows of circular to subcircular pores of equal dimension. Shell closed by a sieve plate in complete specimens.

Measurements based on 30 specimens from Samples 266-18-3, 51-53 cm; 266-17-4, 50-52 cm; and 266-15-3, 50-52 cm: length of the shell (excluding apical horn), 103μ-131μ; maximum width of the abdomen, 102μ-113μ.

Remarks: This species differs from *Lophocyrtis regipileus* in having a more delicate thoracic shell and a wider abdomen, and from *Theocalyptra bicornis* in having an abdomen of more cylindrical shape. This species is named after Robert M. Goll in recognition of his valuable contributions in the field of radiolarian studies.
Abundance: Present.
Range: Miocene.

Lophocyrtis (?) jacchia (Ehrenberg)
(Plate 3, Figures 5, 6)

Thyrsocyrtis jacchia Ehrenberg, 1873, p. 261; 1875, pl. 12, fig. 7.
Thyrsocyrtis dionysia Ehrenberg, 1873, p. 260; 1875, pl. 12, fig. 5.
Lophocyrtis (?) *jacchia* (Ehrenberg), Riedel and Sanfilippo, 1970, p. 530; 1971, p. 1594, pl. 3C, fig. 4, 5; pl. 7, fig. 16.
Abundance: Few to present.
Occurrence: Eocene (upper Eocene?).

Lophocyrtis regipileus n. sp.
(Plate 12, Figures 6, 7)

Description: Cephalis small, cap-shaped, separated from thorax by a slight change in contour, with small circular pores, bearing two spines, one apical, conical, or 3-bladed, and as much as twice the length of the cephalis, the other vertical, three-bladed. Thorax campanulate, slightly narrower at the base, with maximum width of the shell at the middle of the thorax; thoracic wall thick. Thoracic pores circular, arranged in transverse rows, increasing in size distally commonly hexagonally framed in the lower 4-5 rows. Lumbar stricture distinct. Abdomen cylindrical, sometimes with a constriction at the middle; therefore, inverted conical when the lower half broken off, with 2-4 rows of subcircular pores; wall thinner than thoracic wall.

Measurements based on 25 specimens from Samples 266-18-3, 51-53 cm; 266-17-3, 50-52 cm; and 266-15-3, 50-52 cm: length of the shell (excluding apical spine), 90μ-123μ; maximum width of the thorax, 85μ-110μ.

Remarks: This species is similar to *Clathrocyclas bicornis* Hays but differs from the latter in having a smaller apical horn and smaller thoracic pores. Also, in this species the maximum width of the shell is at the middle of the thorax as opposed to *C. bicornis*, with maximum width at the base of the thorax. The specific name is a combination of the Latin *regis* (King's) and *pileus* (cap), and is used as a noun in apposition.
Abundance: Present to common.
Range: Lower to middle Miocene.

Genus LYCHNOCANIUM Ehrenberg

Lychnocanium Ehrenberg, 1847b, p. 54.

Lychnocanium sp. aff. L. grande Campbell and Clark
(Plate 1, Figures 6, 7)

Description: Shell broadly conical. Apical horn conical, as long as cephalis. Cephalis hemispherical, poreless, separated from thorax by a change in contour rather than by sharp stricture. Thorax inflated truncate-conical with maximum width below the middle of the thorax; pores subpolygonal, of uniform size, and arranged in longitudinal rows. Three feet, 3-bladed, slightly diverted and convex inward distally.

Measurements based on 20 specimens from Samples 264-2-6, 105-107 cm; and 264-3-2, 105-107 cm: length of the apical horn, 28μ-40μ; of the cephalis, 36μ-42μ; of the thorax, 90μ-102μ; of the feet, 135μ-179μ; maximum width of the thorax, 98μ-126μ.

Abundance: Common.

Occurrence: Eocene (upper Eocene?).

Genus LYCHNOCANOMA Haeckel

Lychnocanoma Haeckel, 1887, p. 1229.

Lychnocanoma amphitrite Foreman
(Plate 2, Figure 7)

Lychnocanoma amphitrite Foreman, 1973, p. 437, pl. 11, fig. 10.

Remarks: Most specimens have spongy wall on the third segment.

Abundance: Common.

Occurrence: Eocene (upper Eocene?).

Lychnocanoma sp.
(Plate 1, Figures 8, 9)

Description: Shell conical and robust. Cephalis subconical, bearing an apical horn, circular in cross section, up to one and one half the length of the cephalis; pores subcircular, few and scattered. Thorax truncate-conical, thick-walled and rough, with evenly distributed subcircular pores, slightly increasing size distally; bar width about equal to the diameter of the pores. Three feet, stout and circular in cross section, slightly diverted, straight or convex outward.

Measurements based on 15 specimens from Samples 264-2-6, 105-107 cm; and 264-3-2, 105-107 cm: length of the apical horn, 28μ-35μ; of the cephalis, 18μ-25μ; of the thorax, 54μ-65μ; of the feet, 125μ-145μ; maximum width of the thorax, 70μ-81μ.

Abundance: Present.

Occurrence: Eocene (upper Eocene?).

Lychnocanoma babylonis (Clark and Campbell)
(Plate 2, Figure 8)

Dictyophimus babylonis Clark and Campbell, 1942, p. 67, pl. 9, fig. 32, 36.

Sethochytris babylonis (Clark and Campbell) group, Riedel and Sanfilippo, 1970, p. 528, pl. 9, fig. 1-3; Moore, 1971, pl. 3, fig. 9, 10.

Lychnocanoma babylonis (Clark and Campbell), Foreman, 1973, p. 437, pl. 2, fig. 1.

Abundance: Common.

Occurrence: Eocene (upper Eocene?).

Genus PERIPYRAMIS Haeckel

Peripyramis Haeckel, 1881, p. 428.

Peripyramis circumtexta Haeckel

Peripyramis circumtexta Haeckel, 1887, p. 54, fig. 5; Riedel, 1958, p. 231, pl. 2, fig. 8, 9; Petrushevskaya, 1968, p. 111-112, fig. 64,I,II.

Abundance: Few to present.

Occurrence: Neogene (and Oligocene?).

Genus SETHOCONUS Haeckel

Sethoconus Haeckel, 1887, p. 1399.

Sethoconus (?) dogieli Petrushevskaya
(Plate 19, Figure 4)

Sethoconus (?) *dogieli* Petrushevskaya, 1968, p. 94, fig. 53,I,II.

Abundance: Rare.

Range: Pliocene to Recent.

Sethoconus sp.
(Plate 10, Figures 5, 6)

Description: Shell conical. Cephalis cap-shaped with few scattered small circular pores, indistinctly separated from thorax. Thorax conical with large subcircular to polygonal pores of various sizes. Shell occasionally covered with a variable number of conical spines, or with dense meshwork (in Oligocene specimens) in the upper half of the shell.

Measurements based on 45 specimens from Samples 266-20, CC; 266-21, CC; 274-20, CC; and 274-30, CC: length of the shell, 100μ-191μ; maximum width of the thorax, 72μ-135μ.

Abundance: Present to common.

Range: Oligocene to Miocene.

Genus STICHOCORYS Haeckel

Stichocorys Haeckel, 1881, p. 438; Riedel, and Sanfilippo, 1970, p. 530.

Stichocorys delmontensis (Campbell and Clark)
(Plate 20, Figure 10)

Eucyrtidium (Eucyrtis) delmontense 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; Riedel and Sanfilippo, 1971, pl. 1F, fig. 5-7; pl. 2E, fig. 10, 11; Foreman, 1973, p. 439.

Abundance: Rare.

Range: Upper Miocene.

Genus THEOCALYPTRA Haeckel

Theocalyptra Haeckel, 1881, p. 434.

Theocalyptra bicornis (Popofsky)
(Plate 13, Figures 1, 2)

Pterocorys bicornis Popofsky, 1908, p. 228-229, pl. XXXIV, fig. 7, 8.

Theocalyptra bicornis (Popofsky), Riedel, 1958, p. 240, pl. 4, fig. 4.

Theocalyptra (?) *bicornis* (Popofsky), Petrushevskaya, 1968, p. 124-127, fig. 71,II-IX; 72,I-IV.

Abundance: Few to present.

Range: Middle Miocene to Recent.

Theocalyptra bicornis spongothorax n. subsp.
(Plate 12, Figures 1-3)

Description: Cephalis cap-shaped with small circular pores, bearing two 3-bladed spines; apical spine about the same length as the cephalis, vertical spine smaller. Thorax campanulate, circumscribed by one or two ridges formed by connecting adjacent horizontal pore bars, commonly sharp changes in contours appearing as steps at these ridges, thoracic wall of medium thickness and covered by spongy meshwork. Thoracic pores subcircular, arranged in transverse rows, increasing in size distally. Abdomen short, expanded, with 1-2 rows of subcircular pores, terminated by numerous short pore bars. Shell either open or closed by a sieve plate in complete specimens.

Measurements based on 30 specimens from Samples 265-15-3, 10-12 cm; and 265-15, CC: length of the shell (excluding apical horn), 101μ-126μ; maximum width of the thorax, 81μ-125μ.

Remarks: This subspecies is characterized by its spongy thorax but is similar to *Theocalyptra bicornis* in other respects.

Abundance: Present to common.

Range: Upper Miocene to lower Pliocene.

Genus STICHOPHORMIS Haeckel

Stichophormis Haeckel, 1881, p. 439.

Stichophormis sp.
(Plate 13, Figure 8)

Description: Shell slenderly conical with 9-12 annular strictures, four longitudinal ribs arising from the third or fourth stricture and terminated at the middle of the last segment. Cephalis spherical, poreless, separated from thorax by a distinct constriction. From the thorax to the fourth segment, shell conical, segments indistinctly separated from one another, with small subcircular pores arranged in 2-3 transverse rows. From the fifth to the next to last segment, shell inflated conical with subcircular to polygonal pores arranged in 3-4 transverse rows, separated from one another by distinct constrictions.

Last segment inflated conical with an indistinct constriction at the middle; pores subcircular to polygonal and arranged in 7-9 transverse rows above the constriction, and of more irregular size and shape below the constriction. Peristome surrounded by a corona of irregular teeth.

Measurements based on 7 specimens from Samples 266-17, CC; 266-16, CC; 266-16-2, 100-102 cm; and 266-15, CC: total length of the shell, 239μ-276μ; maximum width of the last segment, 108μ-121μ.

Abundance: Rare to few.

Range: Middle Miocene.

Theocorys redondoensis (Campbell and Clark)
(Plate 20, Figures 2, 3)

Theocyrtis redondoensis Campbell and Clark, 1944, p. 49, pl. 7, fig. 4; Casey et al., 1972, pl. 2, fig. 3

Theocorys redondoensis (Campbell and Clark), Kling, 1973, p. 638, fig. 26-28.

Abundance: Few.

Occurrence: Miocene.

Genus THYRSOCYRTIS Ehrenberg

Thyrsocyrtis Ehrenberg, 1847b, p. 54.

Thyrsocyrtis clausa n. sp.
(Plate 14, Figures 1, 2)

Description: Cephalis spherical, poreless, thick-walled, bearing a short conical horn. Thorax campanulate, thick-walled, with small circular pores of regular size and longitudinally aligned. Abdomen inflated cylindrical, separated from the thorax by a distinct constriction. Abdominal pores subcircular, of regular size, and arranged in approximately longitudinal rows in the upper part, more irregular size and arrangement in the lower part. Three diverted stout bladed feet at the base of abdomen. Shell closed by a sieve plate or a sieve sac.

Measurements based on 10 specimens from Samples 266-15-3, 50-52 cm; 266-14, CC; 266-15-1, 45-47 cm; and 266-15, CC: length of the cephalis, 36μ-40μ; of the thorax, 117μ-131μ; and of the abdomen, 126μ-154μ. Width of the thorax, 120μ-178μ; of the abdomen, 126μ-182μ. Length of the feet, 85μ-120μ.

Remarks: This species is distinguished from other members of this genus by its closed abdomen and the larger size of the shell.

Abundance: Rare to few.

Occurrence: Middle Miocene.

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PLATES

Plates 1 through 24 constitute a synchronopticon, Plates 1 through 5 covering the Eocene, Plates 6 through 10 the Oligocene, and Plates 11 through 24 the Neogene. Magnifications are ×300 unless otherwise stated. Notation of specimen location on the slide follows the DSDP sample numbers and is indicated by England Finder coordinates. The England Finder was used with its label to the observer's left.

PLATE 1

Figure 1 — *Lithochytris vespertilio* Ehrenberg. Sample 264-2-6, 105-107 cm; C36.

Figures 2, 3 — *Clathrocyclas universus* Clark and Campbell. Sample 264-2-6, 105-107 cm.
2. S38.
3. D37.

Figures 4, 5 — *Sethocyrtis* sp. Sample 264-2-6, 105-107 cm.
4. V31/2.
5. U56/2.

Figures 6, 7 — *Lychnocanium* sp. aff. *L. grande* Clark and Campbell. Sample 264-2-6, 105-107 cm.
6. D35.
7. C37.

Figures 8, 9 — *Lychnocanium* sp. Sample 264-2-6, 105-107 cm.
8. T36.
9. R36.

PLATE 1

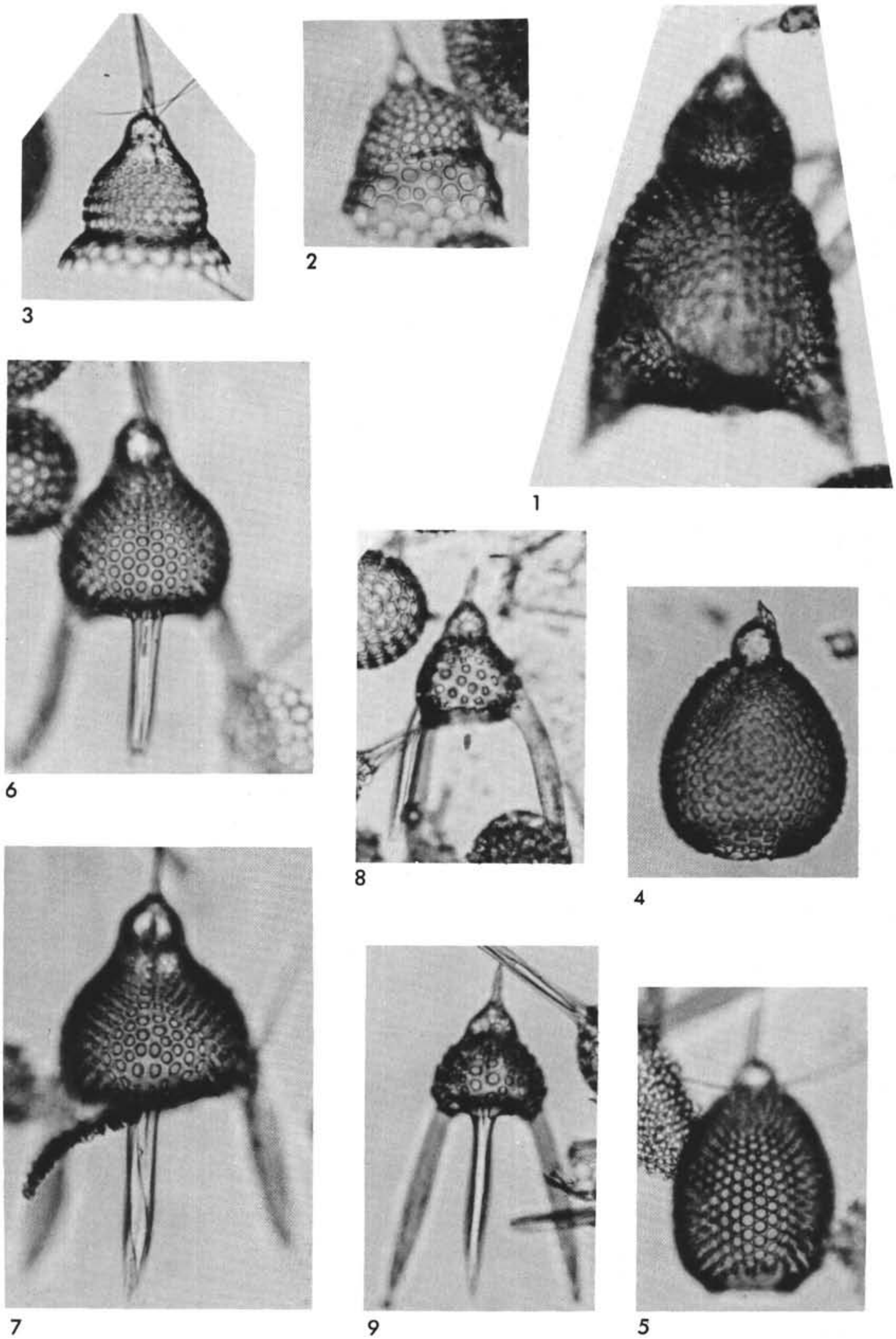


PLATE 2

Figure 1	Gen. and sp. indet. Sample 264-2-6, 105-107 cm; S27.
Figures 2, 3	*Theocampe amphora* (Haeckel) group. Sample 264-3-2, 105-107 cm. 2. V23/2. 3. O10.
Figures 4, 5	*Cyclampterium* (?) *milowi* Riedel and Sanfilippo. Sample 264-3-2, 105-107 cm; V32. 4. ×150. 5. ×300.
Figure 6	*Phormocyrtis proxima* (?) Clark and Campbell. Sample 264-2-6, 105-107 cm; ×48.
Figure 7	*Lychnocanoma amphitrite* Foreman. Sample 264-2-6, 105-107 cm; U39.
Figure 8	*Lychnocanoma babylonis* (Clark and Campbell). Sample 264-2-6, 105-107 cm; S49.
Figure 9	*Lophoconus titanothericeraos* Clark and Campbell. Sample 264-2-6, 105-107 cm; T36.

PLATE 2

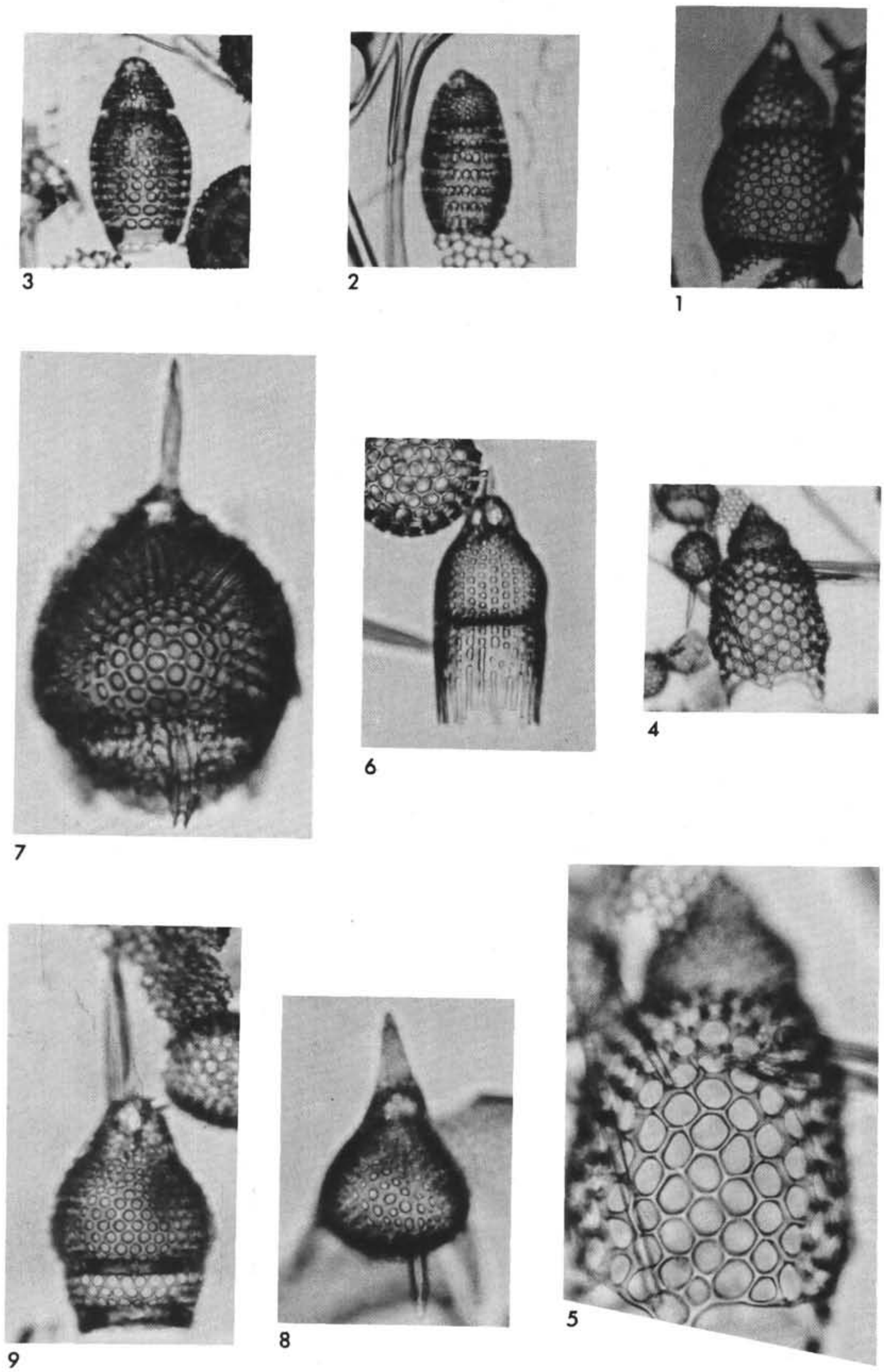


PLATE 3

Figure 1	*Amphisphaera minor* (Clark and Campbell). Sample 264-2-6, 105-107 cm; S25.
Figure 2	*Lophocyrtis biaurita* (Ehrenberg). Sample 264-2-6, 105-107 cm; S39.
Figure 3	*Eusyringium fistuligerum* (Ehrenberg). Sample 264-2-6, 105-107 cm; S35.
Figure 4	*Giraffospyris didiceros* (Ehrenberg). Sample 264-2-6, 105-107 cm; Z55.
Figures 5, 6	*Lophocyrtis* (?) *jacchia* (Ehrenberg). Sample 264-2-6, 105-107 cm. 5. R47/2. 6. Y32.
Figure 7	*Theocampe urceolus* (Haeckel). Sample 264-3-2, 105-107 cm; Y17/2.
Figure 8	*Phormocyrtis striata striata* Brandt. Sample 264-2-6, 105-107 cm; R31.
Figure 9	*Dorcadospyris argisca* (Ehrenberg). Sample 264-2-6, 105-107 cm; Z55.
Figure 10	*Calocyclas hispida* (Ehrenberg). Sample 264-3-2, 105-107 cm; G34/3.

PLATE 3

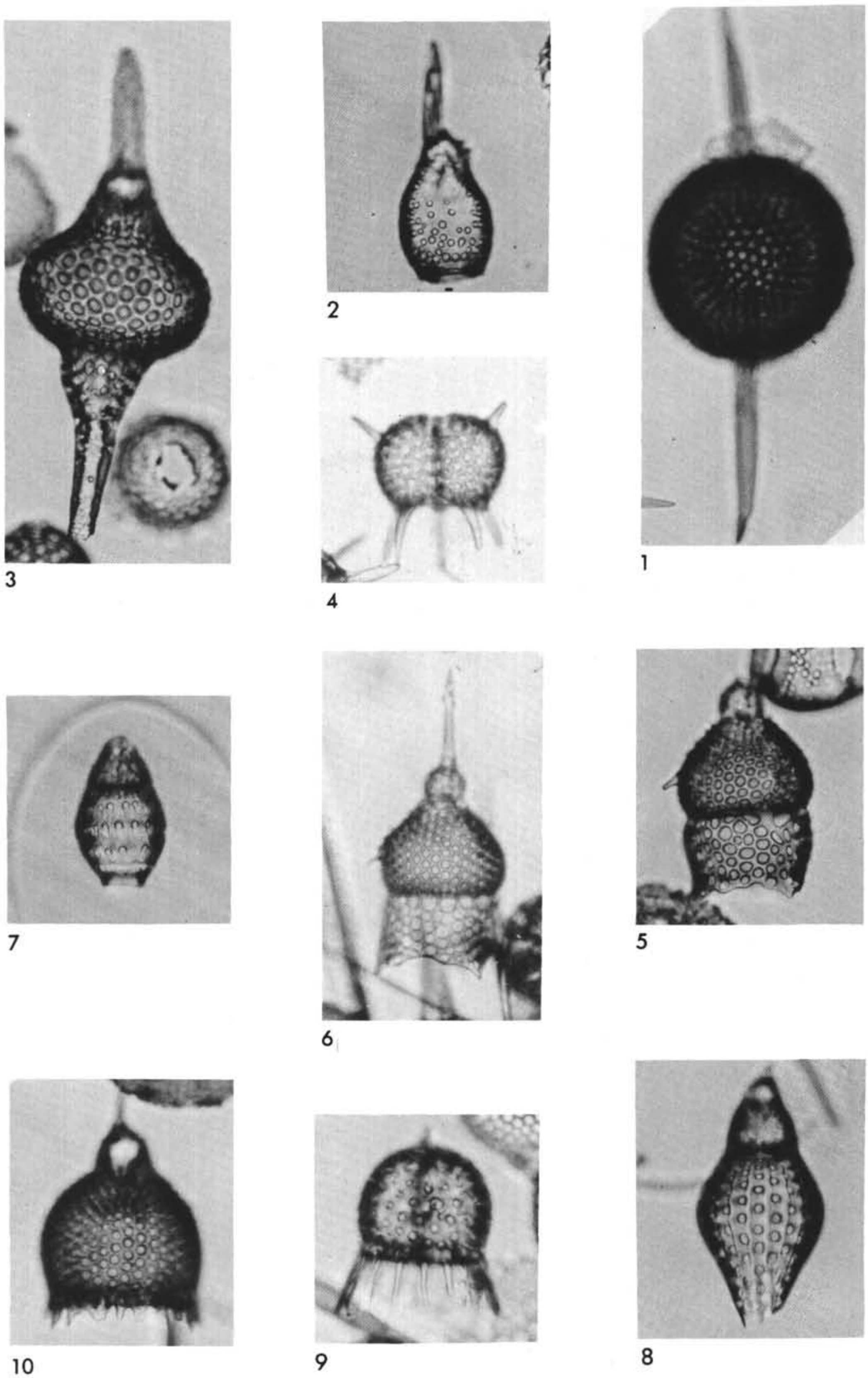


PLATE 4

Figures 1, 2 — *Dictyopodium* sp. aff. *D. oxylophus* Ehrenberg. Sample 264-2-6, 105-107 cm.
1. Z36.
2. D47/2.

Figures 3, 4 — *Artophormis* sp. aff. *A. Dominasinensis* (Ehrenberg). Sample 264-2-6, 105-107 cm.
3. X58.
4. K52.

Figures 5, 6 — Gen. and sp. indet. Sample 264-3-2, 105-107 cm.
5. T44.
6. S42/1.

Figures 7-9 — Gen. and sp. indet. Sample 264-3-2, 105-107 cm.
7. E36.
8. Z39/4.
9. M17.

PLATE 4

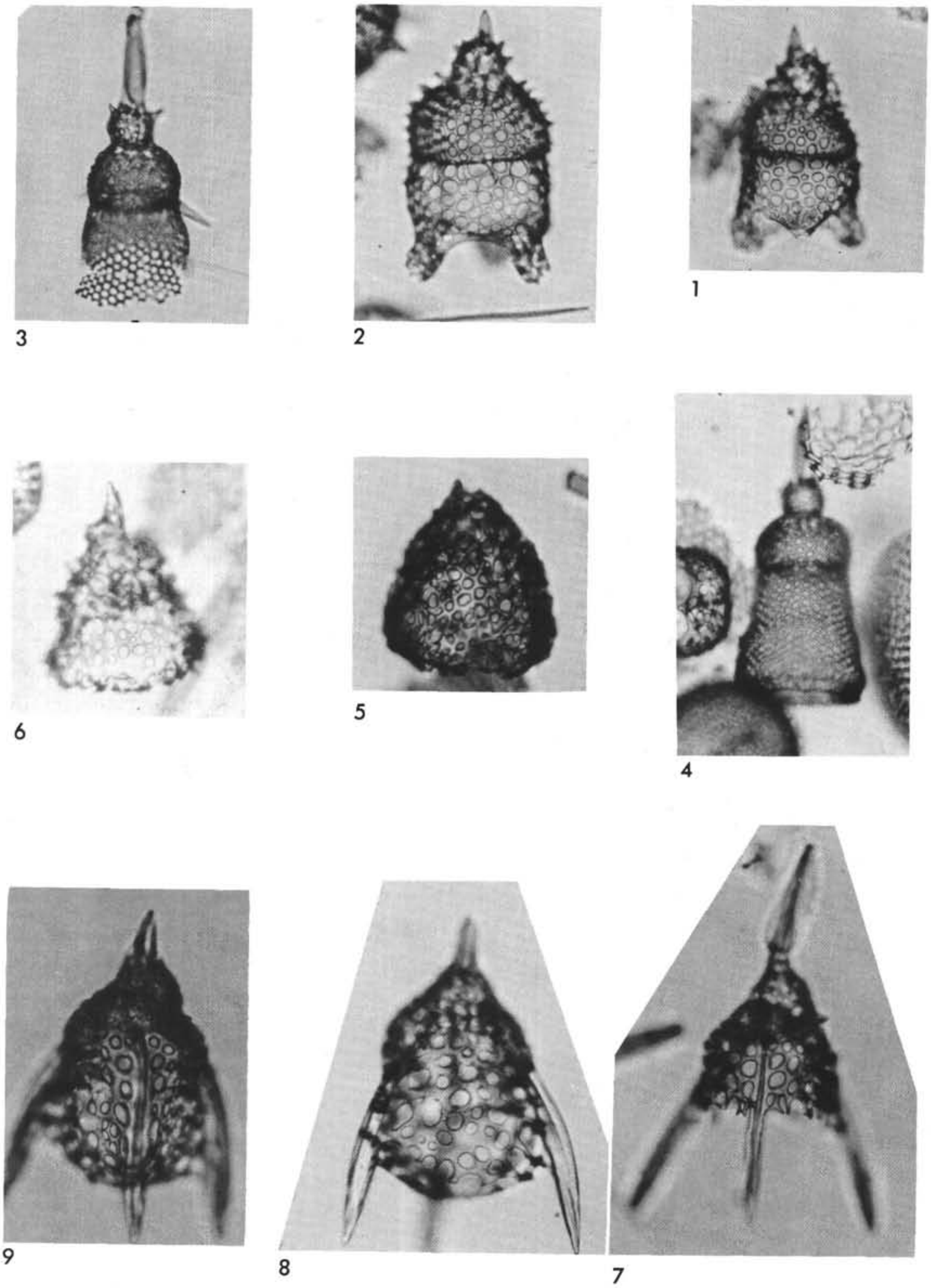
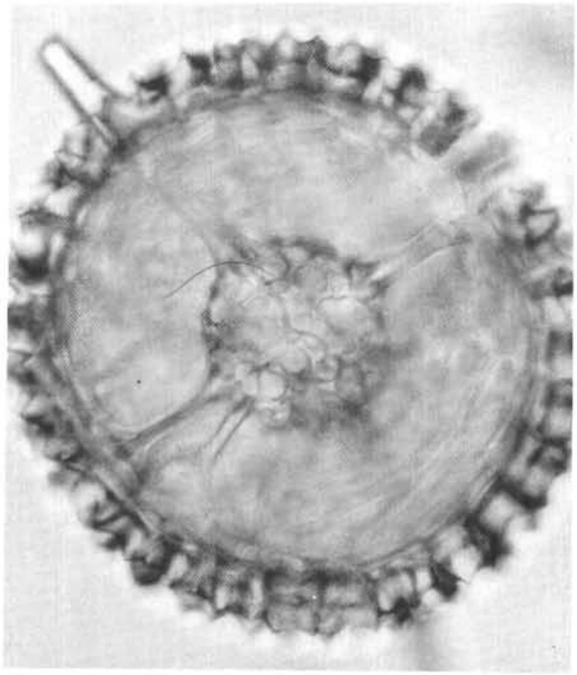


PLATE 5

Figures 1, 2	*Stylasphaera coronata coronata* Ehrenberg. Sample 267-5-3. 1. J25. 2. M25.
Figure 3	*Stylasphaera coronata laevis* Ehrenberg. Sample 264-2-6, 105-107 cm; P16.
Figures 4-7	*Theocyrtis* (*Theocorypha*) *diabloensis* Clark and Campbell. Sample 264-3-2, 105-107 cm. 4. S38/2. 5. G32/2. 6. E15. 7. Sample 264-2-6, 105-107 cm; J41/1.

PLATE 5



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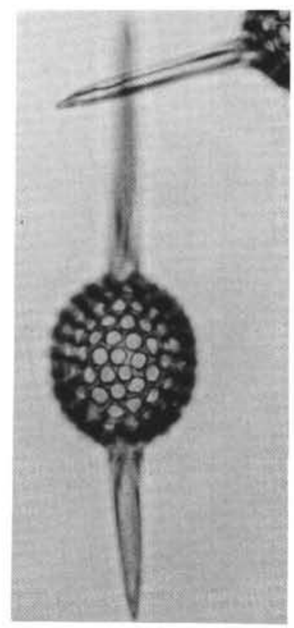

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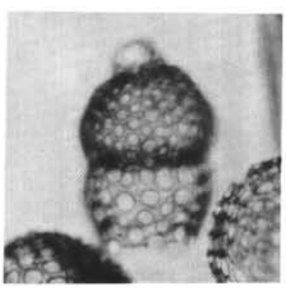

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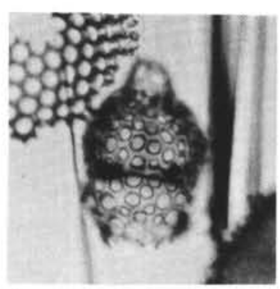

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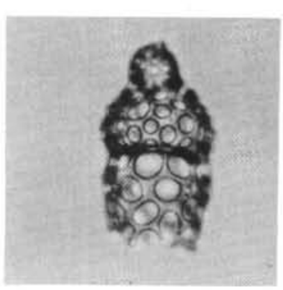

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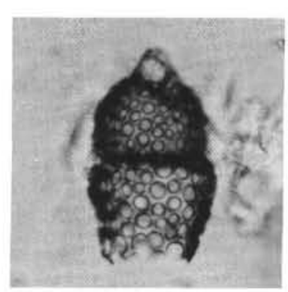

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PLATE 6

Figures 1, 2	*Amphisphaera* sp. 1. Sample 274-20-3, 54-64 cm; R43. 2. Sample 274-25-3, 40-44 cm; M8.
Figure 3-6	*Calocyclas semipolita* (?) Clark and Campbell. 3. Sample 274-33-3, 55-75 cm; Z39. 4. Sample 274-33-3, 55-75 cm; M60/1. 5. Sample 274-21, CC, J36. 6. Sample 274-21, CC, L29 ×200.
Figures 7, 8	*Carpocanarium* sp. 7. Sample 274-21-3, 54-64 cm; K35/1. 8. Sample 274-30-6, 50-70 cm; V41; ×200.
Figure 9	*Cenosphaera* sp. Sample 274-21-3, 54-74 cm; C36/4.

PLATE 6

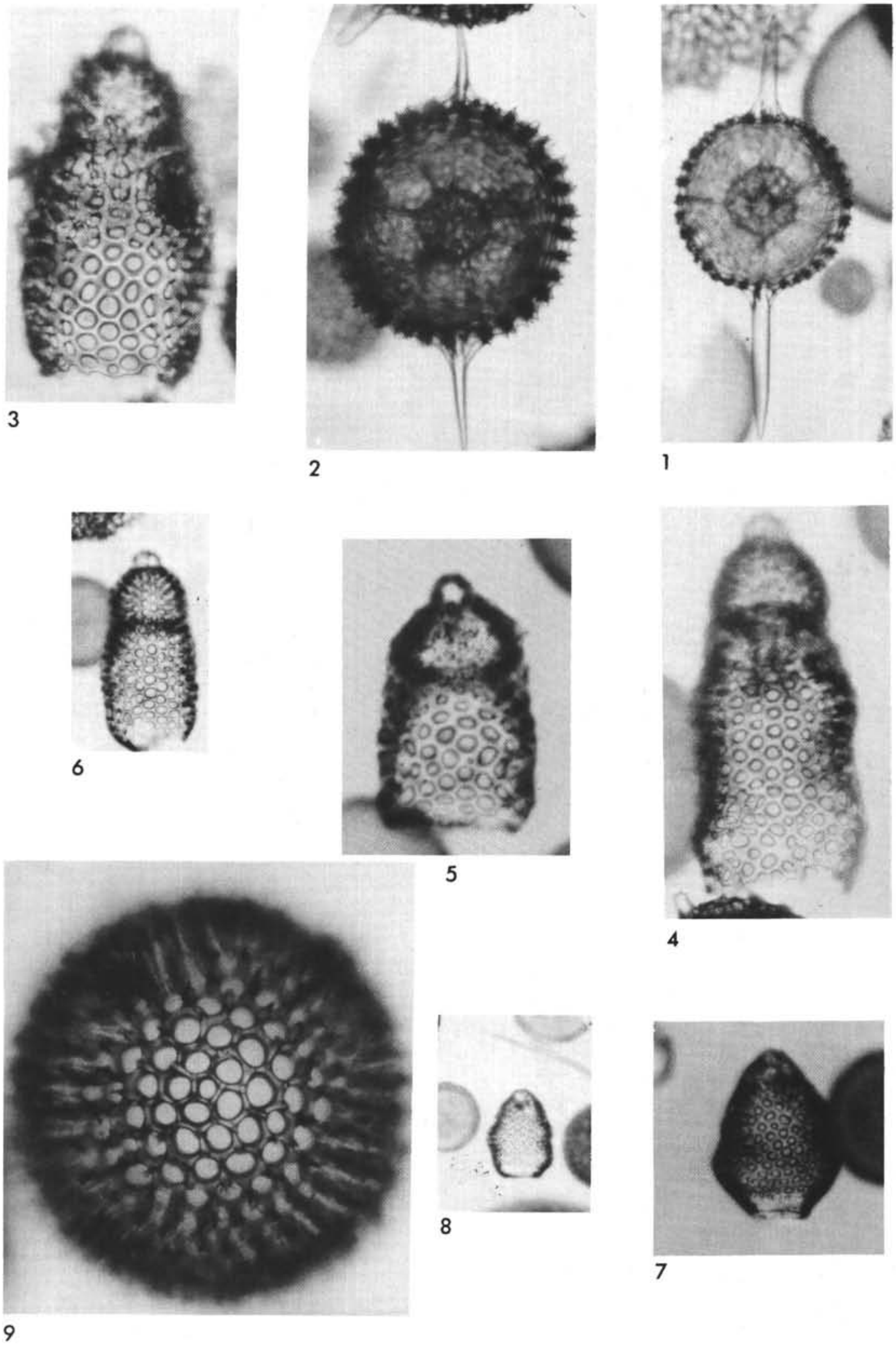
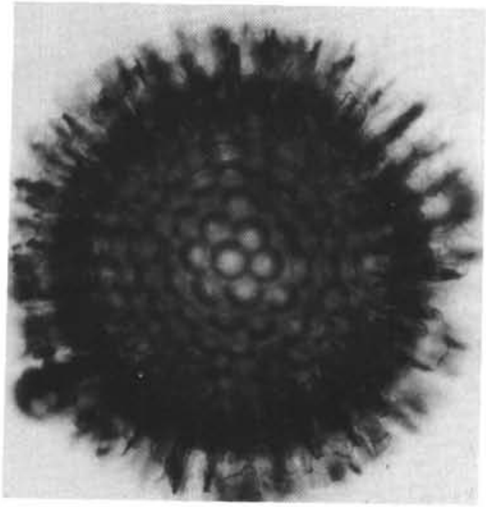


PLATE 7

Figures 1, 2	*Cenosphaera* sp. Sample 274-21-3, 54-64 cm. 1. C36/4. 2. D38.
Figure 3	*Dendrospyris stabilis* Goll. Sample 274-30-6, 50-70 cm; L17.
Figures 4, 5	*Diplocyclas* sp. A group Petrushevskaya and Kozlova. Sample 274-21-3, 54-64 cm. 4. J39. 5. H36.
Figures 6-8	*Eucyrtidium* sp. Sample 274-21-3, 54-64 cm. 6. G46/2. 7. Z16. 8. Z41.

PLATE 7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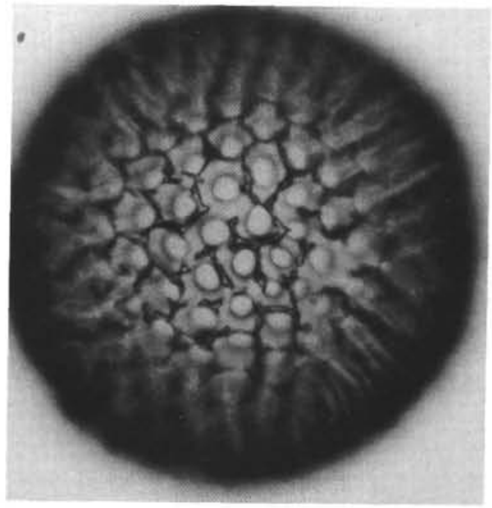
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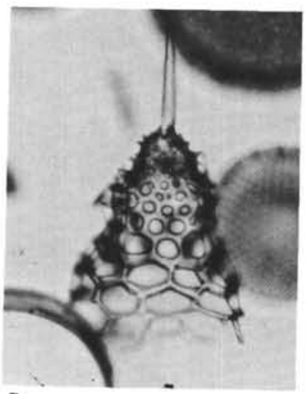
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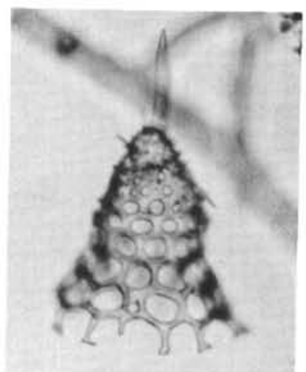
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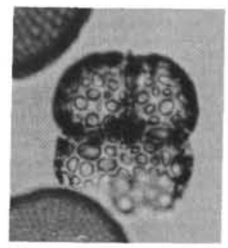
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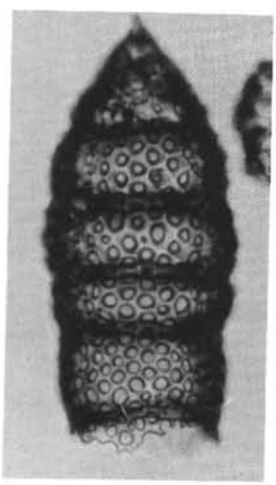
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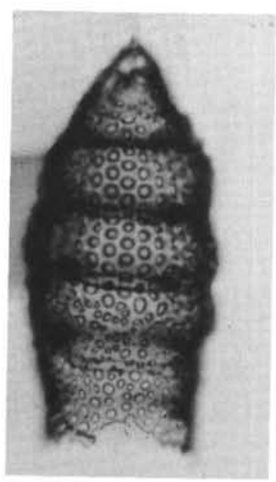
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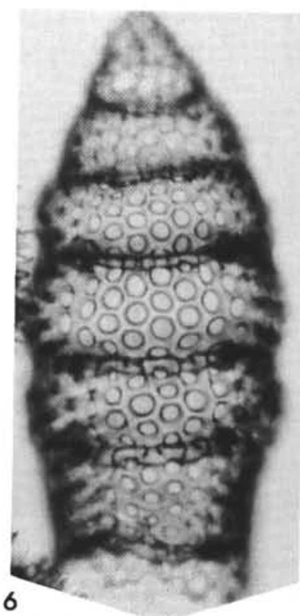
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PLATE 8

Figures 1, 2	*Lithomelissa sphaerocephalis* n. sp. 1. Sample 274-21, CC; J9. 2. Sample 274-25-3, 60-70 cm; W10/4.
Figure 3	*Lithomelissa challengerae* n. sp. Sample 274-22-4, 60-70 cm; D21.
Figures 4, 5	*Lithomelissa mitra* (?) Bütschli. Sample 274-21, CC. 4. V40. 5. L29.
Figures 6, 7	*Lithomelissa tricornis* n. sp. 6. Sample 274-21, CC; W48/1. 7. Sample 274-25-3, 60-70 cm; G52/4.

PLATE 8

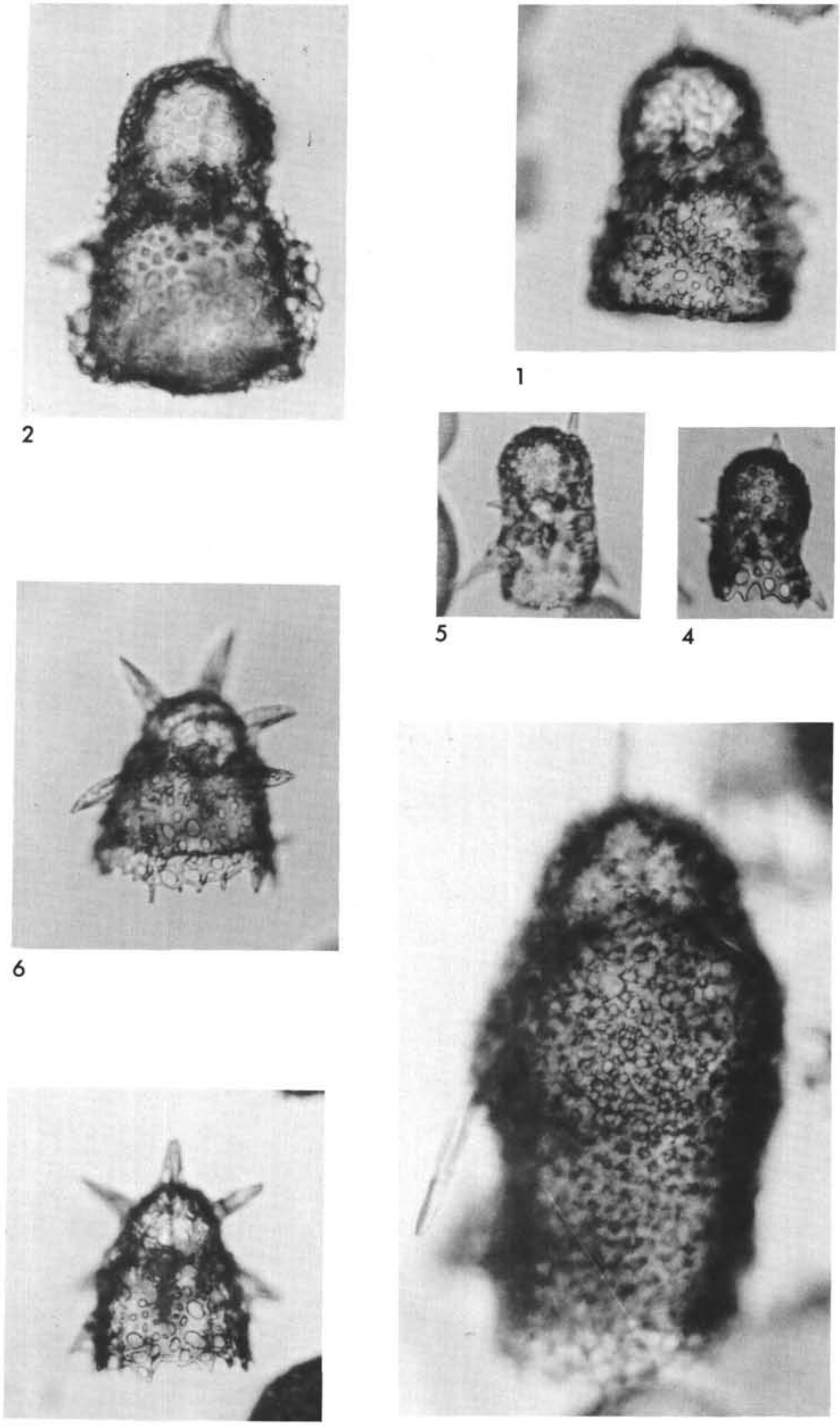
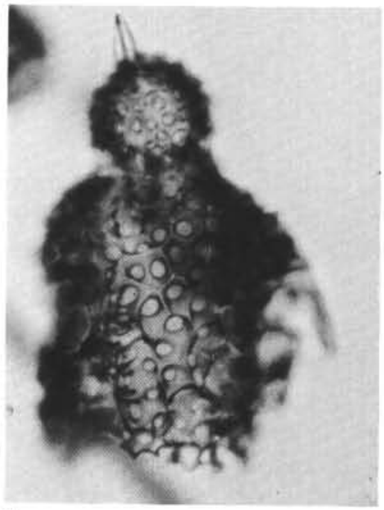


PLATE 9

Figures 1, 2	*Lithomelissa robusta* n. sp. Sample 274-34, CC. 1. U52. 2. F10.
Figures 3-5	*Prunopyle hayesi* n. sp. 3. Sample 274-21-3, 54-64 cm; X40/3. 4. Sample 274-17, CC; X35; ×200. 5. Sample 274-17, CC; Y40; ×200.

PLATE 9



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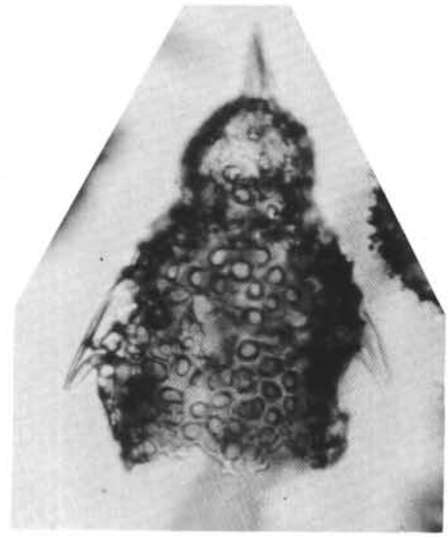

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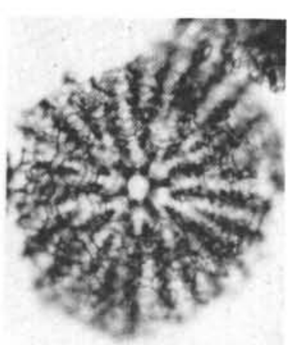

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PLATE 10

Figures 1-3	*Prunopyle frakesi* n. sp. 1. Sample 274-21-3, 54-64 cm; E58. 2. Sample 274-34, CC; E32/1; ×200. 3. Sample 274-34, CC; G13/2; ×200.
Figure 4	*Spongomelissa* sp. Sample 274-21, CC; P31.
Figures 5, 6	*Sethoconus* sp. Sample 274-21-3, 54-64 cm. 5. G46/2. 6. E25.
Figure 7	*Cyclampterium* (?) *longiventer* n. sp. Sample 274-32, CC; U49/2.

PLATE 10

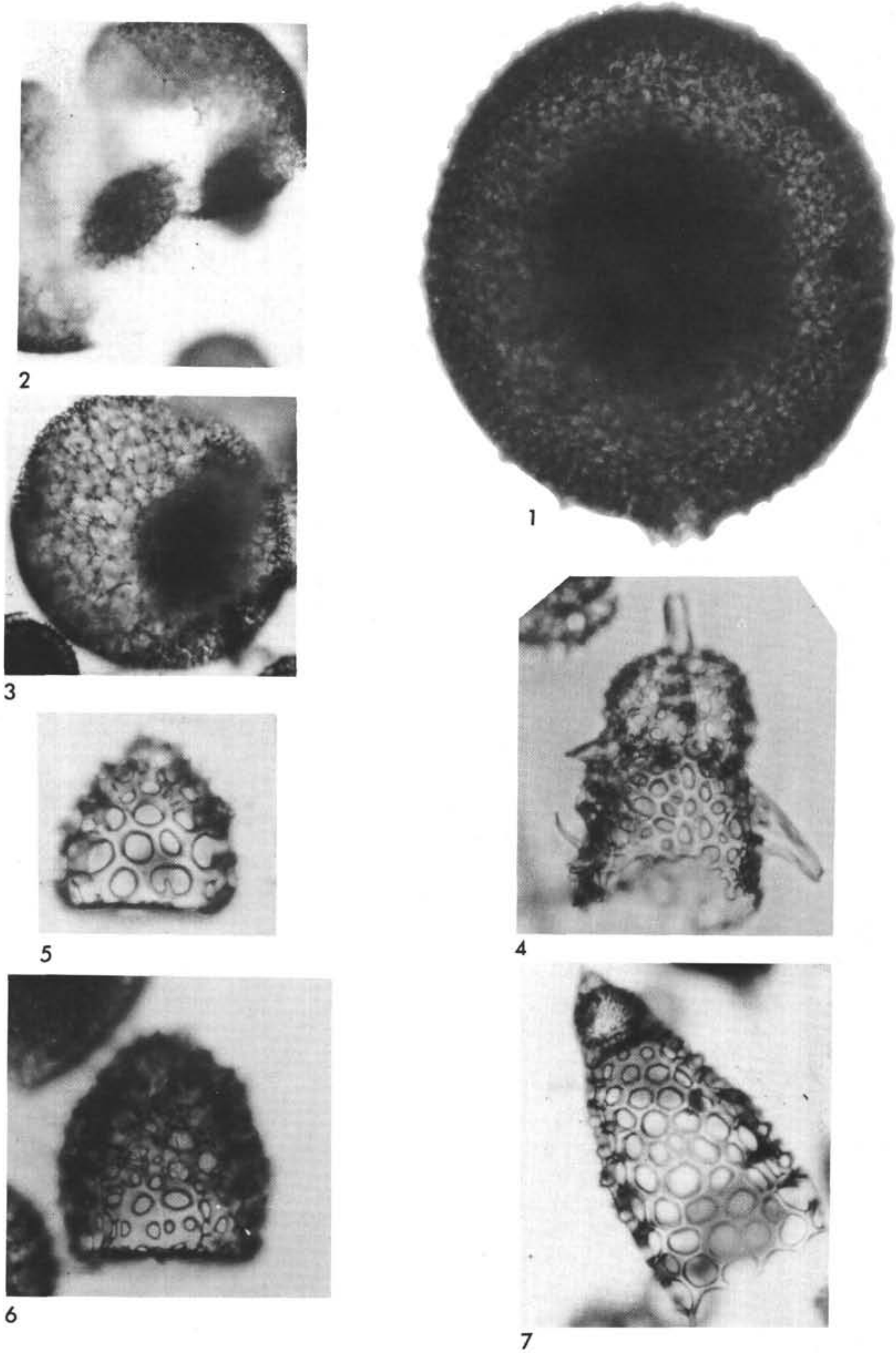
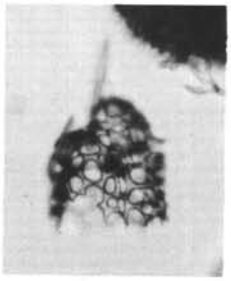


PLATE 11

Figures 1, 2	*Lithomelissa ehrenbergi* (?) Bütschli. 1. Sample 266-19-3, 50-52 cm; V29/2. 2. Sample 266-16-2, 100-102 cm; N44/3.
Figures 3, 4	*Lithomelissa* sp. Sample 266-10-3, 51-53 cm. 3. P58. 4. Z31.
Figures 5, 6	*Actinomma tanyacantha* n. sp. Sample 266-12, CC. 5. N46/3. 6. T30/2.
Figure 7-9	*Cyrtocapsella isopera* n. sp. 7. Sample 266-21-3, 50-52 cm; R10/2. 8. Sample 266-20, CC; K9/2. 9. Sample 266-20, CC; E8.

PLATE 11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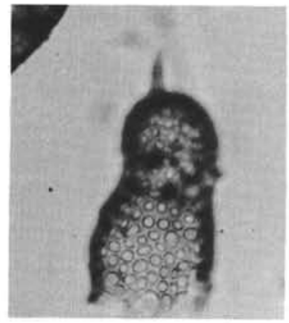
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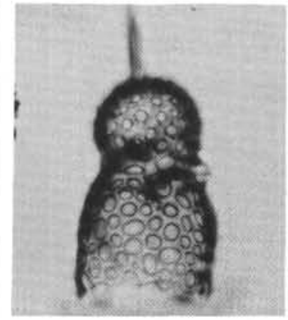
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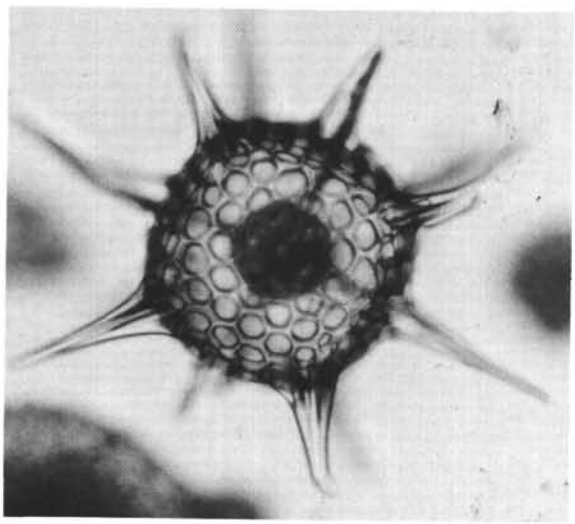
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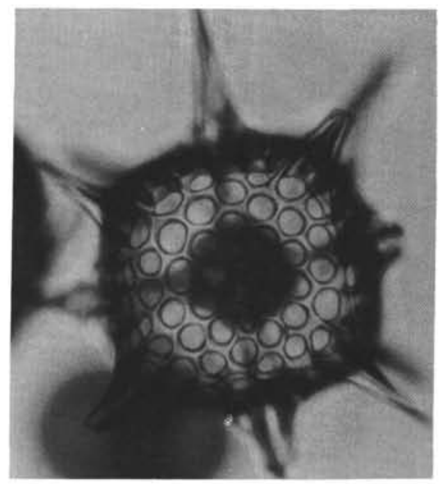
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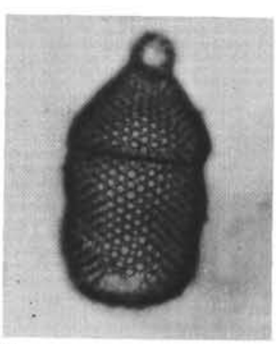
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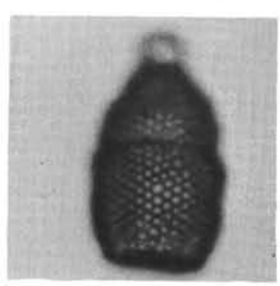
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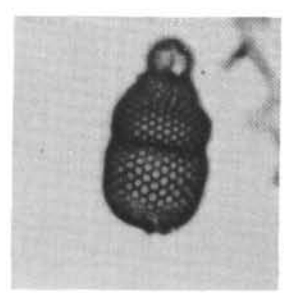
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PLATE 12

Figures 1-3	*Theocalyptra bicornis* Popofsky *spongothorax* n. subsp. Sample 265-15-3, 10-12 cm. 1. G28/4. 2. J25. 3. T52/2.
Figures 4, 5	*Lophocyrtis golli* n. sp. 4. Sample 266-19-3, 50-52 cm; E43/2. 5. Sample 266-17-3, 50-52 cm; Q57/3; ×200.
Figures 6, 7	*Lophocyrtis regipileus* n. sp. Sample 266-18-3, 51-53 cm. 6. V41/3. 7. T10/4; ×200.
Figures 8, 9	*Clathrocyclas bicornis* Hays. Sample 266-6-3, 110-112 cm. 8. K49/1. 9. N45.

PLATE 12

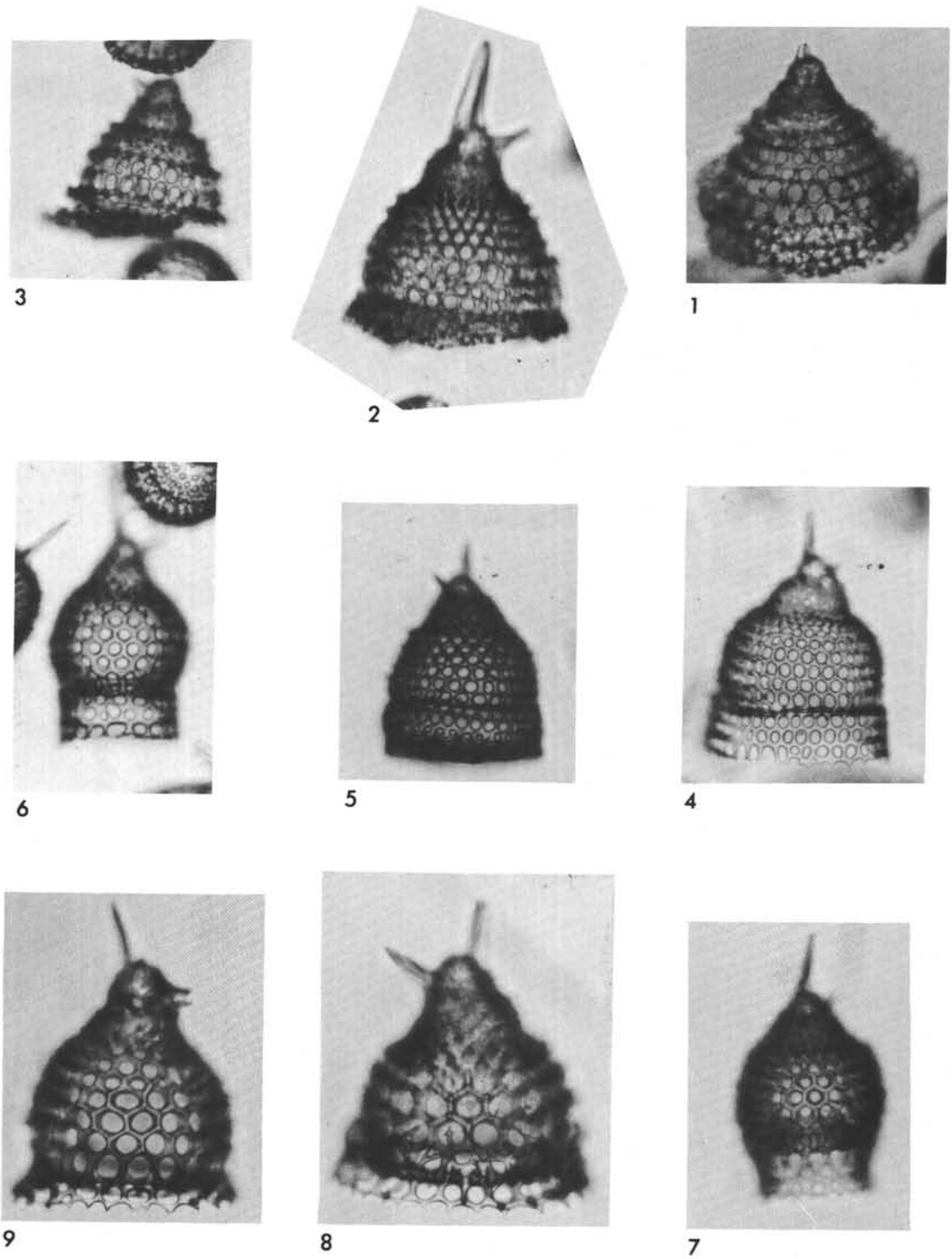


PLATE 13

Figures 1, 2	*Theocalyptra bicornis* Popofsky. 1. Sample 267B-7, CC; E35/2. 2. Sample 265-2-3, 100-102 cm; Q10
Figure 3	*Cycladophora davisiana* Ehrenberg. Sample 265-3-3, 30-32 cm; Z16.
Figures 4, 5	*Calocyclas disparidens* n. sp. Sample 266-16-2, 100-102 cm. 4. F23/4. 5. D55; ×200.
Figures 6, 7	*Spongomelissa dilli* n. sp. 6. Sample 266-11, CC; Y38/1; ×200. 7. Sample 266-16-2, 100-102 cm; E56/3; ×200.
Figure 8	*Stichophormis* sp. Sample 266-16-2, 100-102 cm; D55/2; ×200.
Figure 9	*Pterocanium* sp. Benson. Sample 266-16-2, 100-102 cm; O43; ×200.

PLATE 13

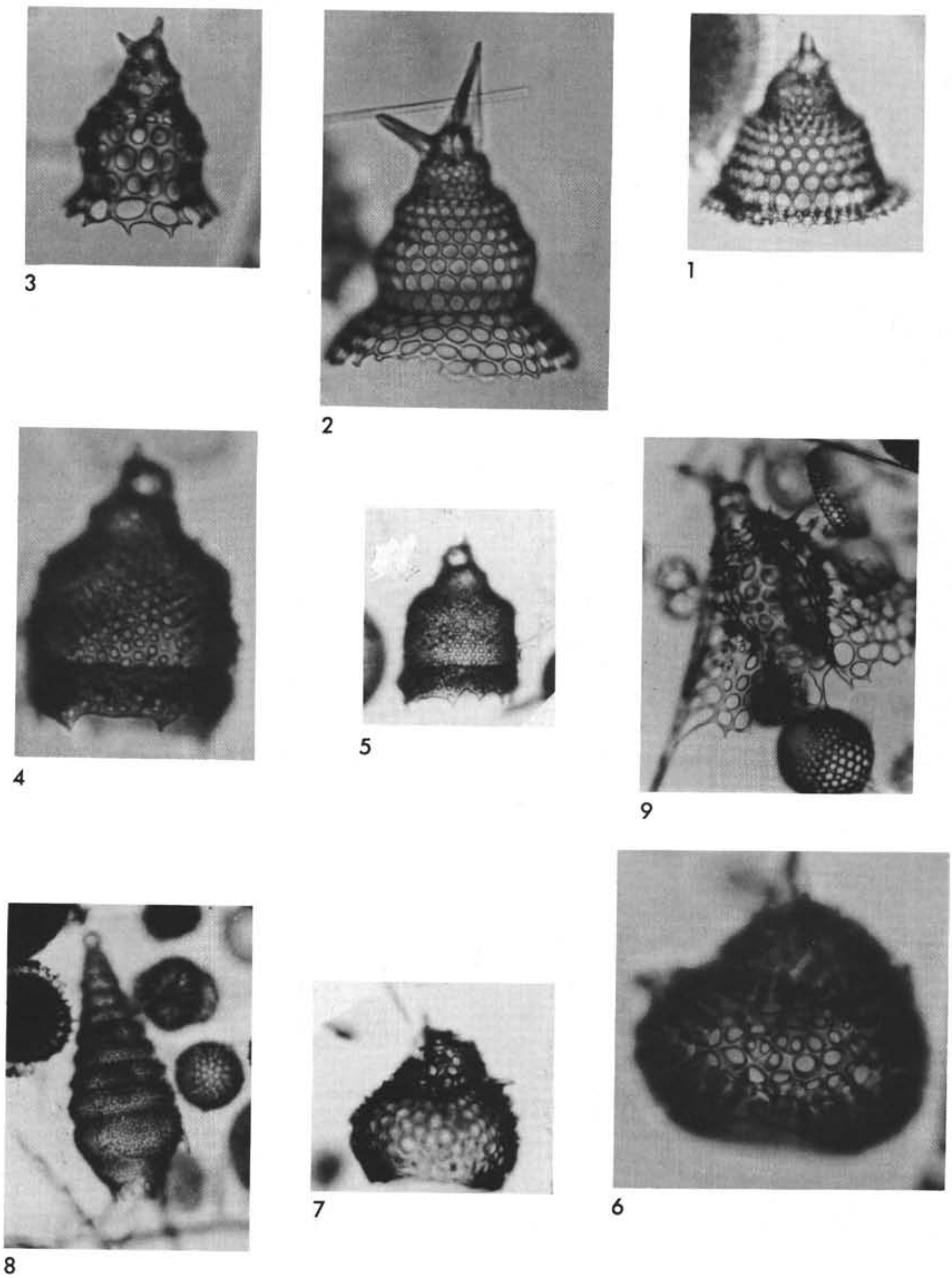


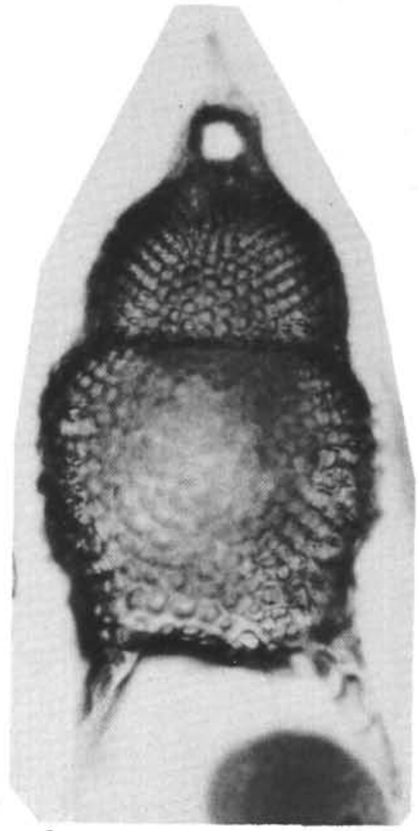
PLATE 14

Figures 1, 2 — *Thyrsocyrtis clausa* n. sp. Sample 266-15-1, 45-47 cm.
1. Z42/2.
2. R21/1.

Figures 3-5 — *Dendrospyris megalocephalis* n. sp. Sample 266-12-3, 80-82 cm.
3. H11/2. ×200.
4. W43/4.
5. G12/2.

PLATE 14

2



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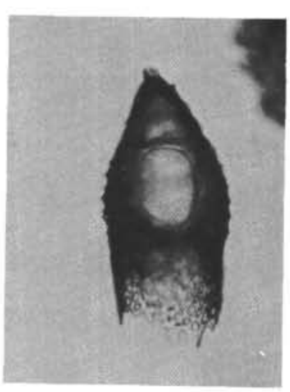

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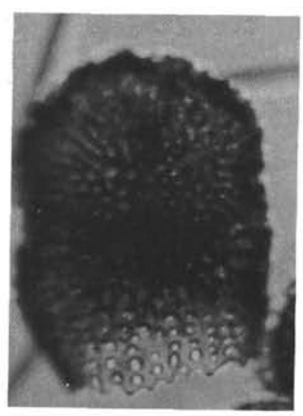

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PLATE 15

Figures 1, 2	*Desmospyris spongiosa* Hays. Sample 266-6-3, 110-112 cm. 1. L16. 2. L14/1.
Figures 3-5	*Dendrospyris haysi* n. sp. Sample 266-19-3, 50-52 cm. 3. D32/1. 4, 5. C10/3.
Figure 6	*Triceraspyris antarctica* (Haecker). Sample 266-6-3, 100-102 cm; T46.
Figure 7	*Eucyrtidium cienkowskii* Haeckel group. Sample 266-18-3, 51-53 cm; W39/4.
Figure 8	*Eucyrtidium punctatum* (Ehrenberg) group. Sample 266-18-3, 51-53 cm; N33/4.
Figure 9	*Eucyrtidium calvertense* Martin. Sample 266-6-3, 110-112 cm, E39.

PLATE 15


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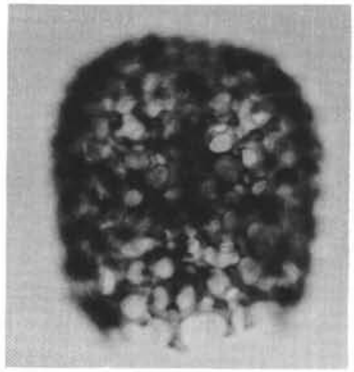
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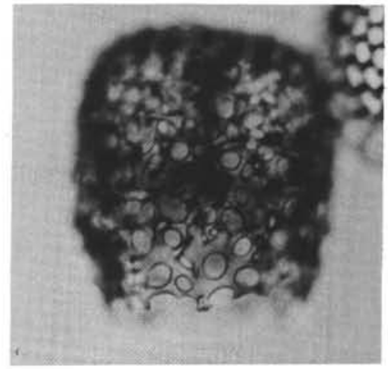
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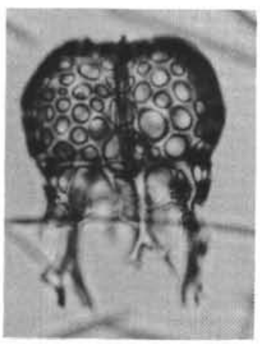
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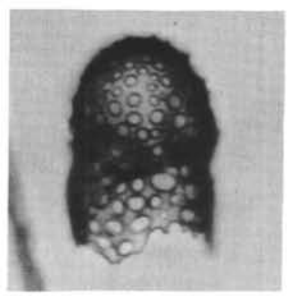
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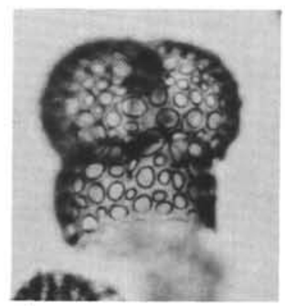
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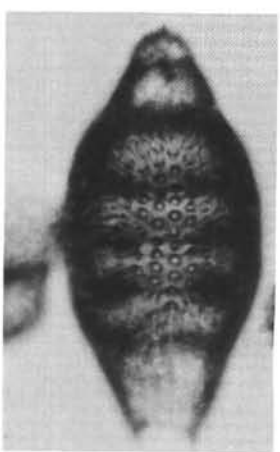
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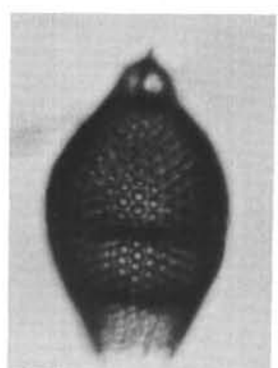
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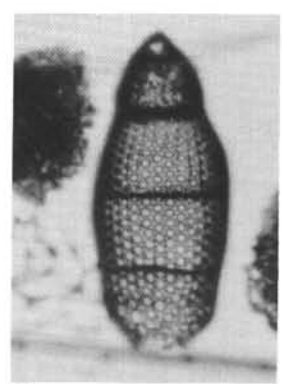
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PLATE 16

Figures 1-4 *Helotholus vema* Hays.
1. Sample 266-6-3, 110-112 cm; C18/4.
2. Sample 266-4-3, 90-92 cm; R50.
3. Sample 266-6-3, 110-112 cm; F42/1; top view.
4. Bottom view of Figure 3.

Figures 5-9 *Antarctissa ewingi* n. sp.
5. Sample 266-9-3, 52-54 cm; X11/2; ×600; bottom view.
6. Sample 267B-3; CC; G36.
7. Sample 266-9-3, 52-54 cm; J25/3.
8. Sample 266-5, CC; L47/1.
9. Sample 265-10, CC; K9/4.

PLATE 16

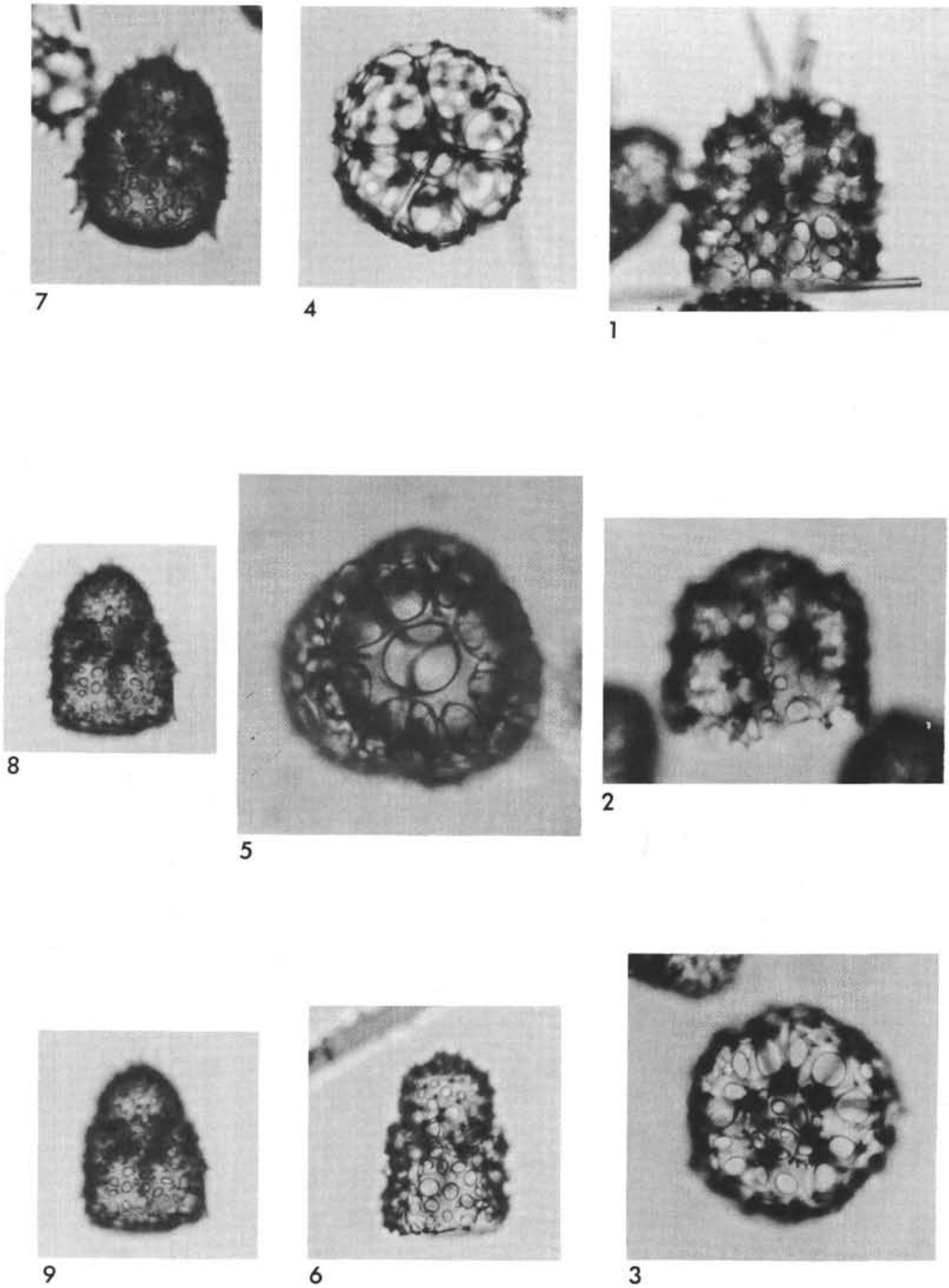
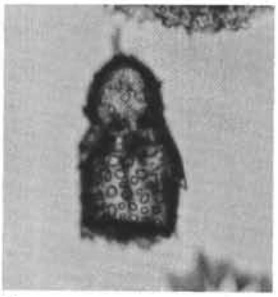


PLATE 17

Figures 1-5	*Antarctissa conradae* n. sp. 1. Sample 266-10, CC; F43/2. 2. Sample 266-10-3, 51-53 cm; W33/4. 3. Sample 267B-4, CC; P16/3. 4. Sample 267B-4, CC; P39/4. 5. Sample 267B-4, CC; Y25/1.
Figures 6-8	*Antarctissa longa* (Popofsky). 6. Sample 266-1-3, 80-82 cm; Z25. 7. Sample 265-2, CC; P45/3. 8. Sample 266-8, CC; Q44.
Figure 9	*Antarctissa strelkovi* Petrushevskaya. Sample 266-9-3, 52-54 cm; R43/2.

PLATE 17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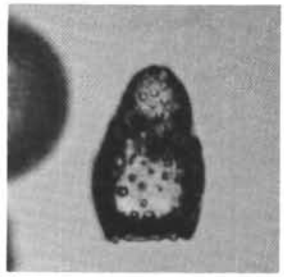
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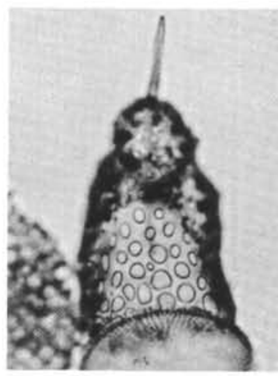
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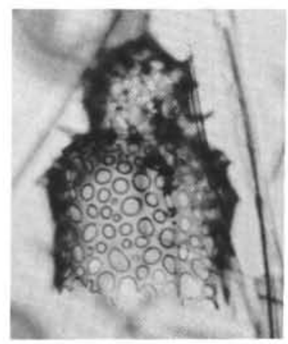
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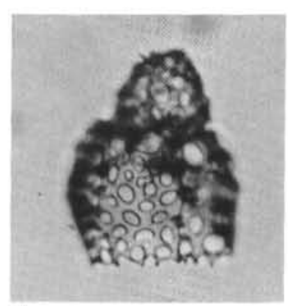
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PLATE 18

Figures 1, 2	*Antarctissa antedenticulata* n. sp. Sample 266-10-3, 51-53 cm. 1. Z30/4. 2. W33/4.
Figures 3-8	*Antarctissa denticulata* (Ehrenberg). 3. Sample 266-8, CC; V34. 4. Sample 266-7-3, 45-47 cm; U31. 5. Sample 266-6, CC; S22/4. 6. Sample 266-1-3, 80-82 cm; Y36. 7. Sample 265-1, CC; P19. 8. Sample 265-1-3, 110-112 cm; N43.
Figure 9	*Cyrtopera laguncula* Haeckel. Sample 266-6-3, 100-102 cm; H14.
Figure 10	*Botryopyle* (?) *antarctica* (Haeckel). Sample 266-4-3, 90-92 cm; E51.

PLATE 18


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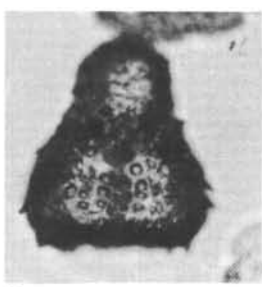
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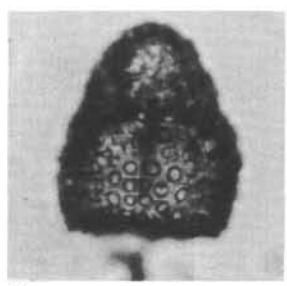
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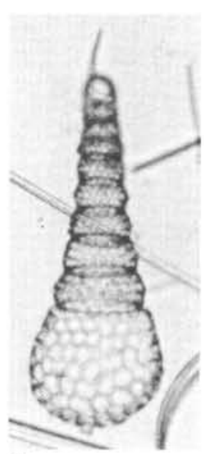
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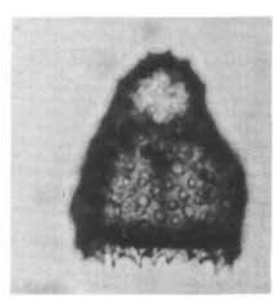
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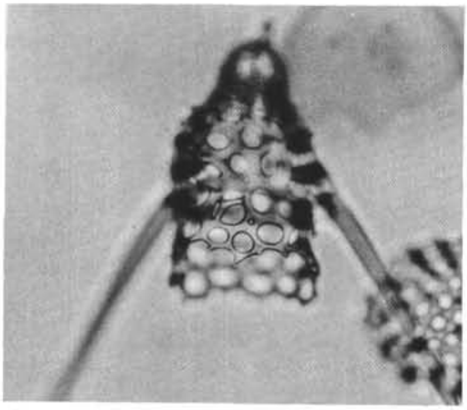
PLATE 19

Figures 1, 2	*Dictyophimus mawsoni* Riedel. 1. Sample 266-3, CC; G12. 2. Sample 266-4-3, 90-92 cm; G18/2.
Figure 3	*Pterocorys hirundo* Haeckel. Sample 266-3, CC; C35.
Figure 4	*Sethoconus dogieli* Petrushevskaya. Sample 266-2-3, 80-82 cm; E36/2.
Figure 5	Gen. and sp. indet. Sample 266-2-3, 80-82 cm; S15.

PLATE 19



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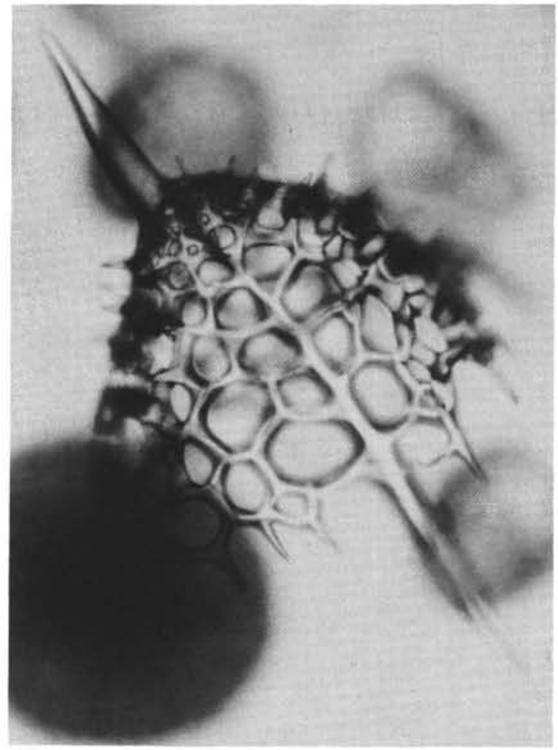

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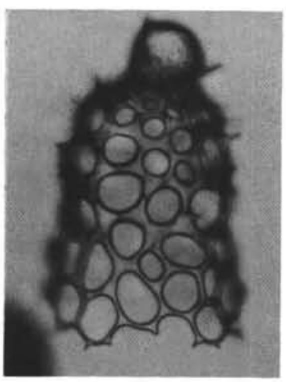

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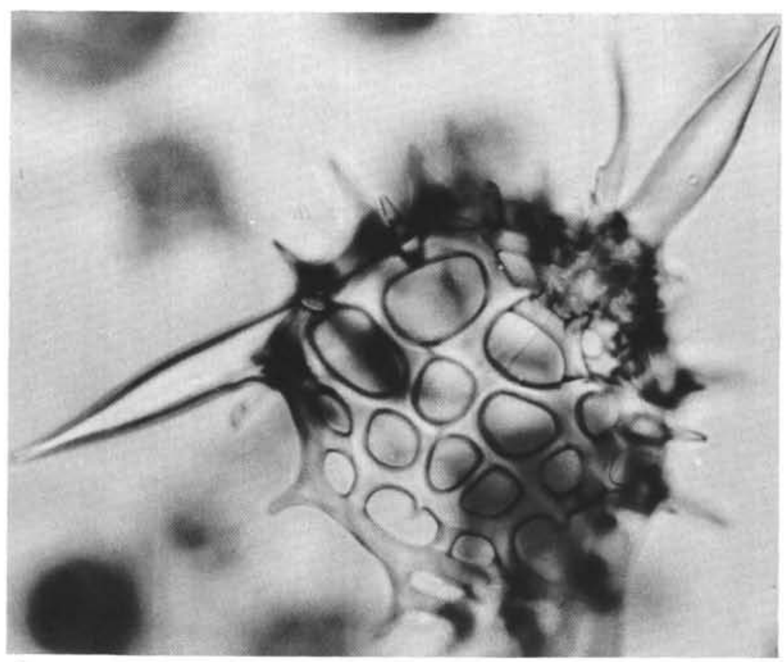

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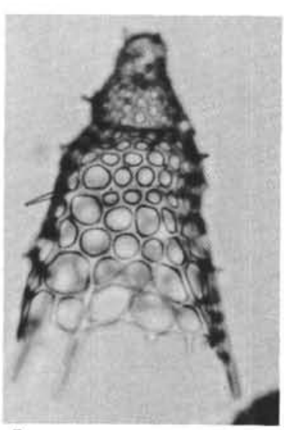

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PLATE 20

Figure 1 — *Cyrtocapsella tetrapera* Haeckel. Sample 266-21-3, 50-52 cm; M31/2; ×200.

Figures 2, 3 — *Theocorys redondoensis* (Clark and Campbell).
2. Sample 266-23-1, 36-38 cm; L57; ×200.
3. Sample 266-11-3, 51-53 cm; P31; ×200.

Figure 4 — Gen. and sp. indet. Sample 266-13-3, 51-53 cm; G14/2; ×200.

Figure 5 — *Eucyrtidium inflatum* Kling. Sample 266-8, CC; U48; ×200.

Figure 6 — Gen. and sp. indet. Sample 266-23-1, 36-38 cm; G14; ×200.

Figure 7 — *Cannartus prismaticus* (Haeckel). Sample 266-11-3, 51-53 cm; Z17; ×200.

Figures 8, 9 — *Ommatartus antepenultimus* Riedel and Sanfilippo. Sample 266-11-3, 51-53 cm.
8. D40; ×200.
9. H46; ×200.

Figure 10 — *Stichocorys delmontensis* (Campbell and Clark). Sample 266-12-3, 80-82 cm; M11; ×200.

Figures 11, 12 — *Druppatractus* sp.
11. Sample 266-16-5, 130-132 cm; X10/1.
12. Sample 266-6-3, 110-112 cm; W31/2.

Figure 13 — *Echinomma popofskii* Petrushevskaya. Sample 266-1-3, 80-82 cm; Y38.

Figures 14, 15 — *Halimmetta miocenica* (Campbell and Clark).
14. Sample 266-2-3, 80-82 cm; O31.
15. Sample 266-1-3, 80-82 cm; M16/2.

PLATE 20

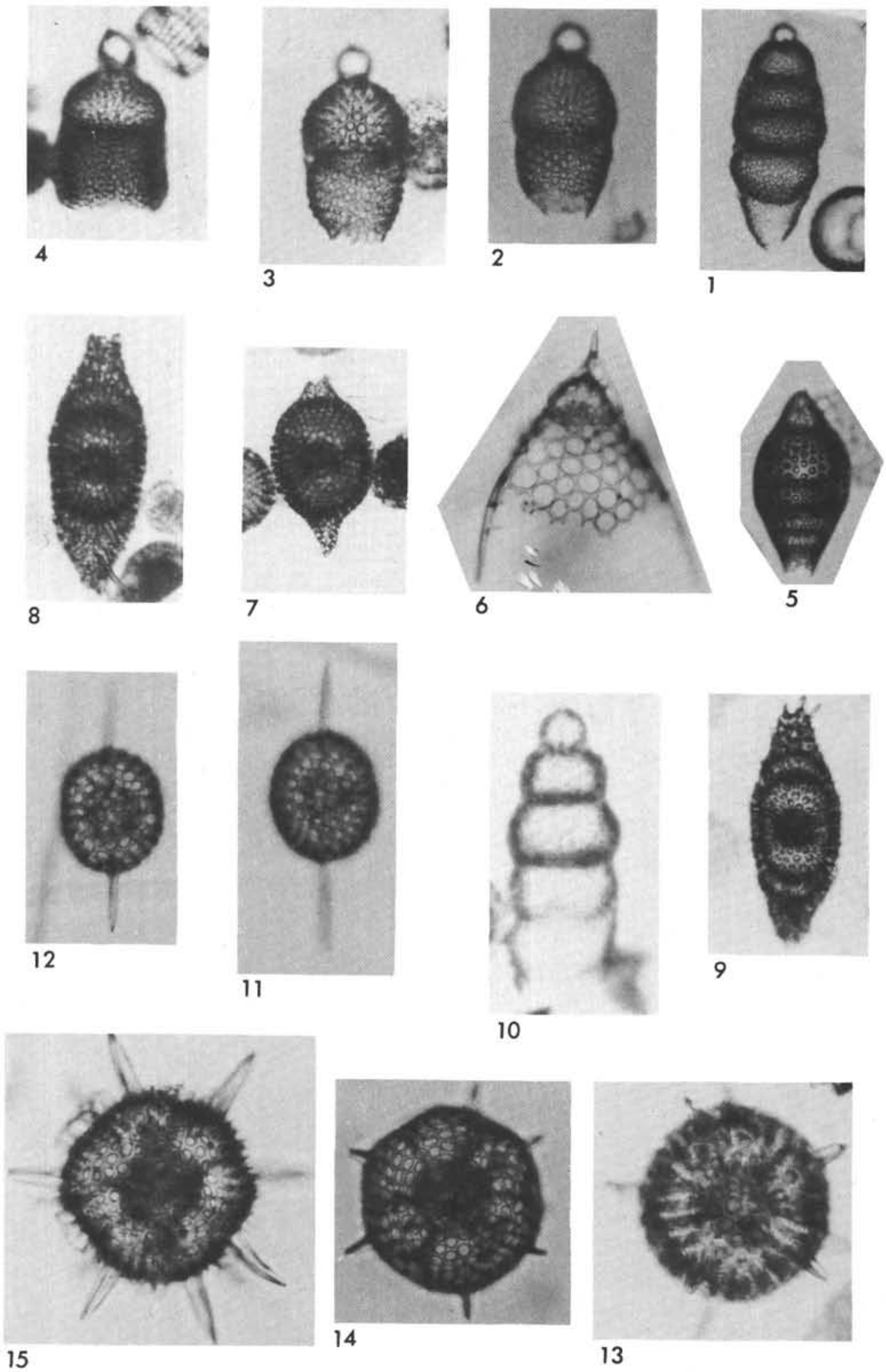
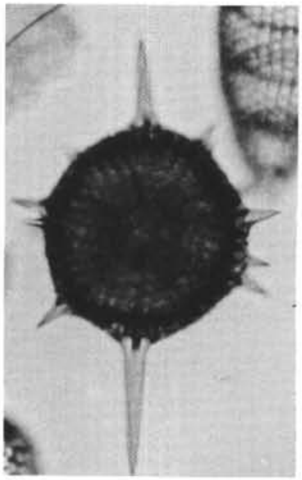


PLATE 21

Figures 1, 2	*Stylacontarium bispiculum* Popofsky. 1. Sample 266-13-1, 51-53 cm; W15/1. 2. Sample 266-15, CC; M26/3.
Figures 3, 4	*Amphistylus angelinus* (Campbell and Clark). 3. Sample 266-13-1, 51-53 cm; M32. 4. Sample 266-14-1, 51-53 cm; Y20/2.
Figures 5-9	*Stylatractus universus* Hays. 5. Sample 267B-4-3, 100-104 cm; F22; ×600. 6. Sample 266-10-3, 51-53 cm; Z29; ×200. 7. Sample 266-10-3, 51-53 cm; Y21; ×200. 8. Sample 266-1, CC; V31. 9. Sample 266-1, CC; M31.

PLATE 21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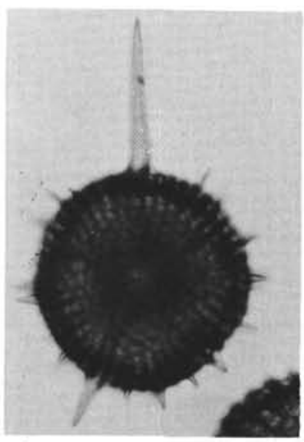
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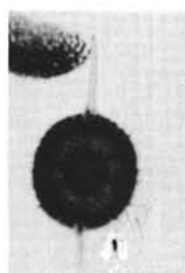
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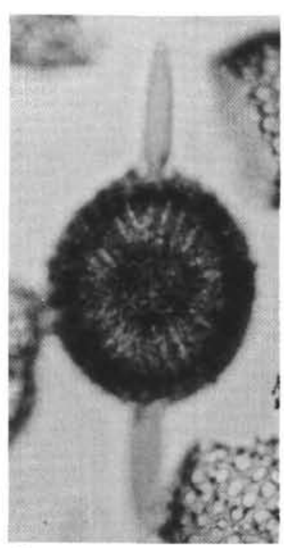
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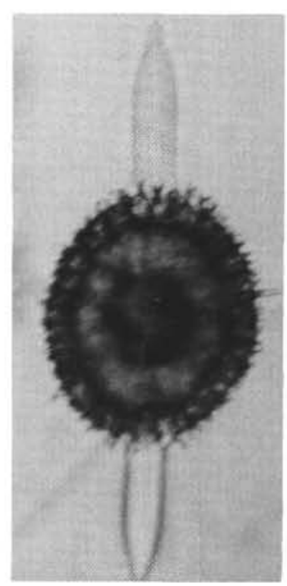
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PLATE 22

Figures 1, 2	*Spongoplegma* sp. Sample 265-15-3, 10-12 cm; F6/2.
Figures 3, 4	*Spongoplegma antarcticum* Haeckel. Sample 266-1, CC; E21/2.
Figure 5	*Acanthosphaera* sp. Hays. Sample 266-1-3, 80-82 cm; Y2.

PLATE 22

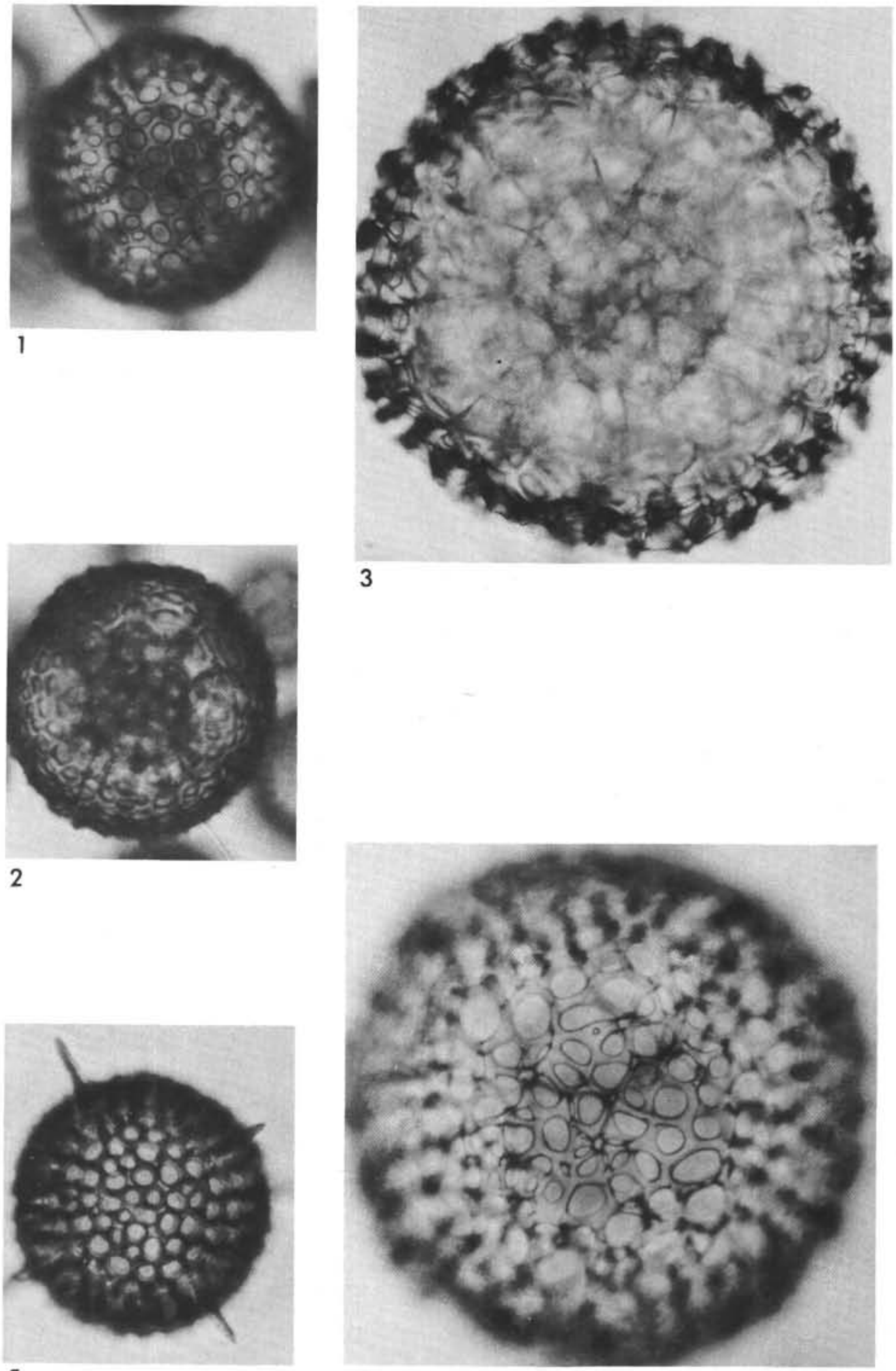
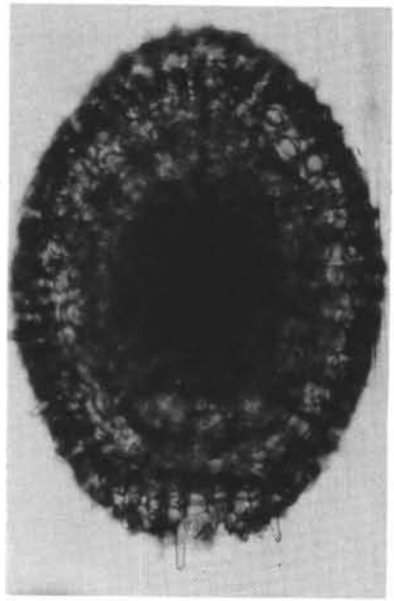


PLATE 23

Figures 1, 2	*Prunopyle titan* Campbell and Clark. 1. Sample 266-6-3, 110-112 cm; C18/4. 2. Sample 266-14-5, 20-22 cm; O8/1.
Figures 3, 4	*Prunopyle tetrapila* Hays. 3. Sample 266-2-3, 80-82 cm; O54. 4. Sample 266-4, CC; M31/4.
Figures 5, 6	*Prunopyle antarctica* Dreyer. 5. Sample 265-2-3, 100-102 cm; Z56. 6. Sample 265-3-3, 30-32 cm; V18.

PLATE 23



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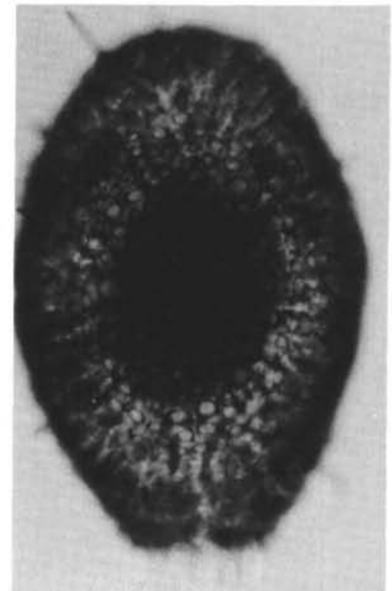

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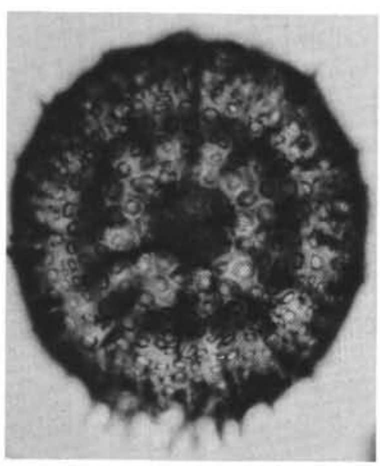

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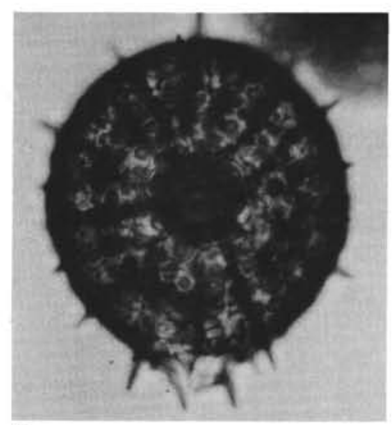

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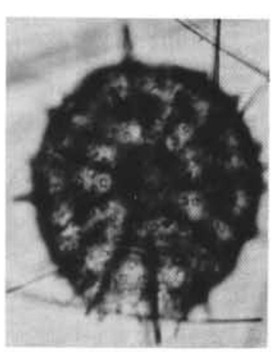

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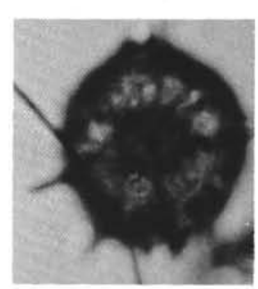

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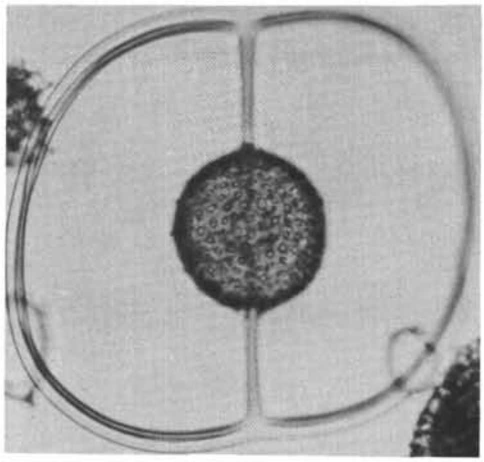
PLATE 24

Figure 1	*Echinomma delicatulum* (Dogiel). Sample 266-1-3, 80-82 cm; Q51.
Figure 2	*Saturnalis circularis* Haeckel. Sample 266-2-3, 80-82 cm; K25/2.
Figure 3	*Stylatractus neptunus* Haeckel. Sample 266-4-3. 90-92 cm; K16/2.
Figure 4	*Spongodiscus osculosus* (Dreyer). Sample 266-2-3, 100-102 cm; W47.
Figures 5, 6	*Spongotrochus glacialis* Popofsky. Sample 266-1-3, 80-82 cm; Z22. 6. X150.
Figure 7	*Lithelius nautiloides* Popofsky. Sample 266-1, CC; K37/1.

PLATE 24



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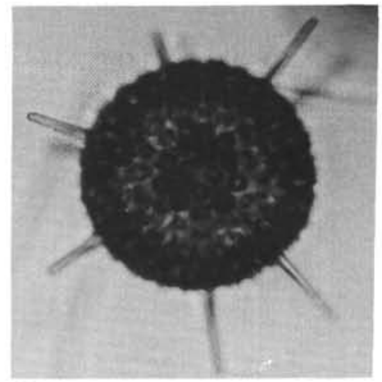

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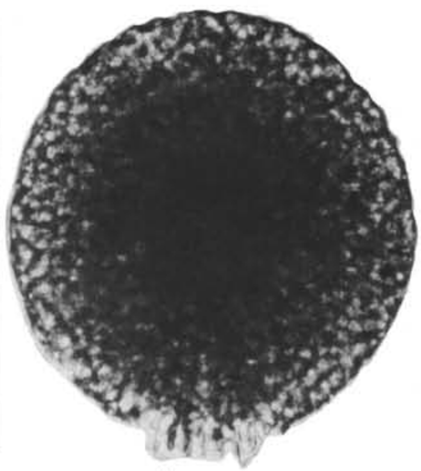

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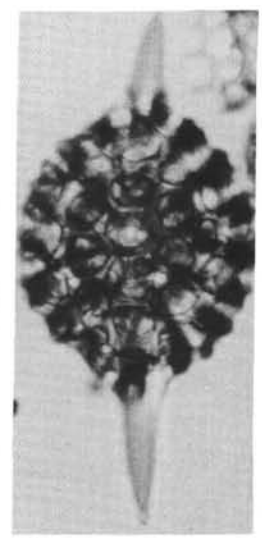

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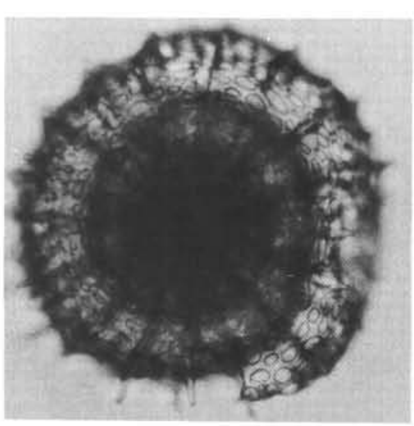

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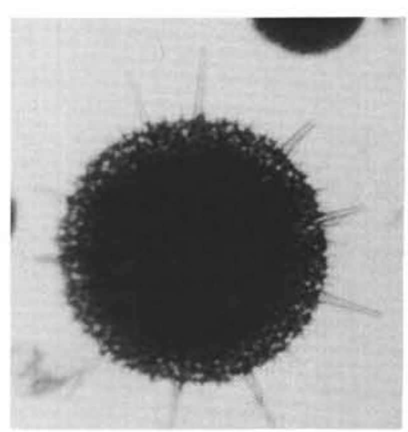

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