

28. RADIOLARIANS FROM THE KERGUELEN PLATEAU, LEG 119¹

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ABSTRACT

Radiolarians are abundant and well preserved in the Neogene of the Kerguelen Plateau. They are common and moderately to well preserved in the Oligocene sequences of Site 738, where the Eocene/Oligocene boundary was observed for the first time in subantarctic sediments, and Site 744. Radiolarians are absent from all glacial sediments from Prydz Bay.

Classical Neogene stratigraphic markers were tabulated at all sites. Correlations with paleomagnetic ages were made at Sites 745 and 746 for 26 Pliocene-Pleistocene radiolarian events. Many Miocene to Holocene species are missing from Sites 736 and 737, which were drilled in shallow water (less than 800 m). The missing species are considered to be deep-living forms.

Occurrences and relative abundances of morphotypes at six sites are reported. Two new genera (*Eurystomoskevos* and *Cymaetron*) and 17 new species (*Actinomma kerguelensis*, *A. campilacantha*, *Prunopyle tryppopyrena*, *Stylodictya tainemplekta*, *Lithomelissa cheni*, *L. dupliphysa*, *Lophophaena(?) thaumasia*, *Pseudodictyophimus galeatus*, *Lamprocyclus inexpectata*, *L. prionotocodon*, *Botryostrobus kerguelensis*, *B. rednosus*, *Dictyoprora physothorax*, *Eucyrtidium antiquum*, *E. (?) mariae*, *Eurystomoskevos petrushevskaae*, and *Cymaetron sinolampas*) are described from the middle Eocene to Oligocene sediments at Sites 738 and 744. Twenty-seven stratigraphic events are recorded in the middle to late Eocene of Site 738, and 27 additional stratigraphic datums are recorded, and correlated to paleomagnetic stratigraphy, in the early Oligocene at Sites 738 and 744. Eight radiolarian events are recorded in the late Oligocene at Site 744.

New evolutionary lineages are proposed for *Calocyclus semipolita* and *Prunopyle tryppopyrena*.

INTRODUCTION

Significant assemblages of radiolarians were recovered at all sites drilled on the Kerguelen-Heard Plateau during Leg 119 of the Ocean Drilling Project (Fig. 1). A sparse fauna was recovered only in mud-line samples from all Leg 119 sites drilled in Prydz Bay.

ODP Leg 119 is one of recent Antarctic legs which has collected a high quality, nearly complete Oligocene record of Antarctic radiolarians. For the first time, the Antarctic radiolarian assemblages deposited at the Eocene/Oligocene boundary are recognized. Neogene (and particularly early Miocene) fauna are not so complete, because of many hiatuses and condensed sequences.

Important additions to our knowledge of Neogene Antarctic fauna have been made recently by a precise description of early to middle Miocene forms (Abelmann, 1990) and a new biozonation (Lazarus, 1990).

Thus, the primary purpose of this paper is to provide a good description of late Eocene to late Oligocene subantarctic radiolarian assemblages and a list of new stratigraphic datums for the same period. Some evolutionary lineages are tentatively proposed.

In order to complement the stratigraphic observations made on other microfossil groups, the occurrence of major radiolarian events in the Neogene and Quaternary intervals are briefly recorded in each site description, and paleomagnetic calibrations for Eocene to Pleistocene radiolarian events are discussed in the synthesis chapter (Barron et al., this volume). A detailed description of Miocene radiolarians from Leg 119 will be given in the Leg 120 *Scientific Results* volume by Lazarus (in press), so as to present a complete study of Miocene assemblages from the Kerguelen Plateau.

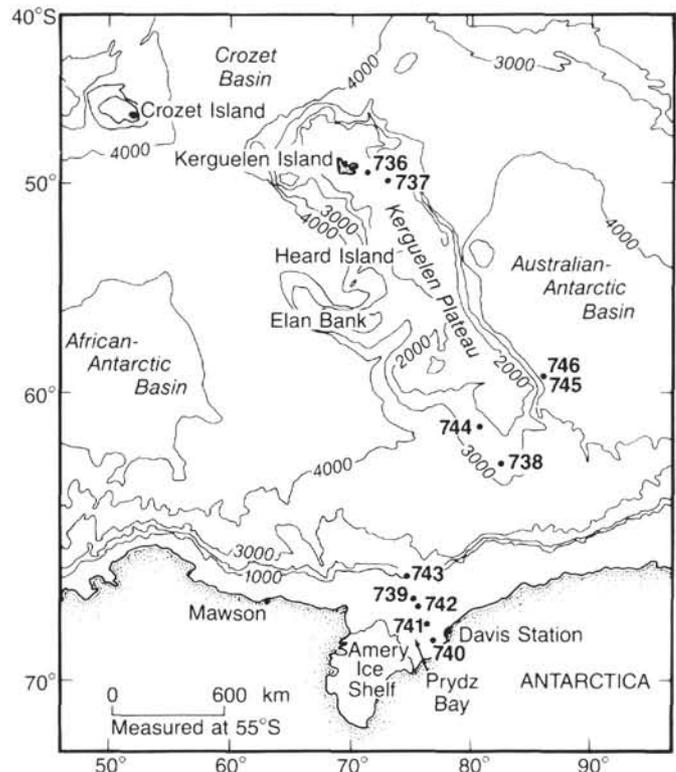


Figure 1. The Kerguelen Plateau and Prydz Bay showing Leg 119 site locations.

Procedures

A total of 260 samples was studied for this paper. In the Eocene and Oligocene levels of Sites 738 and 744 and in all intervals from Sites 736 and 745, one sample per section, plus one from the core catcher was prepared and examined. Sample prep-

¹ Barron, J., Larsen, B., et al., 1991. *Proc. ODP, Sci. Results*, 119: College Station, TX (Ocean Drilling Program).

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aration followed the standard techniques of Sanfilippo et al. (1985). Samples were sieved first at 80 μm to eliminate most of the large centric diatoms. A second mesh of 50 μm was used for control.

For each sample examined, qualitative estimates of radiolarian abundance (A = abundant; C = common; F = few; R = rare; X = one specimen) and preservation (G = good; M = moderate; P = poor) were made. Five grades of abundance were used to indicate the abundance percentage of a taxon relative to the total assemblage of a strewn slide. These abundance grades and their symbols are explained in a footnote to Table 1. A total of 180 taxa was searched for and counted. Range charts based on these estimates were constructed for each site, or interval, containing significant numbers of radiolarians. At Sites 736 and 737 all species present were counted. In Neogene samples from other sites, only the well-known, or promising, stratigraphic species were counted. In Eocene/Oligocene intervals, all species present were counted.

As part of the investigation of Leg 119 radiolarians, the data are supported by detailed documentation from some *Marion Dufresne* (MD) piston cores from the Kerguelen Plateau:

MD 81310 : 45°56'S, 66°34'E, 2300 m water depth
 MD 83487 : 49°57'S, 73°36'E, 709 m water depth
 MD 83491 : 49°57'S, 73°38'E, 953 m water depth
 MD 83492 : 50°01'S, 73°41'E, 873 m water depth
 MD 83513 : 49°58'S, 73°37'E, 772 m water depth

Detailed studies of these cores from the collections of the Laboratoire de Géologie du Muséum (Paris) have been published (Caulet, 1984), or are in preparation.

Some samples from Deep Sea Drilling Project (DSDP) Legs 28, 29, and 90 were also studied:

Leg 28 Hole 274 : 68°59'S, 173°25'E, 3305 m water depth
 Leg 29 Hole 278 : 56°33'S, 160°04'E, 3708 m water depth
 Leg 90 Hole 594 : 45°31'S, 174°56'E, 1204 m water depth

Radiolarian Zonation of Antarctic Sediments

An updated history and inventory of Antarctic radiolarian zonations is discussed by Lazarus (1990). His report points out the important Neogene datums and proposes a new biozonation, based mainly on the Pliocene-Pleistocene zonation of Hays (1965) and Hays and Opdyke (1967) and on the Miocene zonation of Chen (1975). This new zonation was not available when the Leg 119 study began. Thus, a provisional biostratigraphic framework was completed and used for the radiolarian biostratigraphy in the *Initial Reports* volume of Leg 119 (Barron, Larsen, et al., 1989). In order to be consistent with the radiolarian site reports already published (Barron, Larsen et al., 1989), the same biostratigraphic framework is used herein to describe the Neogene assemblages at each site. It is a combination of the radiolarian zonation proposed by Chen (1975) and modified by Weaver (1983) and Caulet (1982, 1985, 1986). Numerical designations are given to the biozones so as to avoid confusion between the old and new biozonations (FCO = first common occurrence; LCO = last common occurrence).

Zone NR1 = *Antarctissa denticulata* Zone, Chen (1975). Recent to the morphotypic top of *Stylatractus universus*.

Zone NR2 = NR2 Zone, Caulet (1982); part *S. universus* Zone, Chen (1975). Morphotypic top of *S. universus* to the morphotypic top of *Phormostichoartus pitomorphus*.

Zone NR3/4 = NR3 and NR4 Zones, Caulet (1982); part *Saturnalis circularis* Zone, Chen (1975). Morphotypic top of *P. pitomorphus* to the LCO of *Cycladophora pliocenica*.

Zone NR5 = part *Eucyrtidium calvertense* Zone, Chen (1975). LCO of *C. pliocenica* to the LCO of *Prunopyle titan*.

Zone NR6 = part *Helotholus vema* Zone, Chen (1975). LCO of *P. titan* to the evolutionary transition between *Pseudocubus vema* and *Helotholus praevema*.

Zone NR7 = *Desmospyris spongiosa* Zone, Weaver (1983); part *H. vema* Zone, Chen (1975). Morphotypic evolution of *P. vema* to the morphotypic bottom of *D. spongiosa*.

Zone NR8 = *Triceraspyris coronata* Zone, Weaver (1983); part *H. vema* Zone, Chen (1975). Morphotypic top of *D. spongiosa* to the LCO of *Stichocorys peregrina*.

Zone NR9 = *S. peregrina* Zone, Weaver (1983); part *H. vema* Zone, Chen (1975). LCO of *S. peregrina* to morphotypic bottom of *S. peregrina*.

Zone NR10 = part *Theocalyptra b. spongothorax* Zone, Chen (1975). Morphotypic bottom of *S. peregrina* to the FCO of *Cycladophora spongothorax*.

Zone NR11 = *Antarctissa conradae* Zone, Chen (1975), plus *Actinomma tanyacantha* Zone, Chen (1975). FCO of *C. spongothorax* to the FCO of *Actinomma golownini*.

Zone NR12 = *Calocyclus polyporos* Zone, Chen (1975). CO of *A. golownini* to FCO of *C. polyporos*.

Zone NR13 = *Spongomelissa dilli* Zone, Chen (1975). FCO of *C. polyporos* to FCO of *S. dilli*.

Zone NR14 = *Eucyrtidium punctatum* Zone, Chen (1975). FCO of *S. dilli* to FCO of *E. punctatum*.

Zone NR15 = *Lophocytis regipileus* Zone, Chen (1975). FCO of *E. punctatum* to FCO of *L. regipileus*.

Zone NR16 = *Cyrtocapsella tetrapera* Zone, Chen (1975). FCO of *L. regipileus* to FCO of *Gondwanaria hister*.

A list of new stratigraphic datums for the Oligocene and for parts of the middle and late Eocene is given in this paper, but a new biozonation is not proposed, because a general correlation with other antarctic drilling sites has not yet been made.

RADIOLARIANS AT LEG 119 SITES

Site 736 (Kerguelen-Heard Plateau)

Site 736 (49°24.121'S, 71°39.611'E; water depth 631 m) is located on the northern part of the Kerguelen-Heard Plateau. A 371 m thick section of upper Pliocene and Quaternary diatomaceous ooze was cored in three holes (736A, 736B, and 736C).

Radiolarians are generally well preserved throughout Holes 736A and 736B (Table 1). They are few or rare in some samples, due to dilution by diatoms. No samples were barren. Radiolarian assemblages range in age from late early Pliocene to Quaternary.

Compared to the fauna described in many subantarctic sediments (Hays, 1965; Petrushevskaya, 1967; Chen, 1975; Weaver, 1983), the Pleistocene radiolarian assemblages from Holes 736A and 736B are not diverse. Some stratigraphic markers, such as *Anthocyrtila callopisma*, and *Stylatractus universus* are completely missing. Many other stratigraphic markers, such as *Cycladophora davisiana* and *Phormostichoartus pitomorphus*, are not present in all samples. Numerous species, usually present or common in Holocene subantarctic assemblages (*Dictyophimus mawsoni*, *Prunopyle antarctica*, *Actinomma popofskii*, *Acanthodesmia viniculata*, and *Saturnalis circularis*) were not found in Holes 736A or 736B. All these Antarctic radiolarian species are absent in the diatom oozes which accumulated in shallow water (less than 1000 m) over the Kerguelen Plateau (personal observation on the sediments collected during the DRAKAR and NASKA cruises of the *Marion Dufresne*, Caulet, unpubl. data). They are considered to be deep-living forms. Thus, the sparse occurrences of some of these species, which are usually

common in deep water sediments, may reflect temporary upward expansion of circumpolar deep waters on the upper part of the Kerguelen Plateau.

Due to the impoverishment of the assemblages, the classical subantarctic zonation cannot be used. Zones NR1 through NR4 are described as the “*Antarctissa denticulata* Interval.” Common species in this interval include *Antarctissa denticulata*, *Botryopera triloba*, *Cycladophora bicornis*, *Lithelius nautiloides*, *Saccospyris antarctica*, *Saccospyris conithorax*, and *Tricerapsyris antarctica*.

The uppermost, clearly recognizable, stratigraphic event in Hole 736A is the last appearance of *Antarctissa cylindrica* (= *A. ewingi*) between Samples 119-736A-7H-CC, and 119-736A-8H-1, 53–55 cm (48.0–48.5 m below seafloor (mbsf)). No absolute age can be directly estimated for this datum; due to the very low magnetic intensities of the green diatomaceous oozes, no paleomagnetic stratigraphy has been established for Holes 736A, 736B, and 736C (Barron, Larsen et al., 1989). However, paleomagnetic calibrations for radiolarian events were successful at Site 745. The absolute ages obtained at this site will be tentatively used at Site 736. An absolute age of 0.55 Ma was first given for the last appearance datum (LAD) of *A. cylindrica* by Lazarus (1990). The paleomagnetic calibration for the same event is at 0.62–0.64 Ma at Site 745 (see this chapter), giving an average age of 0.5–0.6 Ma to the event. Thus, the interval between the top of Hole 736A and Sample 119-736A-7H-CC, could be placed in the NR1–NR2 biozones.

The last appearance of *Pterocanium trilobum* is located between Samples 119-736A-5H-CC, and 119-736A-7H-2, 53–55 cm (38–45 mbsf). An age of 0.4–0.42 Ma was determined for this event at Site 745, but the last appearance of *P. trilobum* was originally located near the boundary of the Psi and Chi Zones (Hays, 1965), at 0.7 Ma. This preliminary calibration (0.7 Ma) seems to be too old, considering that the last appearance of *P. trilobum* is always younger than the last appearance of *A. cylindrica*, whose absolute age is calculated between 0.5 and 0.6 Ma at ODP Sites 689, 690, 693, 695, 696, and 745. Thus, an average age of 0.4 Ma seems to be more appropriate for the last appearance of *P. trilobum*. If so, a small hiatus, or a condensed sequence, may be located in the sedimentary interval between 38 and 45 mbsf. The many, clearly reworked, early Pliocene radiolarian species (*Cycladophora pliocenica*, *Desmospyris spongiosa*, and *Pseudocubus vema*) that were observed in Samples 119-736A-7H-1, 53–55 cm, and 119-736A-7H-2, 53–55 cm (43.5 and 45 mbsf) are indicative of strong reworking processes during this interval.

The first common occurrence (FCO) of *Mitrocalpis araneafera* is located between Samples 119-736A-11H-CC and 119-736A-12H-CC (73.5–79.5 mbsf). An average age of 0.69–0.71 Ma has been calculated for this event at Site 745. Representatives of *P. antarctica* and *C. bicornis* are more common in the radiolarian assemblages of the interval between the LAD of *A. cylindrica* and the FCO of *M. araneafera*.

Occurrences of *Phormostichoartus pitomorphus* are so scarce that the NR2/NR3 boundary cannot be placed.

The FCO of *C. bicornis* is located between Samples 119-736A-13H-5, 53–55 cm, and 119-736A-13H-6, 53–55 cm (86–87.5 mbsf), but a single specimen was found in Sample 119-736H-14H-5, 59–61 cm (95.9 mbsf). Thus, a precise location of the first appearance datum (FAD) of this species could not be determined.

The last common occurrence (LCO) of *C. pliocenica*, and the upper boundary of Zone NR5, is located between Samples 119-736A-17X-CC (127 mbsf), and 119-736A-20H-1, 63–65 cm (147 mbsf). An absolute age of 1.6–1.7 Ma is given for this event (see discussion in “Site 745” section). Below this level, occurrences of *C. davisiana* are very rare. The lower boundary of

Zone NR5 is defined by the LCO of *Prunopyle titan*. At Site 736, the absence of this species can be related either to the shallow-water sedimentation or to a normal evolutionary disappearance. Usually, the last representatives of the species are younger than the FCO of *C. davisiana*. As this event cannot be recognized at Site 736, the location of the NR5/NR6 zonal boundary remains unknown.

The FCO of *L. nautiloides*, *S. antarctica*, and *T. antarctica* were observed in a short interval (10 cm) at Site 745 and dated at 1.85 Ma. At Site 736, these occurrences are placed, respectively, within a 13-m-interval, between Samples 119-736A-21H-5, 53–55 cm (162.4 mbsf), and 119-736B-23X-CC (175.3 mbsf).

The LCO of *D. spongiosa* is slightly younger, between Samples 119-736A-27X-CC (223.2 mbsf), and 119-736A-29X-1, 53–55 cm (233.4 mbsf), than the LCO of *P. vema*, between Samples 119-736A-29X-1, 53–55 cm (233.4 mbsf), and 119-736A-29X-2, 53–55 cm (234.9 mbsf). They are in reverse order at Site 745, but within a very short interval (less than 1 m). An absolute age of 2.3–2.4 Ma has been determined for these events. The evolutionary transition between *Antarctissa robusta* and *A. antarctica* is located, as in Site 745, within the same interval.

Site 737 (Kerguelen-Heard Plateau)

Site 737 (50°13.660'S, 73°01.950'E; water depth 664 m) is located on the northern Kerguelen-Heard Plateau about 100 km southeast of Site 736. A 715.5-m-thick middle Eocene through lower Pliocene section was cored to complete the Pliocene to Quaternary section recovered at Site 736. Siliceous microfossils are consistently common to abundant in the middle Miocene to lower Pliocene interval. Pliocene and Miocene radiolarians are abundant and well preserved throughout all cores recovered at Hole 737A, but diversity is low due to the relatively shallow water depth at the site. A reliable magnetostratigraphy has been developed only for portions of Hole 737B mainly older than the late Miocene and is not really useful for dating radiolarian events at Site 737 (see Barron, Larsen, et al., 1989).

Due to dilution by diatoms, radiolarians are very scarce in the upper layers (0–40 mbsf) of diatom oozes (Table 2). The specific composition of assemblages from Samples 11-737A-1H-CC (5 mbsf), to 119-737A-3H-5, 53–55 cm (21 mbsf), is suggestive of an early Pliocene age, probably Zones NR5/NR6. Representatives of *Cycladophora pliocenica* and *Pseudocubus vema* are rare. *Antarctissa denticulata* was not recognized, but rare specimens of its ancestor, *Antarctissa robusta*, are present. The occurrence of a single specimen of *Prunopyle titan* in Sample 119-737A-3H-CC (24 mbsf) places this level in Zone NR6. The boundary between Zones NR5 and NR6 could not be located due to the absence of *P. titan* in shallow-water deposits (see preceding “Site 736” section).

The lower limit of Zone NR6 is the evolutionary transition between *Helotholus praevema* and *P. vema*, but this transition is not easily recognized. The last specimen of *H. praevema* is located in Sample 119-737A-5H-CC (43 mbsf), but representatives of *P. vema* are common in a long interval down to Sample 119-737A-7H-CC (62 mbsf), where the FCO of *Desmospyris spongiosa* is located. As the FCO of *D. spongiosa* is considered as slightly older than the transition to *P. vema* (Table 2), it can be concluded that a hiatus or a compressed sequence is located between Samples 119-737A-5H-CC (43 mbsf) and 119-737A-8H-CC (71.5 mbsf). The LCO's of *Lychnocanium grande* and *Tricerapsyris coronata* are located in the same interval (between Samples 119-737A-7H-CC, and 119-737A-8H-CC), just near the hiatus: thus they cannot be used to date the samples. Zone NR7 (below the evolutionary transition of *P. vema* to the FCO of *D. spongiosa*) could not be recognized. Strong changes in environmental conditions may have occurred during this interval since some representatives of warmer water faunas (such as *Antho-*

Table 2. Abundance of radiolarian species present at Site 737. Symbols as for Table 1.

Age	Radiolarian biozonation		Depth (mbsf)	abundance preservation	
	Hole	Core, section, interval cm			
early Pliocene	NR5/6	A 1H-CC	005.0	F G	
		A 2H-CC	014.5	R R	
		A 3H-1, 53-55	015.2	R R	
		A 3H-2, 53-55	016.5	R R	
		A 3H-3, 53-55	018.0	R R	
		A 3H-4, 53-55	019.5	R R	
		A 3H-5, 53-55	021.0	R R	
		A 3H-CC	024.0	F F	
		A 4H-CC	033.5	R R	
		A 5H-1, 53-55	034.0	R P	
	NR8	A 5H-2, 53-55	035.5	C O	
		A 5H-3, 53-55	037.0	C O	
		A 5H-4, 51-53	038.5	R R	
		A 5H-5, 51-53	040.0	R R	
		A 5H-6, 51-53	041.5	R R	
		A 5H-CC	043.0	R G	
		A 6H-CC	052.5	A G	
		A 7H-CC	062.0	A G	
		A 8H-CC	071.5	A G	
		A 9H-CC	081.0	C G	
late Miocene	NR9	A 10H-CC	090.5	A G	
		A 11H-CC	100.0	C G	
		A 12H-1, 40-42	100.4	C G	
		A 12H-2, 40-42	101.9	C G	
		A 12H-3, 40-42	103.4	C G	
		A 12H-4, 40-42	104.9	C G	
		A 12H-5, 40-42	106.4	C G	
		A 12H-CC	109.5	A G	
		A 13H-CC	119.0	A G	
		B 2R-CC	124.2	A G	
	NR10	B 3R-CC	133.8	A G	
		A 15H-CC	138.0	A G	
		A 16H-CC	147.5	A G	
		A 17H-CC	157.0	C G	
		A 18H-CC	166.5	C G	
		A 19H-CC	176.2	R G	
		A 20X-CC	185.9	R G	
		A 21X-CC	195.6	F G	
		A 22X-CC	205.3	C G	
		A 23X-CC	215.0	C G	
NR11	A 25X-CC	234.4	F G		
	A 26X-1, 53-55	234.9	R G		
	A 26X-CC	244.1	A G		
	A 27X-2, 53-55	246.1	A G		
	A 27X-3, 53-55	247.6	C G		
	A 27X-4, 53-55	249.4	A G		
	A 27X-CC	253.8	C G		
	B 5R-CC	263.2	A G		
	A 28X-CC	263.5	C G		
	B 6R-1, 54-56	263.7	A G		
B 6R-3, 54-56	266.7	A G			
B 6R-4, 54-56	268.2	A G			
B 6R-CC	272.9	R G			
B 7R-CC	282.5	R G			
B 8R-CC	292.2	R G			
B 9R-CC	301.8	C G			
B 10R-CC	311.5	R M			
B 12R-CC	330.8	R P			

cyrtidium pliconica) and deep-living assemblages that are usually rare (such as *P. titan*) are present. Many intervals barren of radiolarians in the upper part of the hole are probably indicative of eutrophic conditions. However, no reworked forms were observed.

Below Sample 119-737A-8H-CC (71.5 mbsf), radiolarian assemblages are more abundant and very well preserved. Conditions of deposition were probably different because many species, common at deep-water sites (Sites 745 and 746), are present.

The FCO of *P. titan* (4.59-4.67 Ma at Site 745) between Samples 119-737A-12H-1, 40-42 cm (100.4 mbsf), and 119-737A-

12H-2, 40-42 cm (101.9 mbsf), is the only datable event in this interval.

The LCO of *Stichocorys peregrina* (4.8 Ma at Site 745) places the lower boundary of Zone NR8 between Samples 119-737A-12H-2, 40-42 cm (101.9 mbsf), and 119-737A-12H-3, 40-42 cm (103.4 mbsf).

The FCO of *S. peregrina* places the lower limit of Zone NR9 between Samples 119-737A-27X-2, 53-55 cm (246.1 mbsf), and 119-737A-27X-3, 53-55 cm (247.6 mbsf). Radiolarian assemblages are abundant and well-preserved throughout this interval. *Amphymenium challengeræ* is common between Samples

119-737A-12H-5, 40–42 cm (106.4 mbsf), and 119-737A-20X-CC (185.9 mbsf). The stratigraphic range of this species is similar to that found in Hole 513A (DSDP Leg 71), where it was recognized for the first time (Weaver, 1983). The LCO of *Desmospyris rhodospyroides* is not distinctive within this interval. Rare representatives of *Actinomma golownini* in Samples 119-737A-17H-CC (157 mbsf) and 737B-18H-CC (166.5 mbsf), are indicative of reworking processes. The FCO of *A. robusta* seems to be correctly located between Samples 119-737A-23X-CC (215 mbsf), and 119-737A-25X-CC (234.4 mbsf).

The FCO of *C. spongothorax* (lower limit of Zone NR10) is tentatively placed between Samples 119-737B-6R-4, 54–56 cm (268.2 mbsf), and 119-737B-6R-CC (272.9 mbsf). An age of 11.3 Ma was given to this event by Lazarus (1990) for ODP Leg 113 Sites 689, 690, and 693. A precise paleomagnetic calibration of this event at Site 737 is unrealistic, but all the material recovered in Core 119-737B-6R may be correlated to the interval between Chrons 5 and 5AA (10–13 Ma) (Barron, Larsen, et al., 1989). Radiolarian assemblages are abundant and well-preserved through this biozone. The LCO of *A. golownini*, dated at 10.3 Ma for ODP Leg 113 (Lazarus, 1990), is located between Samples 119-737B-5R-CC (263.2 mbsf), and 119-737A-28X-CC (263.5 mbsf). First occurrences of *L. grande*, *Eucyrtidium inflatum*, and *Theocorys redondoensis* are also recorded in this interval.

Below the FCO of *C. spongothorax*, poorly preserved faunas occur rarely in samples down to Sample 119-737B-12R-CC (330.8 mbsf). This interval may be related to Zone NR11. Some early Miocene forms, such as *Stauroxiphos communis*, *Prunopyle hayesi*, and *Botryopera deflandrei*, are rare to common.

The material recovered in Cores 119-737B-13R through 119-737B-47R is barren of radiolarians. Core-catcher samples from Cores 119-737B-48R (677.6 mbsf) to 119-737B-52R (715.5 mbsf) contain a few recrystallized, apparently Eocene, specimens, but this age determination is uncertain because these specimens are rare and are identified to the genus level only.

Site 738 (Kerguelen-Heard Plateau)

Site 738 (62°70.937' S, 82°78.776' E; water depth 2257.7 m) drilled a 490-m-thick lower Turonian through Quaternary pelagic sediment section overlying 43 m of basaltic breccia and altered basalts, on the southern tip of the Kerguelen Plateau.

Radiolarians are abundant and well preserved in Miocene to Pleistocene sediments, but sporadically present and moderately preserved in Oligocene, Eocene, and Cretaceous sediments.

Eocene to Oligocene assemblages were carefully analyzed (Table 3). Detailed results are presented in a separate section (see below). A brief description of Miocene to Quaternary faunas is given here. A stratigraphic correlation with the other groups is published in the synthesis chapter of this volume (Barron et al., this volume). Unfortunately, the magnetic polarity was identified only in approximately 30% of the stratigraphic sequence, and it has proven impossible to correlate the polarity of much of the sequence rich in radiolarians (Barron, Larsen, et al., 1989).

Radiolarians are abundant and well preserved in Cores 119-738B-1H to 119-738B-3H, although they are overwhelmed by an abundant diatom flora. Species diversity is high, and all stratigraphic markers are present. Sample 119-738B-1H-CC (4 mbsf), is related to the upper part of the NR3/NR4 interval because of the occurrence of *Stylatractus universus* and *Phormostichoartus pitomorphus*. Deep-living forms are present, although they remain rare. Phaeodarian debris is common. The radiolarian assemblage in Sample 119-738B-2H-CC (13.5 mbsf), is assigned to Zone NR7 (early Pliocene) because of the abundance of *Desmospyris spongiosa*, *Prunopyle titan*, and *Helotholus praeveva*. These datums suggest a hiatus spanning most of the upper Pliocene and lower Pleistocene. Due to very low rates of sedimenta-

tion, samples, other than the core-catcher sample, were processed for Core 119-738B-3H. The absence of *D. spongiosa* places Sample 119-738B-3H-2, 52–53 cm (15.5 mbsf), in Zone NR8. Sample 119-738B-3H-3, 52–53 cm (17 mbsf), is tentatively placed in Zone NR9 (occurrence of *Stichocorys peregrina*). The radiolarian population from this sample is composed mostly of large specimens, and many reworked individuals of Eocene age, such as *Artobotrys biaurita* or *Lithomitrella* sp., can be recognized. All these observations suggest a strong winnowing. The occurrence of *Actinomma golownini* places Sample 119-738B-3H-3, 130–132 cm (17.5 mbsf), in Zone NR10 (late to middle Miocene).

Sample 119-738B-3H-4, 53–55 cm (18.5 mbsf), contains an early Oligocene assemblage including *Calocyclus semipolita*, *Periphaena decora*, and many other species. The occurrence of this Oligocene assemblage just at the top of Section 119-738B-3H-4 suggests an important hiatus spanning much of the lower and middle Miocene between 14.8 and 23.5 mbsf.

The Eocene/Oligocene boundary is recognized for the first time in the subantarctic area, between Samples 119-738B-4H-CC (32.5 mbsf), and 119-738B-5H-2, 53–55 cm (34.5 mbsf). Samples 119-738B-5H-5, 53–55 cm (39 mbsf), to 119-738B-17X-1, 52–54 cm (137.7 mbsf), are barren of radiolarians.

Rare fragments of *A. biaurita* and *Lychnocanoma amphitrite* (middle to late Eocene) occur in Sample 119-737B-11H-4, 53–55 cm (90 mbsf), but no zonal assignment can be made.

A well preserved fauna has been found from Sample 119-738B-17X-1, 52–54 cm (137.7 mbsf), to 119-738B-18X-4, 52–55 cm (151.8). The assemblage composition is diagnostic of the middle middle Eocene. Many species are similar to those described by Clark and Campbell (1942) from the Kellogg Shale of California: *Artobotrys auriculaleporis*, *Lychnocanoma conica*, *C. semipolita*, etc.

Samples 119-738B-19X-3, 52–54 cm (160 mbsf), through 119-738B-21X-2, 52–55 cm (177.7 mbsf), are barren of radiolarians. Late early to early middle Eocene assemblages are abundant and well preserved from Sample 119-738B-22X-1, 53–55 cm (185.9 mbsf), to 119-738B-23X-1, 53–55 cm (195.5 mbsf). Many tropical species are common (*Lophocytis jacchia*, *Stylosphaera coronata*, and *Stylosphaera minor*), but most closed Theoperids are missing. The absence of *Dictyoprora mongolfieri*, *Spongastractus balbi*, and *Buryella clinata*, which are common in lower middle Eocene sediments of the northern sector of the Kerguelen-Heard Plateau (personal observation of Marion Dufresne material), is indicative of local climatic changes.

Samples 119-738B-23X-CC (204.6 mbsf), to 119-738B-24X, CC (214.3 mbsf), are barren of radiolarians.

Very rare and recrystallized Eocene radiolarians were found in core-catcher samples from Cores 119-738C-2R through 119-738C-9R. All other core-catcher samples are barren of radiolarians down to Sample 119-738C-21R-CC (389.6 mbsf), which yielded rare and strongly recrystallized specimens of *Dictyomittra* sp., suggesting a Cretaceous age. In Sample 119-738C-23R-CC (408.9 mbsf), a few moderately preserved radiolarians, such as *Archaeodictyomittra lamellicostata*, *Amphipyndax stocki*, and *Siphocampe bassilis*, are diagnostic of the *Amphipyndax tylotus* Zone (upper Campanian to Maestrichtian). The same assemblage was found in Samples 119-738C-24R-CC (418.6 mbsf), through 119-738C-26R-CC (437.9 mbsf), where a single specimen of *A. tylotus* was observed. Samples 119-738C-27R-CC, through 119-738C-31R-CC, (447.6–485.9 mbsf) are completely barren of radiolarians.

Site 739 (Prydz Bay)

Site 739 (67°16.570' S, 75°04.914' E; water depth 410.3 m) drilled a thick sequence of glacial sediments ranging in age from Quaternary to late Eocene-early Oligocene, on the shelf of east-

ern Antarctica, in the outer part of Prydz Bay. Well preserved Holocene radiolarians were observed in Samples 119-739A-1H-CC (3.3 mbsf), 119-737B-1H-CC (0.6 mbsf), and 119-739C-1R-CC (9.5 mbsf). All other core-catcher samples are barren of radiolarians. Holocene forms are rare. Only 10 species, dominated by *Antarctissa strelkovi* and *Botryopera triloba*, were recognized. All species are diagnostic of a Holocene age.

Sites 740 to 743 (Prydz Bay)

All sediments, except the uppermost layers, recovered at Prydz Bay sites are barren of radiolarians. Very few specimens of extant antarctic living forms are present in the mud-line samples. The most common forms are representatives of the *Antarctissa* group and of some Plagiacanthidae.

Site 744 (Kerguelen-Heard Plateau)

Site 744 (61°34.656'S, 80°35.463'E; water depth 2317 m) was drilled on the southern Kerguelen Plateau in order to core a more complete Neogene and Oligocene section than that recovered at Site 738. Radiolarians are consistently present and generally well preserved in the Oligocene to Pleistocene sediments, but the upper Eocene and lowermost Oligocene levels are barren of radiolarians. Many hiatuses and low rates of sedimentation were recorded in the Neogene (see Barron et al., this volume). Thus, a brief description of Neogene radiolarian assemblages is given here (Table 4) (for more details, see Lazarus, in press).

The LCO of *Cycladophora pliocenica* between Samples 119-744B-1H-CC (9.5 mbsf), and 119-744A-2H, CC (13.7 mbsf), places the upper interval in Zone NR3/4 (lower Pleistocene). Common representatives of *Antarctissa cylindrica*, *Stylatractus universus*, and *Cycladophora davisiana* are indicative of a relatively deep-water deposition.

The LCO of *Prunopyle titan* between Samples 119-744A-2H-CC, and 119-744B-2H-CC, places the lower boundary of Zone NR5 between 13.7 and 19.0 mbsf. Specimens of *C. davisiana* (FCO dated at 2.6 Ma) are present in Sample 119-744A-2H-CC (13.7 mbsf).

Zone NR6 is delimited by the LCO of *P. titan* and the evolutionary transition between *Helotholus praevema* and *Pseudocubus vema*. At Site 744, this evolutionary transition was very difficult to document, but the oldest specimens of *H. praevema* were observed in Sample 119-744B-3H-CC (21.5 mbsf), placing the NR6/NR7 boundary between Samples 119-744B-2H-CC (19 mbsf), and 119-744B-3H-CC (21.5 mbsf). The total thickness of the NR6 Zone does not exceed 5 m.

The interval related to Zone NR7 is thinner, as the morphotypic bottom of *Desmospyris spongiosa* is located between Samples 119-744B-3H-CC and 119-744A-3H-CC (21.5–23.2 mbsf).

Many hiatuses are located in the sequence, and Zone NR8 is missing. The occurrence of some specimens of *Stichocorys peregrina* in Sample 119-744A-3H-CC (23.2 mbsf), places this sample in Zone NR9 (late Miocene to lower Pliocene). Due to a very compressed and incomplete sequence, no radiolarian datum levels could be located.

The FCO of *Cycladophora spongothorax* in Sample 119-744A-6H-CC (51.7 mbsf), places the lower limit of Zone NR10 between this sample and Sample 119-744A-7H-CC (61.2 mbsf). Radiolarian assemblages are abundant and well preserved. The LCO of *Actinomma golownini* (10.3 Ma, for ODP Leg 113 according to Lazarus, 1990) is located between Samples 119-744A-4H-CC, and 119-744A-5H-CC (32.7–42.2 mbsf).

All of the lower to middle Miocene sequence is also compressed at Site 744, into a total length of 50 m. Radiolarian assemblages are not abundant and only moderately preserved. Robust forms such as *Eucyrtidium cienkowski*, *Prunopyle hayesi*, and *Cyrtocapsella tetrapera* are predominant. The absence of

many stratigraphic markers does not permit a more precise age assignment of samples from this interval. Preservation of radiolarians is slightly better in Sample 119-744A-8H-CC (70.7 mbsf). Species such as *Cycladophora golli*, *Cyrtocapsella longithorax*, *Eucyrtidium punctatum*, and *Spongomelissa dilli* are diagnostic of the early Miocene. Sample 119-744A-9H-CC (80.2 mbsf), cannot be related to a precise zone because many stratigraphic markers are missing. Sample 119-744A-10H-CC (89.7 mbsf), is tentatively assigned to Zone NR16, because it contains the first occurrence of *C. tetrapera*. Other species, such as *C. golli*, *Prunopyle frakesi*, and *P. hayesi*, are rare. Many corroded spumellarians and orosphaerids are indicative of strong dissolution of the radiolarian assemblage.

The composition of radiolarian assemblages gradually changes at the Oligocene/Miocene boundary, which is located between Cores 119-744A-11H and 119-744A-12H. Many early Miocene species, such as *Cycladophora campanula*, *Gondwanaria hister*, *Lychnocanoma elongata*, have their FCO in this interval.

The major changes in the composition occur during the early Oligocene, and are documented in a special section of this paper. The early/late Oligocene boundary is located between Samples 119-744A-14H-5, 53–55 cm (124.7 mbsf), and 119-744A-15H-1, 53–55 cm (128.2 mbsf) (Table 5). Some radiolarian events can be related to this boundary: the LCO of *Calocyclus asperum*, *Prunopyle monikae*, and *Siphocampe pachyderma*. No FCO's are clearly correlated to this boundary. Preservation is good down to Sample 119-744A-16H-4, 53–55 cm (142.2 mbsf).

As Samples 119-744A-19H-CC (166.6 mbsf), and 119-744A-20H, CC (176.1 mbsf), are barren of radiolarians, there is no radiolarian evidence of the Eocene/Oligocene boundary.

Site 745 (Southeast Slope of Kerguelen Plateau)

Site 745 (59°35.710'S, 85°51.600'E; water depth 4082 m) was drilled on a large sediment drift at the base of the Southeast slope of southern Kerguelen Plateau in order to provide a deep-water Neogene reference section which could be compared with the shallow-water sections recovered at Sites 736 and 737.

Radiolarians were studied in 76 samples from Hole 745B. Well preserved, abundant, and highly diverse assemblages were encountered at almost all levels. Occurrences of 49 species (mostly well-known stratigraphic markers) were recorded (Table 6). Calibrations of radiolarian events with the paleomagnetic stratigraphy, and comparisons with absolute ages published in the literature are given in Table 7.

Samples 119-745B-1H-CC (5 mbsf), to 119-745B-3H-2, 53–55 cm (16.5 mbsf), are correlated with the upper Quaternary NR1 Zone. They contain a typical Antarctic radiolarian assemblage. Common and well preserved species include *Antarctissa denticulata*, *Antarctissa strelkovi*, *Cycladophora bicornis*, *Cycladophora davisiana*, and *Saccospyris antarctica*.

The LAD of *Stylatractus universus* (0.42 Ma) falls within the interval between Samples 119-745B-3H-2, 53–55 cm (16.5 mbsf), and 119-745B-3H-3, 53–55 cm (18 mbsf), and marks the upper boundary of Zone NR2. The LAD of *Phormostichoartus pitomorphus* (lower boundary of Zone NR2) occurs between Samples 119-745B-5H-2, 53–55 cm (35.5 mbsf), and 119-745B-5H-3, 53–55 cm (37 mbsf). A paleomagnetically derived age of 0.64–0.65 Ma has been calculated for this boundary. Radiolarians are abundant and well-preserved throughout this interval. The LAD of *Anthocyrtella callopisma* (a temperate form described from Crozet Basin sediments by Caulet, 1986) occurs between Samples 119-745B-4H-CC (33.5 mbsf), and 119-745B-5H-1, 53–55 cm (34 mbsf). A paleomagnetically derived age of 0.6–0.62 Ma is estimated for this event. The LAD of *Antarctissa cylindrica* is located between Samples 119-745B-5H-1, 53–55 cm (34 mbsf), and 119-745B-5H-2, 53–55 cm (35.5 mbsf), with an age of 0.62–0.6 Ma (0.55 Ma in ODP Leg 113 Sites, Lazarus, 1990). Occur-

Table 3. Abundance of Eocene to Oligocene radiolarian species at Hole 738B. Symbols as for Table 1.

Age	Core, section, interval (cm)	Depth (mbsf)	Abundance																										
			AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	
early Oligocene	3H-3, 53-55	017	O	O																									
	3H-4, 53-55	018.5	A	A																									
	3H-5, 53-55	020	A	B		R	R																						
	3H-6, 53-55	021.5	C	C		R	R																						
	3H-CC	023	C	M																									
	4H-1, 53-55	023.5	O	O																									
	4H-2, 53-55	025	A	B		R	R																						
	4H-3, 53-55	026.5	C	C		R	R		X																				
late Eocene	5H-1, 53-55	033	C	C		R	R			F																			
	5H-2, 53-55	034.5	C	B		R	R			R	R																		
	5H-3, 53-55	036	C	B		R	R			R	R																		
	5H-4, 53-55	037.5	C	M		R	R			X																			
	5H-5, 53-55	039	C	M		R	R			R																			
	5H-6, 53-55	040.5	O	O																									
	5H-7, 53-55	042	O	O																									
	6H-3, 53-55	045	O	O																									
	7H-3, 53-55	055	O	O																									
	8H-3, 53-55	064.5	O	O																									
	9H-3, 53-55	074	O	O																									
	middle Eocene	11H-1, 53-55	085.5	O	O																								
		11H-2, 53-55	087	O	O																								
		11H-3, 53-55	088.5	O	O																								
		11H-4, 53-55	090	R	P																								
		11H-5, 53-55	091.5	O	O																								
		11H-6, 53-55	093	O	O																								
		12H-3, 53-55	098	O	O																								
		13H-3, 24-26	107.3	O	O																								
		14X-3, 53-55	111.7	O	O																								
		15X-3, 53-55	121.3	O	O																								
		16X-1, 37-39	127.8	O	O																								
		16X-2, 53-55	128.4	O	O																								
		16X-3, 45-47	129.5	O	O																								
17X-1, 52-54		137.7	A	B		R	R		A		F																		
17X-2, 53-55		139.2	A	B		R	R		A		F	C																	
17X-3, 53-55		140.7	A	M		X		A	R		C																		
17X-4, 53-55		142.2	R	M		C		R	R		R																		
17X-5, 39-41		143.3	A	B		R	R		A	R	R	R																	
17X-CC		146.8	O	O																									
18X-1, 52-54		147.3	A	B		R	R		A	R		C	R		R														
18X-2, 52-54		148.8	A	B		C		A	F		C	R		X															
18X-3, 52-54		150.3	A	B		C		C	R	X	R	R		X															
18X-4, 52-54		151.8	R	R		F		X																					
19X-3, 52-54		160	O	O																									
20X-3, 53-55	169.7	O	O																										
21X-1, 53-55	176.3	O	O																										
21X-2, 53-55	177.7	O	O																										
22X-1, 53-55	185.9	R	R		F		X	R		X																			
22X-2, 53-55	187.4	C	M		F		C	C	R	X	R	X																	
22X-3, 53-55	188.9	F	M		R		C	F	X	R	R																		
22X-4, 53-55	190.4	A	B		A	X	A	C	C	C	C	R	R	R															
23X-1, 53-55	195.5	A	B		C	X	F	C	C	F	C	X	A	X															
24X-3, 53-55	208	R	P																										

rence of the temperate Arctic and "upwelling" species, *Streblacantha circumtexta* (Nigrini, in press), is recorded for the first time in Antarctic deep-water assemblages.

Radiolarian assemblages are moderately preserved in the NR3/NR4 interval (early Pleistocene), below the LAD of *P. pitomorphus* and above the LAD of *Cycladophora pliocenica*, which marks the NR4/NR5 boundary. This event is generally consid-

ered to be the radiolarian Pliocene/Pleistocene boundary in Antarctic assemblages. Rare and moderately preserved faunas do not permit a precise record of this last appearance in Hole 745B (see Table 6). The LCO of good specimens of *Cycladophora pliocenica* is located between Samples 119-745B-10H-3, 53-55 cm (84.5 mbsf), and 119-745B-10H-4, 53-55 cm (86 mbsf). The estimated age (1.71-1.75 Ma) is slightly older than the pub-

Table 4. Abundance of Neogene stratigraphic species at Site 744. Symbols as for Table 1.

early Miocene		middle Miocene		late Mioc. Plioc.		early to late Pleist.		Age	
NR 11/16		NR 10/9		NR 9/8		NR 8/7		Radiolarian biozonation	
A 11H-CC		A 6H-CC		A 3H-CC		A 1H-CC		Hole	
A 10H-CC		B 6H-CC		A 4H-CC		B 1H-CC		Core, section	
A 9H-CC		A 5H-CC		A 3H-CC		A 2H-CC		Depth (mbsf)	
A 8H-CC		B 5H-CC		A 2H-CC		B 1H-CC		abundance	
A 7H-CC		A 4H-CC		A 3H-CC		A 2H-CC		preservation	
A 7H-CC		A 3H-CC		A 2H-CC		A 1H-CC			
A 6H-CC		A 2H-CC		A 1H-CC					
A 5H-CC		A 1H-CC							
A 4H-CC									
A 3H-CC									
A 2H-CC									
A 1H-CC									
									Carpocaniastrea brevispina
									Cycladophora humerus
									Cyrtocapsella tetrapera
									Cyrtocapsella tetrapera
									Dendrospyrus megaloccephalus
									Ceratocystis amplius
									Circodiscus sinuatus
									Cycladophora c. coesa
									Euchyrtidium cikowskii
									Saturulalis circularis
									Spongomelissa illi
									Stauraxiphos communis
									Stylosphaera angelina
									Euchyrtidium punctatum
									Cyrtocapsella cornuta
									Gondwanaria hister
									Botryopora derlandrei
									Desmosphyrus rhodospyroides
									Euchyrtidium biconicum
									Phormostichoartus fistula
									Prunophye frakesi
									Thyrocystis clausa
									Actinomma golownini
									Cycladophora spongothorax
									Prunophye tetrapila
									Spongodiscus craticulatus
									Antarctissa robusta
									Spongotrochus glacialis
									Cycladophora pliocenica
									Euchyrtidium inflatum
									Prunophye titan
									Antarctissa cylindrica
									Botryostrobus/e/australis
									Helioholus praeveva
									Lychnocanium grande
									Siphocampe arachnea
									Stichocorys peregrina
									Triceraspis coronata
									Antarctissa streikovi
									Desmosphyrus spongiosa
									Euchyrtidium calvertense
									Pseudocubus vema
									Cycladophora davisiana
									Cyrtolagena laguncula
									Gondwanaria dogieli
									Prunophye antarctica
									Saccosphyrus conithorax
									Antarctissa denticulata
									Litholus nauilooides
									Saccosphyrus antarctica
									Triceraspis antarctica
									Ceratocystis histricosa
									Phormostichoartus pifomorphus
									Pterocanium trilobum
									Spongodiscus setosus

Table 5. Abundance of Oligocene radiolarian species at Hole 744A. Symbols as for Table 1.

Age		Depth (mbsf)	abundance preservation	
core, section, interval, cm, Hole 744 A	Age			
early Oligoc	late Oligocene			
15H-1, 53-55	12H-1, 53-55	099	A G	<i>Actinomma kerguelensis</i>
15H-3, 53-55	12H-3, 53-55	102	A G G	<i>Ampheium splendidiareatum</i>
15H-5, 53-55	12H-5, 53-55	105	A G G G	<i>Archipilium</i> sp.
15H-7, 53-55	12H-7, 53-55	108	A G G G	<i>Axoprunum</i> sp.
16H-2, 53-55	13H-2, 53-55	110	A G G G	<i>Bothyostrobos kerguelensis</i>
16H-4, 53-55	13H-4, 53-55	113	A G G G	<i>Bothyostrobos rednose</i>
	13H-6, 53-55	116	A G G G	<i>Calocucias asperum</i>
	14H-1, 53-55	118	A G G G	<i>Cenospaera oceanica</i>
	14H-3, 53-55	121	A G G	<i>Ceratocurtis amplius</i>
	14H-5, 53-55	124	A G	<i>Ceratocurtis mashae</i>
				<i>Cyamastron sinoiampae</i>
				<i>Dictyophimus archipilium</i>
				<i>Dictyophimus callosus</i>
				<i>Dictyopora physothorax</i>
				<i>Eucyrtidium antiqum</i>
				<i>Eucyrtidium mariae</i>
				<i>Eurystomosteus pefrushevskaae</i>
				<i>Lithellus aff. foresanae</i>
				<i>Lithellus ehrenbergi</i>
				<i>Lithomelissa challengerae</i>
				<i>Lithomelissa dupliiphyae</i>
				<i>Lithomelissa robusta</i>
				<i>Lophocurtis longuenter</i>
				<i>Perichlamidium praetertum</i>
				<i>Periphaena decora</i>
				<i>Prunopyle frakesi</i>
				<i>Prunopyle haqesi</i>
				<i>Prunopyle monikae</i>
				<i>Prunopyle polyacantha</i>
				<i>Pseudodictyophimus galeatus</i>
				<i>Siphocampe fabricata</i>
				<i>Siphocampe pachyderma</i>
				<i>Spongomelissa</i> sp.
				<i>Stylodictya targaiformis</i>
				<i>Theocurtis diabloensis</i>
				<i>Tricolocapsa</i> sp.
				<i>Tripilidium clavipes</i>
				<i>Actinomma campiacantha</i>
				<i>Cyrtocapsella robusta</i>
				<i>Prunopyle trypophyrea</i>
				<i>Vellicuculus</i> sp.
				<i>Stylodictya ocellata</i>
				<i>Theocorys</i> sp.
				<i>Cycladophora c. subhumerus</i>
				<i>Lithomelissa sphaerocephalis</i>
				<i>Cycladophora conica</i>
				<i>Dictyophimus pacillum</i>
				<i>Lamprocucias inexpectata</i>
				<i>Hitrocalpis</i> sp.
				<i>Saturnalis circularis</i>
				<i>Stylodictya haerata</i>
				<i>Stylosphaera hispida</i>
				<i>Ceratocurtis cucullaris</i>
				<i>Lipmanella</i> sp.
				<i>Phormostichoartus marulandicus</i>
				<i>Spongodiscus osculosus</i>
				<i>Stylatractus universus</i>
				<i>Lithomelissa cheni</i>
				<i>Stylosphaera radiosa</i>
				<i>Theospuris</i> gr.
				<i>Cyrtocapsella longithorax</i>
				<i>Lychnocanoma conica</i>
				<i>Antarctiasa</i> sp.
				<i>Actinomma medusa</i>
				<i>Acrosphaera</i> sp.
				<i>Eucyrtidium teuscheri</i>
				<i>Stylosphaera angelina</i>
				<i>Lamprocucias prionotocodon</i>
				<i>Lophophaena thumasia</i>
				<i>Cycladophora campanula</i>
				<i>Gondwanaria hister</i>
				<i>Lychnocanoma elongata</i>
				<i>Theocurtis robusta</i>

Table 6. Abundance of some radiolarian species at Hole 745B. Symbols as for Table 1.

Age	Radiolarian biozonation	Core, section, interval (cm)	Depth (mbsf)	abundance preservation		Species
				abundance	preservation	
Pleistocene	NR1	1H-CC	005.0	F	G	Cycladophora plicenica
		2H-CC	014.5	F	G	Desospyris rhodospirroides
		3H-1, 53-55	015.0	F	G	Euclitidium biconicum
	NR2	3H-2, 53-55	016.5	F	G	Helotholus praeveva
		3H-3, 53-55	018.0	F	G	Lychnocanium grande
		3H-CC	024.0	F	G	Prunopyle frakesi
	NR3/4	4H-CC	033.5	F	G	Stichocorys peregrina
		5H-1, 53-55	034.0	F	G	Antarctisea cylindrica
		5H-2, 53-55	035.5	F	G	Antarctisea robusta
		5H-3, 53-55	037.0	F	G	Anthochryteilla calloplisma
		5H-4, 53-55	038.5	F	G	Euclitidium cienkowskii
		5H-5, 53-55	040.0	F	G	Prunopyle tetrapila
		5H-6, 53-55	041.5	F	G	Spongotrochus glacialis
		5H-CC	043.0	F	G	Streblacantha circumtexta
		6H-CC	052.5	F	G	Euclitidium inflatum
7H-CC		062.0	F	G	Haliometra mlocenica	
8H-CC		071.5	F	G	Prunopyle buepingeri	
9H-CC		081.0	F	G	Saturnalis circularis	
late Pliocene	NR5	10H-1, 53-55	081.5	F	G	Stylatractus universus
		10H-2, 53-55	083.0	F	G	Theocorys reddensensis
		10H-3, 53-55	084.5	F	G	Triceraspyris coronata
		10H-4, 53-55	086.0	F	G	Prunopyle titan
		10H-5, 53-55	087.5	F	G	Rhizosphaera antarctica
		10H-6, 53-55	089.0	F	G	Laeprocurtis heteroporos
		10H-7, 53-55	090.4	F	G	Euclitidium t. orthoporos
	NR6	10H-CC	090.5	F	G	Pterocorys clausus
		11H-CC	100.0	F	G	Desospyris spongiosea
		12H-CC	109.5	F	G	Phoriticium claveli
		13H-1, 53-55	110.0	F	G	Pseudocubus vema
		13H-2, 53-55	111.5	F	G	Bothropora triloba
		13H-3, 53-55	113.0	F	G	Euclitidium calvertense
		13H-4, 53-55	114.5	F	G	Acanthodesmia viniculata
		13H-5, 53-55	116.0	F	G	Gondwanaria dogieli
early Pliocene	NR7	13H-6, 53-55	119.0	F	G	Cycladophora davisiana
		14H-CC	128.5	F	G	Phormostichoartus pitomorphus
		15H-1, 53-55	129.0	F	G	Actinomma popofski
		15H-2, 53-55	130.5	F	G	Antarctisea denticulata
		15H-3, 53-55	132.0	F	G	Pterocanium trilobum
	NR8	15H-4, 53-55	133.5	F	G	Antarctisea stralkovi
		15H-5, 53-55	135.0	F	G	Euclitidium t. teuchneri
		15H-6, 53-55	136.5	F	G	Lithelius naufrigidus
		15H-CC	138.0	F	G	Saccospyris antarctica
		16H-CC	139.0	F	G	Saccospyris conithorax
		17H-CC	148.5	F	G	Triceraspyris antarctica
		18H-1, 53-55	149.0	F	G	Cycladophora bicornis
		18H-2, 53-55	150.5	F	G	Prunopyle antarctica
		18H-3, 53-55	152.0	F	G	Prunopyle antarctica
		18H-4, 53-55	153.5	F	G	Dictyophidius saesoni
late Mioc.	NR8	18H-5, 53-55	155.0	F	G	Mitrocalpis araneifera
		18H-6, 53-55	156.5	F	G	Plectacantha sp.
		18H-CC	158.0	F	G	Litharacanthium tentorium
		19H-1, 46-48	158.4	F	G	
		19H-2, 46-48	159.9	F	G	
	NR8	19H-3, 46-48	161.4	F	G	
		19H-4, 46-48	162.9	F	G	
		19H-5, 46-48	164.4	F	G	
		19H-6, 46-48	165.9	F	G	
		19H-CC	167.5	F	G	
		20H-1, 53-55	168.0	F	G	
		20H-2, 53-55	169.5	F	G	
		20H-3, 53-55	171.0	F	G	
		20H-4, 53-55	172.5	F	G	
		20H-5, 53-55	174.0	F	G	
20H-6, 53-55	175.5	F	G			
20H-CC	177.0	F	G			
21H-CC	186.5	F	G			
22H-CC	196.0	F	G			
23H-1, 53-55	196.5	F	G			
23H-2, 53-55	198.0	F	G			
23H-3, 53-55	199.5	F	G			
23H-4, 53-55	201.0	F	G			
23H-5, 53-55	202.5	F	G			
23H-6, 53-55	204.0	F	G			
23H-7, 53-55	205.4	F	G			
23H-CC	205.5	F	G			
24H-CC	215.0	F	G			

at 1.64 Ma. Petrushevskaya (1975) has also observed the co-occurrences of the LCO's of *P. tetrapila* and *C. plicenica* at Sites 278, and 281 from DSDP Leg 29. A possible lineage between *P. tetrapila* and *P. antarctica* might be demonstrated after more detailed studies.

The last occurrence of *Prunopyle titan* between Samples 119-745B-15H-2, 53-55 cm (130.5 mbsf), and 119-745B-15H-3, 53-55 cm (132.0 mbsf), gives an age of 3.28-3.36 Ma to the lower boundary of Zone NR5 (late Pliocene). This absolute age is similar to the previously published age of 3.2 Ma for the LCO of *P.*

Table 7. Late Miocene to Holocene radiolarian datum levels at Sites 745 and 746.

Event	Species	Depth interval (mbsf)	Age Ma (calculated)	Age ^a (Leg 113)
Site 745				
Top	<i>Pterocanium trilobum</i>	15–16.5		
Top	<i>Stylatractus universus</i>	16.5–18		0.425
Top	<i>Anthocyrtella callopisma</i>	33.5–34	0.60–0.62	
Top	<i>Antarctissa cylindrica</i>	34–35.5	0.62–0.64	0.55
Top	<i>Phormostichoartus pitomorphus</i>	35.5–37	0.64–0.65	
Bottom	<i>Mitrocalpis araneafera</i>	41.5–43	0.69–0.71	
Bottom	<i>Theocalyptra bicornis</i>	62–71.5	1.10–1.40	
Top	<i>Prunopyle tetrapila</i>	81–81.5	1.62–1.64	
Top	<i>Cycladophora pliocenica</i>	84.5–86	1.71–1.75	1.6
Bottom	<i>Lithelius nautiloides</i>	90.4–90.5	1.85	
Bottom	<i>Triceraspyris antarctica</i>	90.4–90.5	1.85	
Bottom	<i>Saccospyris conithorax</i>	90.4–90.5	1.85	
Top	<i>Pseudocubus vema</i>	109.5–110	2.31–2.33	2.4
Top	<i>Eucyrtidium biconica</i>	110–111.5	2.33–2.36	
Top	<i>Desmospyris spongiosa</i>	110–111.5	2.33–2.36	2.4
Bottom	<i>Antarctissa denticulata</i>	111.5–113	2.36–2.40	
Bottom	<i>Cycladophora davisiana</i>	114.5–116	2.47–2.53	2.7
Top	<i>Prunopyle titan</i>	130.5–132	3.28–3.36	3.2
Top	<i>Eucyrtidium inflatum</i>	148.5–149	4.03–4.06	
Bottom	<i>Pseudocubus vema</i>	153.5–156.5	4.17–4.22	4.2
Top	<i>Helotholus praevema</i>	153.5–156.5	4.22–4.24	
Top	<i>Triceraspyris coronata</i>	164.4–165.9	4.47–4.50	
Top	<i>Lychnocanium grande</i>	164.4–165.9	4.47–4.50	4.4
Top	<i>Desmospyris rhodospyroides</i>	168–169.5	4.50–4.57	
Bottom	<i>Desmospyris spongiosa</i>	174–175.5	4.55–4.58	
Bottom	<i>Prunopyle titan</i>	177–186.5	4.59–4.67	
Site 746				
Top	<i>Cycladophora spongothorax</i>	232.3–233.8	8.0–8.5	5.4
Bottom	<i>Helotholus praevema</i>	250.2–251.8	7 to 8	
Bottom	<i>Lychnocanium grande</i>	250.2–251.8	7 to 8	

^a Ages after Lazarus (1990).

titan (Lazarus, 1990) for ODP Leg 113. Within all of Zone NR5, typical late Pliocene Antarctic radiolarians, dominated by *Antarctissa cylindrica* and *C. pliocenica*, are common in rich, but moderately preserved, assemblages. From the top to the bottom of the biozone, eight radiolarian events were recorded. The FCO's of *Lithelius nautiloides*, *Saccospyris conithorax*, and *Triceraspyris antarctica* are located between Samples 119-745B-10H-7, 53–55 cm (90.4 mbsf), and 119-745B-10H-CC (90.5 mbsf). An absolute age of 1.85 Ma has been calculated for these events. The FCO of *L. nautiloides* was reported from the Gauss interval in sediments from DSDP Site 514 (Leg 71, Falkland area) by Weaver (1983), and from the lower Matuyama interval in Eltanin core E14-8 (Hays and Opdyke, 1967). The next important event is the LCO of *Pseudocubus vema*, located between Samples 119-745-12H-CC (109.5 mbsf), and 119-745B-13H-1, 53–55 cm (110.0 mbsf). An absolute age of 2.31–2.33 Ma can be estimated from the paleomagnetic stratigraphy. This age is slightly younger than the average age (2.4 Ma) obtained from the radiolarian assemblages of Leg 113 (Lazarus, 1990). Two other LCO's can be recognized just below the LCO of *P. vema*: the last occurrences of *Desmospyris spongiosa* and *Eucyrtidium biconicum* are located between Samples 119-745B-13H-1, 53–55 cm (110.0 mbsf), and 119-745B-13H-2, 53–55 cm (111.5 mbsf). The estimated age of 2.33–2.36 Ma appears also to be slightly younger than the age given by Lazarus (1990) for the top of *D. spongiosa* in Leg 113 material (2.4 Ma). No absolute age has been published for the LCO of *E. biconicum* probably because this species can be easily confused with *Eucyrtidium calvertense*. However, Petrushevskaya (1975) located its last occurrence in Leg 29 Sites 278, 280, and 281 approximately between the FCO of *C. davisiana* and the LCO of *C. pliocenica* (i.e., Zone NR5). Relationships between the different species of this group (including also *Eucyrtidium inflatum*) are not yet clearly under-

stood, and a lot of new data must be gathered before this species can be considered as a reliable stratigraphic marker. The FCO of *A. denticulata* is located between Samples 119-745B-13H-2, 53–55 cm (111.5 mbsf), and 119-745B-13H-3, 53–55 cm (113.0 mbsf), with an estimated age of 2.36–2.40 Ma. This event is not easy to place because gradational changes between *A. denticulata* and *Antarctissa robusta* can be observed above and below the appearance of the first typical specimens of *A. denticulata*. More information is needed on the transition between the two species before this datum can be used. The first occurrence of *C. davisiana* is well documented in the literature. Hays et al. (in press) demonstrated that the species migrated from the North Pacific to the world ocean at 2.6 Ma BP. At Site 745, the FCO of *C. davisiana* appears to be slightly younger than 2.6 Ma and is located between Samples 119-745B-13H-2, 53–55 cm (111.5 mbsf), and 119-745B-13H-3, 53–55 cm (113.0 mbsf), at 2.47–2.53 Ma. However, the preservation of radiolarian assemblages is not very good just below this LCO, and an age of 2.5–2.6 Ma may be more appropriate for the first appearance of *C. davisiana* at Site 745, Zone NR5. Many species first appear during this interval: *Eucyrtidium t. teuscheri*, *A. strelkovi*, *Pterocanium trilobum*, *Actinomma popofskii*, *Gondwanaria dogieli*, and *E. calvertense*. Most of radiolarian species, which are characteristic of the living Antarctic fauna, appear during this period, between 2.6 and 1.8 Ma. Rare specimens of *Lamprocyrtis heteroporos*, *Haliometta miocenica*, and *Streblacantha circumtexta* are present. Only one sample (119-745B-13H-2, 53–55 cm, at 111.5 mbsf) contains rare reworked debris (*Stichocorys peregrina*).

The base of Zone NR6 (evolutionary transition between *Helotholus praevema* and *P. vema*) is located between Samples 119-745B-18H-4, 53–55 cm (153.5 mbsf), and 119-745B-18H-6, 53–55 cm (156.5 mbsf). An absolute age of 4.17–4.22 Ma, esti-

746A-14X-CC (261.5 mbsf), fall within Zone NR10. Specimens of *Desmospyris rhodospyroides*, *Cycladophora spongothorax*, and *Eucyrtidium inflatum* are present. Sample 119-746A-15X-CC (271.1 mbsf), contains rare and moderately preserved radiolarians, but no precise age can be assigned to this sample.

PALEOGENE RADIO-LARIAN EVENTS AND POTENTIAL DATUM LEVELS

Many radiolarian species appear or disappear from the fossil record during the Eocene/Oligocene period. Few events, such as first or last common occurrences, can be reported in Leg 119 material from the middle to late Eocene interval, where long barren intervals occur. Fortunately, radiolarian assemblages at the Eocene/Oligocene boundary, and throughout the Oligocene, are well preserved. Continuous occurrences and well understood taxonomy permit the recognition of 70 datum levels which can be used for stratigraphic and evolutionary interpretations. Middle and late Eocene events were calibrated by using unpublished data from the study of *Marion Dufresne* cores where these intervals are rich in well-preserved radiolarians. A synthesis of both Leg 119 and MD observations will be published (Caulet, unpubl. data). All results for Sites 738 and 744 are summarized in Figures 2 and 3. Remarks about the geographic distribution, taxonomy, and evolution of the species are given in this chapter. Comparisons are made, when possible, with other published data concerning these potentially interesting stratigraphic markers. A general stratigraphic correlation of these events is given in Barron, et al. (this volume).

Eocene Radiolarian Events at Site 738 (Fig. 2).

Few data are available for the early middle Eocene. Two main events are, however, recorded at the same level in the early CP13 nannofossil biozone (early middle Eocene, approximately 50–44 Ma):

1. FCO of *Periphaena decora* and *Lychnocanoma amphitrite*. Both of these forms are easy to recognize. They are common to abundant in all samples. *P. decora* is common in tropical areas, but appears earlier, in the *Buryella clinata* Zone (late early Eocene), according to Riedel and Sanfilippo (1977). Few to rare in subtropical sediments, *L. amphitrite* has not been used as a stratigraphic marker. It seems to have a different range in the Gulf of Mexico where its first occurrence is younger, in the late Eocene (Foreman, 1973).

Within the middle middle Eocene (upper CP13 nannofossil zone, and in the P11–12 foraminifer zone, approximately between 46 and 43 Ma), eight events are recorded. They are, from oldest to youngest, as follows:

2. FCO of *Heliostylus* sp. group at 148.8 mbsf in Hole 738B. Few to common in Kerguelen Plateau sediments, these forms were first described in the Caribbean area, where they occur in the early Eocene (Sanfilippo and Riedel, 1973). The LCO is unknown, but is probably after the late Eocene.

3. FCO of *Anthocyrta spatiosa* at 143.3 mbsf at Hole 119-738B. This taxon is rare in middle Eocene assemblages. The LCO is probably after the late Eocene. The species is present in tropical areas, but it is rarely mentioned, probably because it is rare and identification is not easy.

4. LCO of *Clathrocyclas aurelia* and *Stylosphaera spinulosa* at the same level (143.3 mbsf at Hole 119-738B). *C. aurelia* was described by Clark and Campbell (1945) from the Kreyenhagen Shales (middle and late Eocene of California), but it seems to be absent in subtropical assemblages. No stratigraphic range is presently known. The FCO is unknown, probably in the early Eocene. This is the first report of the species since its description. *S. spinulosa* was described by Ehrenberg (1873), from Barbados and reported from Caribbean material (Eocene) by Petrushev-

skaya and Kozlova (1972). It is reported herein for the first time from subantarctic material.

5. FCO of *Calocyclus semipolita*, *Dictyophimus callosus*, *Dictyophimus archipilium* and *Pseudodictyophimus galeatus* in the interval between 139.2 and 137.7 mbsf at Hole 119-738B. *C. semipolita* was described by Clark and Campbell (1942) from the middle Eocene (CP13–14 nannofossil zones) Kellogg and Sydney shales of California. It is rare or absent in subtropical areas, but abundant in Kerguelen and South Australian radiolarian assemblages of the same age. *D. callosus* was described by Petrushevskaya (Petrushevskaya and Kozlova, 1972) in Oligocene sediments from the Norwegian Sea. It has not been reported in subtropical areas. *D. archipilium* was recognized in lower Miocene sediments from Site 278 (Leg 29) by Petrushevskaya, 1975. It is rare to few in Eocene assemblages from Kerguelen. Its LCO is in the early Oligocene of Hole 744A. It is possible that Petrushevskaya's (1975) specimens were reworked, because they were not reported in her abundance tables. More detailed taxonomic data are, however, necessary to determine whether this species can be used as a stratigraphic marker. *P. galeatus* is apparently restricted on the Kerguelen Plateau (see description of this new species in the taxonomy section).

6. LCO of *Axoprimum pierinae* in the same interval (140.2–139.2 in Hole 119-738B). The first occurrence of *A. pierinae* was recorded in the upper Paleocene of the Caribbean area by Sanfilippo and Riedel (1973), who placed its LCO in the *Podocyrta ampla* Zone (middle Eocene-CP13 nannofossil zone). The LCO of this species seems to be roughly synchronous in subtropical and subantarctic areas.

Late Eocene events were difficult to recognize because most of the upper Eocene sediments are barren of radiolarians. The following first occurrence may be located in the late middle to late Eocene.

7. The FCO of *Botryostrobus kerguelensis* is located at 37.5 mbsf in Hole 738B just below the Eocene/Oligocene boundary where rare specimens are present. It is more common in the Oligocene.

Eocene/Oligocene Boundary at Site 738 (Fig. 2)

The Eocene/Oligocene boundary is well marked by a great change in the radiolarian fauna.

8. Six LCO's: *Astrophacus inca*, *Lithomelissa ehrenbergi*, *Lithomelissa haeckeli*, *Clathrocyclas nova*, *L. amphitrite*, and *Lychnocanoma babylonis* gr. These last common occurrences are easy to recognize, because the species are distinctive and abundant to common in the assemblages. *A. inca* was described by Clark and Campbell (1942) from the Kellogg Shale (middle and late Eocene) of California. Its FCO was not observed in Hole 738B, but it probably occurs during the late middle Eocene to late Eocene interval. *L. haeckeli* was first described by Bütschli (1882) with no indication of type locality. Petrushevskaya (1975) observed some representatives of this species in the upper Eocene/Oligocene of Sites 280 and 281, DSDP Leg 29. The FCO is unknown, but probably occurs during the late middle to late Eocene interval. *C. nova* was also described by Clark and Campbell (1942) from Californian assemblages. *L. amphitrite* and *L. babylonis* gr. are common in tropical assemblages, but their ranges are poorly documented.

9. Six FCO's: *Prunopyle polyacantha*, *P. frakesi*, *P. hayesi*, *Lithelius* aff. *foremanae*, *Lithomelissa sphaerocephalis*, and *Calocyclus asperum*. *P. polyacantha* was described by Campbell and Clark (1944) from the Miocene deposits of southern California. Its representatives were also observed in upper Eocene/Oligocene sediments of Leg 29 (Petrushevskaya, 1975). Close examination of radiolarian assemblages from Hole 738B shows that the first morphotypes are present as early as the Eocene/

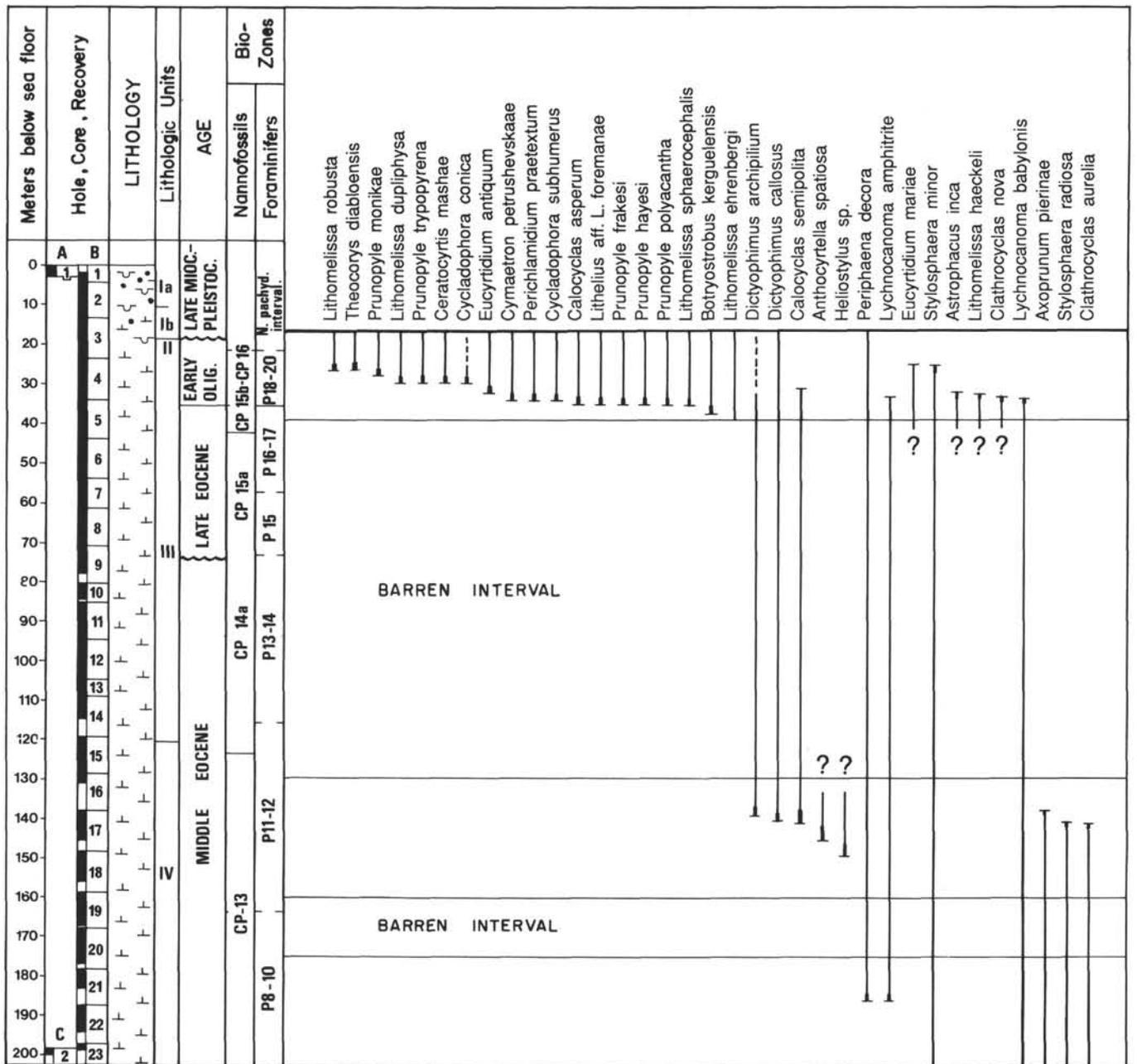


Figure 2. Radiolarian ranges at Site 738 and correlation with calcareous nannofossil (Wei and Thierstein, this volume) and planktonic foraminiferal (Huber, this volume) stratigraphy.

Oligocene boundary. Specimens are rare to few in lower Oligocene sediments. The two other *Prunopyle* species are known to be common in Miocene subantarctic sediments (Chen, 1975; Petrushevskaya, 1975; Weaver, 1976, 1983). Occurrences of *P. hayesi* were observed in Oligocene sediments (Sites 689 and 690, ODP Leg 113; Abelmann, 1990). *P. frakesi* and *P. hayesi* are restricted to the subantarctic. Their last occurrence is located in the Miocene. They are rare in lower Oligocene sediments. More data are needed before a good description of this species group just at the Eocene/Oligocene boundary. *L. sphaerocephalis* was first described by Chen (1975) in lower Oligocene sediments. It is common in lower Oligocene sediments with its LCO in the late

Oligocene. The appearance of true representatives of *Calocyclus asperum* is not easy to determine, as many forms transitional with *C. semipolita* are present. However, the FCO of true *C. asperum* appears to be located at the Eocene/Oligocene boundary. It is common to abundant in Oligocene sediments. This species was first described by Ehrenberg (1873), but was rarely reported by subsequent authors.

Earliest Oligocene Radiolarian Events at Site 738 (Fig. 2)

Above the Eocene/Oligocene boundary, numerous appearances and extinctions of species are indicative of a large change in radiolarian faunas during the early Oligocene. Immediately above the Eocene/Oligocene boundary (CP16 nannofossil zone, 37-35 Ma) are located three FCO's and three LCO's.

10. FCO of *Perichlamidium praetextum*, *Cycladophora c. subhumerus*, and *Cymaetron sinolampas*. Many species have probably been grouped under the name *P. praetextum*. Originally described by Ehrenberg (1847b) from Barbados, this species was reported from Oligocene and early Miocene age sediments at Site 278, DSDP Leg 29, by Petrushevskaya (1975). Occurrences are rare to few in Oligocene assemblages with a LCO in the early Oligocene. Some related forms may be observed in the Miocene. *C. subhumerus* was designated by Lombardi and Lazarus (1988) for some specimens from the early Miocene to Pliocene in the eastern North Pacific. This is the first time that the species has been seen in the Antarctic. *C. subhumerus* is rare in the early and late Oligocene with an LCO unknown. *C. sinolampas* is common to rare in lower Oligocene sediments from the Kerguelen Plateau.

Many radiolarian events follow closely in the early early Oligocene.

11. LAD of *Calocyclus semipolita* at 33 mbsf (Hole 738B). The transition within the *C. semipolita* group to *Calocyclus asperum* is very quick (overlapping interval of only 1.5 m).

12. FCO of *Eucyrtidium antiquum* at 31 mbsf (Site 738). *E. antiquum* seems to be restricted to the subantarctic area. Its representatives are common to abundant and restricted to the Oligocene epoch.

13. FCO of *Prunopyle tryppyrena*, *Ceratocyrtis mashae*, *Lithomelissa dupliphysa*, and *Cycladophora conica*. *P. tryppyrena* and *L. dupliphysa* are newly described herein, and seem to be restricted to the subantarctic area. Their stratigraphic ranges are discussed in the systematic section. *C. mashae* is an Arctic species first recognized by Björklund (1976) from the middle Oligocene to lower middle Miocene of the Norwegian Sea and also reported from the Oligocene of Sites 689 and 690 (ODP Leg 113) by Abelmann (1990). *C. conica* was described by Lombardi and Lazarus (1988) from lower Miocene sediments of North Pacific and subantarctic areas. Its LCO is unknown.

14. FCO of *Prunopyle monikae* at 26.5 mbsf (Hole 738B). Described by Petrushevskaya (1975), this species is rare and restricted to subantarctic sediments. Its stratigraphic range is short, in the early Oligocene.

15. FCO of *Theocyrtis diabloensis* and *Lithomelissa robusta*, between 25 and 26.5 mbsf (Hole 738B). *T. diabloensis* is common in Eocene Californian assemblages and has a short stratigraphic range. *L. robusta* is an Antarctic species described by Chen (1975). Its LCO is located between the early and late Oligocene. Some related forms were reported from early Miocene assemblages from Leg 113 sediments by Abelmann (1990).

Oligocene Events at Site 744 (Fig. 3)

Early to late Oligocene radiolarian events occurring at Site 744 are summarized in Table 9 and Figure 3. For all events, depth intervals and correlations with the paleomagnetic record are given. Only a few remarks are added here for species which have not been previously described in detail. From the early to the late Oligocene.

Lamprocyclas inexpectata is a newly described species with a short stratigraphic range. Evolutionary transitions are unknown.

Spongodiscus osculosus is a typical Antarctic form, common in middle Miocene to Holocene assemblages.

Ceratocyrtis cucullaris was described by Ehrenberg (1873) from Barbados material. It belongs to the same generic group as *C. mashae*.

Dictyoprora physothorax is a new species, apparently restricted to the early Oligocene. Its FCO is not clear, but is apparently just above the Eocene/Oligocene boundary.

Lithomelissa cheni is an Antarctic species. Its LCO is unknown, probably in the early Miocene (Abelmann, 1990).

Siphocampe pachyderma was described by Ehrenberg (1873) from Barbados from the middle to late Eocene. It is easy to recognize.

Dicytophimus archipilium is an Antarctic species described by Petrushevskaya from Leg 29 material (1975). Its FCO is unknown, probably late Eocene.

Lychnocanoma conica is also a "Californian" species described by Clark and Campbell (1942). Its LCO is not well identified, but is probably in the early Miocene, according to Abelmann (1990).

Cyrtocapsella longithorax is a typical early Miocene subantarctic form. Its LCO was generally considered as early Miocene. The relationships with ancestors are discussed subsequently.

Botryostrobus rednosus is a new species related to the *B. joides* group. Stratigraphic range is short with the FCO in the early Oligocene. It is rare throughout its range.

Lophophaena thaumasia is a new species. Its LCO is unknown.

Oligocene/Miocene Boundary (Fig. 3)

Changes in radiolarian assemblages at the Oligocene/Miocene boundary are poorly documented in Antarctic sediments, because many hiatuses or condensed sequences were recorded at most sites previously drilled at this interval. Preservation is not good at Site 744, and minor hiatuses cannot be excluded between the Oligocene and the early Miocene, but three events can be recognized probably just below the boundary (Table 5).

FCO of *Gondwanaria hister*, *Cycladophora campanula* and *Lychnocanoma elongata*. *G. hister* was described from middle Miocene Leg 29 material by Petrushevskaya (1975). Its LCO is unknown. *C. campanula* is an early Miocene cycladophorid described by Lombardi and Lazarus (1988) from Leg 29 material. Relationships with *C. antiqua* Abelmann (1990) are not yet clear. *L. elongata* is an early Miocene form common in the Mediterranean area (Sanfilippo et al., 1973). Its LCO is unknown.

EVOLUTIONARY LINEAGES

It is not the purpose of this paper to present detailed evolutionary studies based on morphometric analysis, but it is of importance for a biostratigraphic application of the information included in this report to suggest two new evolutionary groups of morphotypes. Studies are in progress to define the evolutionary patterns of these lineages in greater detail.

Calocyclus semipolita Evolutionary Lineage (Fig. 4).

Many morphotypes (found in different geographic areas, such as California and subantarctic regions) may be related to the *C. semipolita* group. On the Kerguelen Plateau, slender middle Eocene forms with an apical horn become progressively larger and lose their apical horn toward the end of the Eocene. Forms transitional to *C. asperum* (showing a progressive closing of the distal aperture) are common in the late Eocene. The first large specimens of *C. asperum* with a closed abdomen are common in the early Oligocene. Later, in the early Oligocene, forms transitional to *Cyrtocapsella robusta* Abelmann appear. The first specimens of *C. robusta* have a long abdomen and a robust spherical thorax. Progressively, the closed third segment is reduced in length to the thoracic length. At the same time, the thorax becomes more cylindrical. At the end of the early Oligocene, *C. asperum* disappears and *C. robusta* representatives become smaller. Pores are more regular in size and shape, and forms transitional to *Cyrtocapsella longithorax* are common. *C. robusta* disappears in the early Miocene, while *C. longithorax* is represented throughout the middle Miocene. Relations with *Cyrtocapsella japonica* were not clearly recognized, but this taxon may be considered as a member of the lineage. Many other

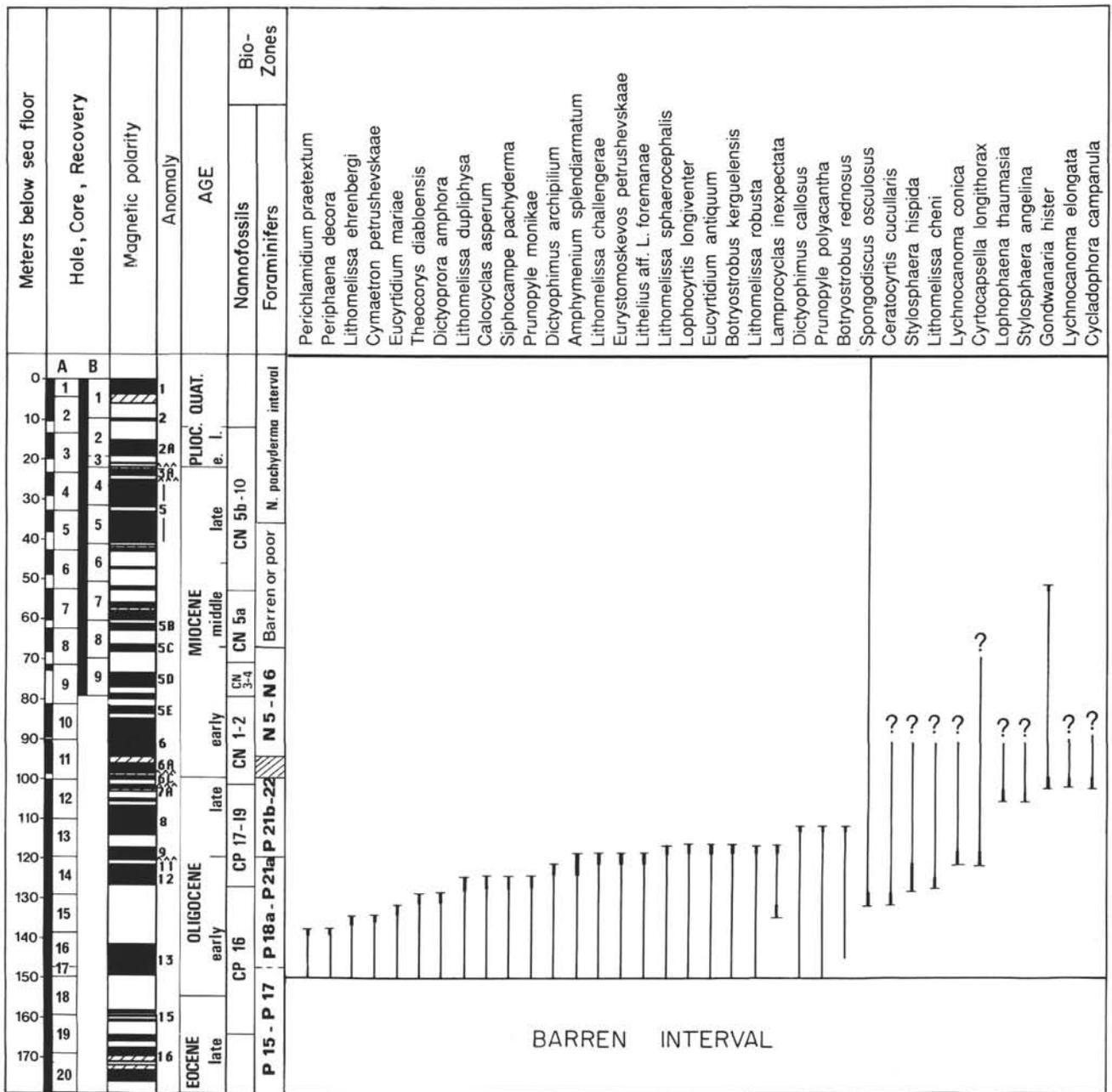


Figure 3. Radiolarian ranges at Site 744 and correlation with paleomagnetic (Barron, Larsen, et al., 1989), calcareous nannofossil (Wei and Thierstein, this volume), and planktonic foraminiferal (Huber, this volume) stratigraphy.

forms, whose taxonomic status is not clear, may be related to the group. It is interesting to note that Petrushevskaya (1975, p. 580) in her original description of *C. longithorax*, which was given the generic name *Theocorys*, points out that "the difference from *Calocyclus* is in the smaller shell dimensions, the thinner walls, and smaller pores," and "it is possible that this species and the species referred to as *C. semipolita robusta* belong to the same genus." New stratigraphic evidence shows the validity of these observations, and a new taxonomic status should be given to *C. robusta* and *C. longithorax* after morphometric studies are made.

***Prunopyle tryppyrena* Lineage**

Four actinomid species with well-differentiated pyloms can be recognized in subantarctic faunas. All of them are provision-

ally placed in the genus *Prunopyle*. They are *P. antarctica*, *P. tetrapila*, *P. buspinigerum*, and *P. tryppyrena*. All of them are different from other *Prunopyle* species, which are, in fact, representatives of the litheliid group. It is not clear if the type species of the genus (*P. pyriformis*) is really an actinomid or a litheliid. Probably for this reason, Petrushevskaya (1975) placed the actinomid species in the genus *Actinomma* and all others in the genus *Lithocarpium*. Today, it is still not clear if the pylom is such an important taxonomic character that a genus may be erected on its presence, disregarding all other morphologic characters. However, all transitional forms can be recognized between the four actinomid morphotypes related to the genus *Prunopyle*, suggesting an evolutionary lineage. *P. tryppyrena* appears in the early Oligocene from an unknown ancestor. It evolves into *P. tetrapila* in the late Miocene. *P. tetrapila* evolves

Table 9. Paleomagnetic correlation and Oligocene-early Miocene radiolarian events at Site 744.

Event	Species	Depth interval (mbsf)	Chron	Age ^a (Ma)
Bottom	<i>Cycladophora campanula</i>	99–102	6CN3–C7A	24.0–26.0
Bottom	<i>Gondwanaria hister</i>	99–102	6CN3–C7A	24.0–26.0
Bottom	<i>Lychnocanoma elongata</i>	99–102	6CN3–C7A	24.0–26.0
Bottom	<i>Lophophaena thaumasia</i>	102–105	C7A–C8	26.0–27.0
Top	<i>Dictyophimus callosus</i>	110–113	C8	27.5–28.0
Top	<i>Prunopyle polyacantha</i>	110–113	C8	27.5–28.0
Top	<i>Botryostrobus rednosus</i>	116–118	C9–C11	28.0–32.0
Top	<i>Eucyrtidium antiquum</i>	116–118	C9–C11	28.0–32.0
Top	<i>Lamprocyclas inexpectata</i>	116–118	C9–C11	28.0–32.0
Top	<i>Lithelius</i> aff. <i>L. foremanae</i>	116–118	C9–C11	28.0–32.0
Top	<i>Lithomelissa robusta</i>	116–118	C9–C11	28.0–32.0
Top	<i>Lithomelissa sphaerocephalis</i>	116–118	C9–C11	28.0–32.0
Top	<i>Lophocyrtis longiventer</i>	116–118	C9–C11	28.0–32.0
Bottom	<i>Cyrtocapsella longithorax</i>	118–121	C11–C12	31.5–32.5
Top	<i>Eurystomos. petrushevskaae</i>	118–121	C11–C12	31.5–32.5
Bottom	<i>Lychnocanomma conica</i>	118–121	C11–C12	31.5–32.5
Top	<i>Dictyophimus archipilium</i>	121–124	C12	32.5–33.0
Top	<i>Prunopyle monikae</i>	124–128	C12	33.0–33.8
Top	<i>Calocyclus asperum</i>	124–128	C12	33.0–33.8
Bottom	<i>Lithomelissa chenii</i>	124–128	C12	33.0–33.8
Top	<i>Lithomelissa dupliphysa</i>	124–128	C12	33.0–33.8
Top	<i>Siphocampe pachyderma</i>	124–128	C12	33.0–33.8
Bottom	<i>Stylosphaera radiosa</i>	124–128	C12	33.0–33.8
Bottom	<i>Ceratocyrtis cucullaris</i>	128–131	C12	33.8–34.0
Top	<i>Dictyoprora physothorax</i>	128–131	C12	33.8–34.0
Bottom	<i>Spongodiscus osculosus</i>	128–131	C12	33.8–34.0
Top	<i>Theocyrtis diabloensis</i>	128–131	C12	33.8–34.0
Top	<i>Eucyrtidium mariae</i>	131–134	C12	34.0–34.5
Bottom	<i>Lamprocyclas inexpectata</i>	131–134	C12	34.0–34.5
Top	<i>Cymaetron sinolampas</i>	134–137	C12	34.5–35.0
Top	<i>Lithomelissa ehrenbergi</i>	134–137	C12	34.5–35.0
Top	<i>Perichlamidium praetextum</i>	137–139	C12–C13	35.0–35.3
Top	<i>Periphaena decora</i>	137–139	C12–C13	35.0–35.3

^a Ages after Berggren et al. (1985).

into *P. antarctica* in the early Pliocene. *P. buspinigerum* is so rare that its first appearance is unknown, but it is clearly related to the group.

SYSTEMATICS

The systematic study of radiolarians from Leg 119 is presented in two parts.

1. Taxonomic notes: descriptions of new genera and new species of Eocene/Oligocene age, with or without revised concepts of the genus. Only new species with an interesting stratigraphic range are described. New species which are rare will be described in a forthcoming paper (Caulet, unpubl. data). Type specimens are deposited in the micropaleontological collections of the Muséum National d'Histoire Naturelle, Paris. Measurements have been made on at least 20 specimens.

2. Species list: bibliographic references for well-known taxa that are not discussed in the taxonomic notes. The only literature references given are to the original description and to my present concept of the species, if different from the original one. Photographs are included only for species formerly illustrated by drawings.

Some groups (mostly Actinommids, Trissocyclids, and the Lithomitrella group) are purposely not studied, because taxonomic concepts of these groups are not yet clear. They will be discussed in subsequent publications.

TAXONOMIC NOTES

Family ACTINOMMIDAE Haecckel, 1862, emend. Riedel 1967a

Genus ACTINOMMA Haecckel, 1860a, emend. Nigrini, 1967

Type species. *Haliomma trinacrium* Haecckel, 1860a, p. 815; 1862, pl. 24, figs. 6–8.

Actinomma kerguelensis n. sp. (Pl. 1, Figs. 1, 2)

Description. Skeleton consists of four concentric spherical shells. Outermost (fourth) shell always present, thin walled with small pores of irregular size and form, more or less spiny. Cortical (third) shell with irregular, thickly-framed pores commonly polygonal. At the junction of the pore bars, there are small nodes which extend to the outer shell. Distance between the fourth and the third shells short (1/3 of the distance between the medullary and cortical shells). Medullary (second) shell thin-walled with subcircular to circular pores, almost equal in size. Surface smooth, with scattered needle-shaped by-spines. Innermost shell consists of an irregular mesh, connected to the medullary shell by thin radial beams which are strongly developed outward from the medullary shell. These radial beams are about 10–15 in number and three-bladed. Radial beams extend beyond the fourth shell as main spines. Outer length of these spines no longer than the distance between the cortical and medullary shells.

Remarks. *A. kerguelensis* is easy to distinguish from other Eocene/Oligocene actinommids by its large size and the two cortical shells. It differs from *A. holtedahli* (an early Miocene actinommid with two external shells described by Björklund (1976) from the Arctic sediments), by the presence of an internal medullary shell.

Name. After the geographic location (Kerguelen Plateau).

Occurrences. Upper Eocene to upper Oligocene at Sites 738 and 744 (Tables 4 and 6). The FCO was not observed, but is probably located in the middle to upper Eocene (a barren interval at Site 738). LCO is in Sample 119-744A-14H-1, 53–55 cm (late Oligocene). No evolutionary transition was observed. Abundant to rare.

Dimensions. Outermost shell diameter: 235–292 μm (mean value: 263 μm); outermost shell pore diameter: 4–25 μm ; cortical shell diameter: 182–240 μm (mean value: 204 μm); cortical shell pore diameter: 10–30 μm ; medullary shell diameter: 96–105 μm (mean value: 100 μm); medullary shell pore diameter: 8–10 μm ; external spine length: 50–120 μm .

Types. Holotype (MNHN no. F61368), Sample 119-744A-15H-1, 53–55 cm, 3-Z50/4, (Pl. 1, Fig. 1). Paratypes: (MNHN no. F61369 and

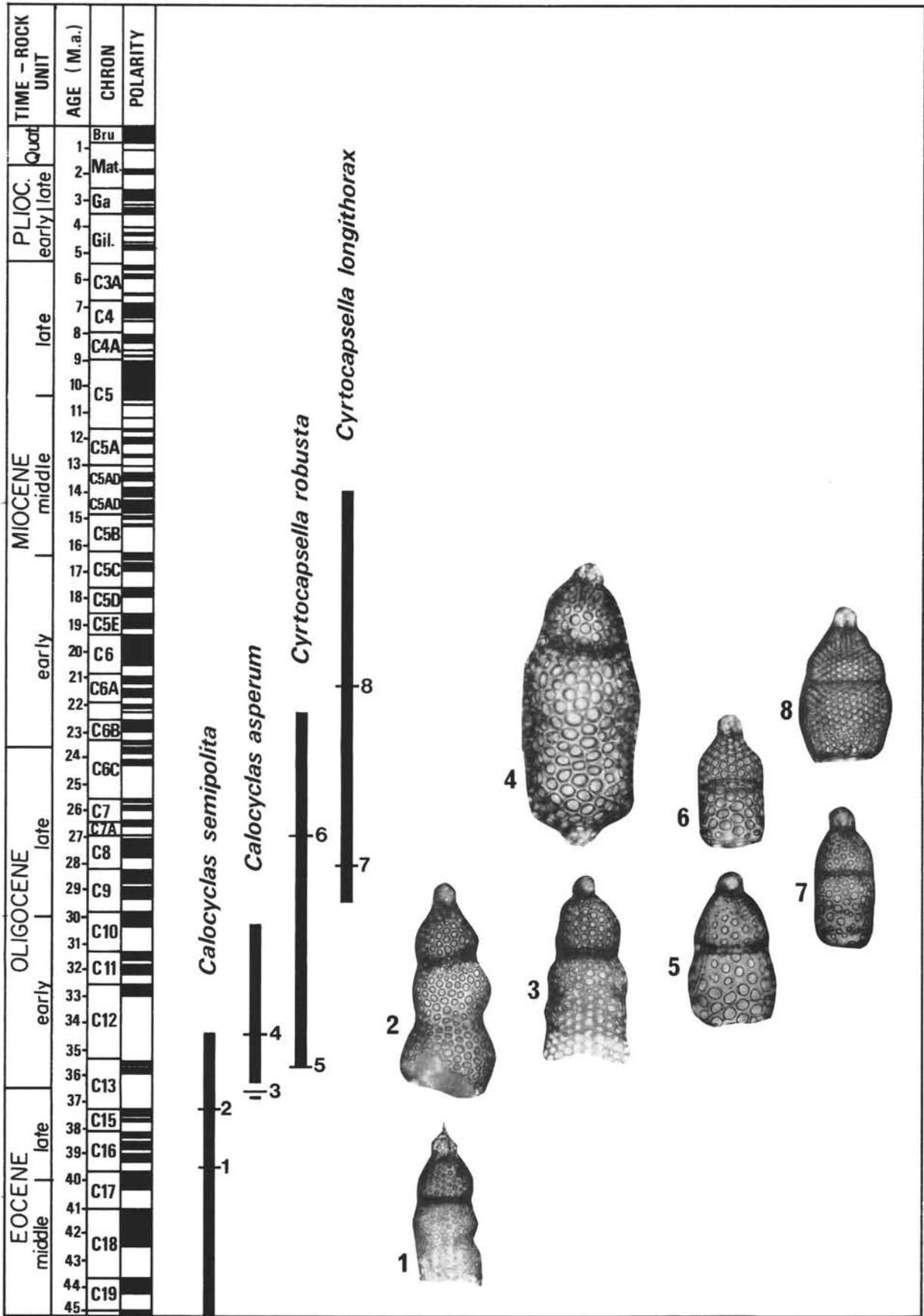


Figure 4. Range chart suggesting some generic and specific relationships within the *Calocyclas semipolita* group.

MNHN no. F61370), Sample MD 83481, 3.40 m, 1-V27/3, (Pl. 1, Fig. 2), and Sample 119-744A-16H-4, 53–55 cm, 1-D35/1.

Actinomma campilacantha n. sp.
(Pl. 1, Figs. 3, 4)

Description. Actinommid with three shells. Cortical shell, spherical, smooth with subcircular to polygonal pores of irregular size. Pores not framed. Thick-walled medullary shell, subspherical, two times smaller than the outer one, with regular subcircular pores. Small inner shell with few large pores. Cylindrical radial beams (12–15) begin at the medullary shell. Some are irregularly curved between the medullary and the cortical shells. They extend beyond the cortical shell as three-bladed main spines, frequently broken.

Remarks. This species is distinguished from the other actinommids by its inner, more or less curved main beams and the irregular shape of the medullary shell.

Name. *Kampilos* (Greek: curved), *akantha* (Greek: spine).

Occurrences. Very short stratigraphic range in Sites 738 and 744: early to early late Oligocene. The FCO is in Sample 119-744A-16H-2, 53–55 cm, LCO in Sample 119-744A-14H-3, 53–55 cm. Rare.

Dimensions. Cortical shell diameter: 205–230 μm (mean value: 212 μm); cortical shell pore diameter: 5–30 μm ; medullary shell diameter: 91–110 μm (mean value: 95 μm); medullary shell pore diameter: 5–10 μm ; inner shell diameter: 35 μm ; inner shell pore diameter: 10 μm ; external spine length: 60–90 μm .

Types. Holotype (MNHN no. F61371), Sample 119-744A-14H-3, 53–55 cm, 5-C32 (Pl. 1, Figs. 2, 3). Paratypes (MNHN no. F61372 and MNHN no. F61373), Sample 119-744A-15H-7, 53–55 cm, 1-D40 and Sample 119-744A-15H-5, 53–55 cm, 1-X37.

Genus *PRUNOPYLE* Dreyer, 1889

Type species. *Prunopyle pyriformis* Dreyer, 1889, p.18, fig. 19.

Prunopyle tryppyrena n. sp.
(Pl. 1, Figs. 5-7)

Description. Actinommid with a well developed pylom on the outermost (fourth) shell. General shape more spherical than ellipsoidal. External shell very smooth, thick-walled, with very small circular pores located in hollow tubes. Diameter of the bars similar to the width of the pores. Diameter of pylom larger than the diameter of the innermost shell, framed by a solid peristome indented to form three or more terminal teeth. Cortical shell (third) thin-walled, spherical with no pylom. Subcircular pores unequal in size, hexagonally framed. Medullary and inner shells closely spaced and difficult to describe. Three-bladed radial beams (more than 12) begin at the medullary shell, and extend through the cortical and outer shells, ending in robust and short external spines. The length of the external spines do not exceed the length of the pylom, and they are often broken.

Remarks. This species is distinguished from its probable descendant (*P. tetrapila* Hays) by its smaller size, a longer, well-developed pylom, and a shorter distance between the cortical and external shells. The evolutionary transition between the two species occurs in the early Miocene. The external fourth shell of *P. antarctica* Dreyer (the likely descendant of *P. tetrapila*) is a porous plate. *P. buspinigerum* Hays has very stout and long external spines, and a small pylom. Differences with other *Prunopyle* species are more obvious (all of them have ellipsoidal and more or less spongy outer shells).

Name. *Trypao* (Greek: to bore), *pyren* (Greek: fruit stone).

Occurrences. The first occurrence of *P. tryppyrena* is probably located just above the Eocene/Oligocene boundary. A single specimen was found in the upper Eocene (Sample 119-738B-5H-3, 53–55 cm), but the first occurrence of numerous good representatives is located in the lower Oligocene (Sample 119-738B-4H-4, 53–55 cm). Since radiolarian assemblages are not well-preserved at the Eocene/Oligocene boundary, the FCO's of rare species are difficult to define precisely. It is rare in lower Oligocene sediments, it is more abundant in late Oligocene assemblages. The transition to *P. tetrapila* is not documented.

Dimensions. Outer shell diameter: 115–134 μm (mean value: 120 μm); cortical shell diameter: 80–90 μm (mean value: 85 μm); medullary shell diameter: 33–38 μm (mean value: 35 μm); inner shell diameter: 15 μm ; pylom diameter: 30 μm ; pylom length: 20 μm .

Types. Holotype (MNHN no. F61374) Sample DSDP 29-278-32-4, 103–107 cm, 1-L49/2 (Pl. 1, Fig. 6), Oligocene. Paratypes (MNHN no.

F61375 and MNHN no. F61376), Sample 119-744A-14H-1, 53–55 cm, 3-M30/1 (Pl. 1, Fig. 7), early late Oligocene, and Sample DSDP 29-278-26-1, 48–52 cm, 3-D41/3, early Miocene.

Family SPONGODISCIDAE Haeckel, 1862, emend. Riedel 1967a
Genus *STYLODICTYA* Ehrenberg, 1847a, emend. Kozlova, 1972 in Petrushevskaya and Kozlova, 1972

Type species. *Stylodictya gracilis* Ehrenberg, 1854a, pl. 36, fig. 28.

Stylodictya tainemplekta n. sp.
(Pl. 1, Figs. 8, 9)

Description. Shell discoid, flat, with circular outline. Central nucleus consists of two cupola-shaped coalescent chambers of unequal size, both with small circular pores of uniform size. Central nucleus surrounded by girdles of irregular chambers disposed in a rose pattern. No girdles or chambers toward the periphery. Diameter of circular pores increases gradually from the center toward the outer edge. No porous plate. No median bars. No spines.

Remarks. This species is easily distinguished from other members of the genus by its cupola-shaped inner chambers.

Name. *Tainia* (Greek: ribbon), *Em-pleko* (Greek: to interlace).

Occurrences. The FCO is in the middle Eocene at Hole 738B; first common representatives are in Sample 119-738B-18X-3, 52–55 cm. Last specimens in Sample 119-738B-4H-4, 53–55 cm, lower Oligocene. It was not observed at Site 744. Rare to very rare in poorly preserved radiolarian assemblages. The precise location of both the FCO and LCO of this species were not located due to barren or poorly preserved intervals.

Dimensions. Small cupola diameter: 20 μm ; big cupola diameter: 30 μm ; inner ribbon breadth: 20 μm ; cupola pore diameter: 5 μm ; outer shell pore diameters: 6–10 μm .

Types. Holotype (MNHN no. F61377), Sample 119-738B-18X-2, 52–55 cm, 1-G50/2 (Pl. 1, Fig. 8). Paratype (MNHN no. F61378 and MNHN no. F61379), Sample 119-738B-17X-1, 52–54 cm, 1-S30/1 (Pl. 1, Fig. 9), and Sample 119-738B-5H-5, 53–55 cm, 1-E42/2.

Family PLAGONIIDAE Haeckel, 1881, emend. Riedel, 1967a
Genus *Lithomelissa* Ehrenberg, 1847b, emend. Petrushevskaya, 1971a
Type species. *Lithomelissa microptera* Ehrenberg, 1854a, pl. 36, fig. 2.

Lithomelissa cheni n. sp.
(Pl. 2, Figs. 1, 2)

Lithomelissa sp. A aff. *L. ehrenbergi*(?) Bütschli, Chen 1975, p. 458, pl. 11, figs. 1, 2.

Lithomelissa ehrenbergi Bütschli, Caulet, 1985, p. 853, table 3, pl. 2, fig. 7.

Description. Smooth two-segmented shell, cephalis smaller than the thorax. Apical spine free in the inner part of the cephalis, protruding outward as a stout apical horn shorter than the thoracic length. Vertical spine thin, extending through the cephalic wall as a short, three-bladed vertical horn, in the plane of the collar stricture. Lateral and dorsal spines extend for a short distance inside the upper part of the thoracic wall forming small shoulders. No external prolongations. Small subcircular pores. Collar stricture distinct. Thorax wider than the cephalis, smooth. Termination always ragged.

Remarks. The main differences between this species and *L. ehrenbergi* were observed by Chen (1975): "... differs in having a longer thorax and in the absence of exposed dorsal and two lateral spines." The illustration published by Bütschli (1882) is not clear about the lateral and dorsal spines, but his synonymy with the specimen described by Ehrenberg (1875, pl. 3, fig. 8) shows that *L. ehrenbergi* must possess strong external lateral and dorsal spines. *L. cheni* is also distinguished from *L. ehrenbergi* by a prominent horizontal vertical spine.

Name. In honor of Pei-Hsi Chen who first described this species.

Occurrences. The FCO is in Sample 119-738B-3H-6, 53–55 cm (early Oligocene). The LCO was not observed in Leg 119 material. The LCO is in the middle Miocene at DSDP Site 594 (Chatham Rise, south of New Zealand).

Dimensions. Length of apical horn: 20–40 μm ; of vertical spine: 10–15 μm ; of cephalis: 60–65 μm ; of thorax: 85–95 μm . Maximum breadth of cephalis: 55–62 μm ; of thorax: 60–75 μm .

Types. Holotype (MNHN no. F61380), Sample 90-594-52-2, 84–86 cm, 1-R42/3 (Pl. 2, Fig. 1). Paratype (MNHN no. F61381), Sample DSDP 90-594-52-2, 84–86 cm, 2-B50/3 (Pl. 2, Fig. 2).

Lithomelissa dupliphysa n. sp.
(Pl. 2, Fig. 4)

Description. Spongy two-segmented shell, cephalis as large as the thorax. Apical spine free in the inner part of the cephalis, protruding outward as a stout apical horn as long as the cephalis. Some pores at the base of the apical horn. Vertical spine thin, extending through the cephalic wall as a short thornlike spine. Collar stricture not distinct. Primary lateral and dorsal spines protrude outward at the collar stricture as three equally strong spines with one or two pores at their base. Thorax spongy probably closed in well-preserved adult specimens.

Remarks. This species is distinguished from *L. challengerae* Chen by a cephalis as wide as the thorax and robust lateral spines, as long as the apical horn. It is distinguished from *Pseudodictyophimus* species, and particularly *P. galeatus*, by a well-developed thorax and a small external prolongation of the vertical spine.

Name. *Duplex* (Latin: twofold) and *Physaos* (Greek: swollen).

Occurrences. The FCO is in Sample 119-738B-4H-4, 53–55 cm (early Oligocene). The LCO is in Sample 119-744A-15H-1, 53–55 cm (early/late Oligocene boundary). Rare.

Dimensions. Length of apical horn: 50–75 μm ; of cephalis: 65–72 μm ; of thorax: 75–100 μm . Maximum breadth of cephalis: 100–115 μm ; of thorax: 105–115 μm .

Holotype. Holotype (MNHN no. F61382), Sample 119-744A-15H-3, 53–55 cm, 3-B49/3 (Pl. 2, Fig. 4). Paratype (MNHN no. F61383), Sample 119-744A-16H-2, 53–55 cm, 1-O33.

Genus *LOPHOPHAENA* Ehrenberg, 1847b, emend. Petrushevskaya, 1971a

Type species. *Lophophaena galeaorci* Ehrenberg, 1854b, p. 245.

Lophophaena(?) thaumasias n. sp.
(Pl. 2, Figs. 5, 6)

Description. Two-segmented shell. Cephalis small, with two small dorso-lateral lobes, largely coalesced with the thorax. Apical spine included in the cephalic wall, protruding as a strong three-bladed apical horn as long as the cephalis. Vertical spine short, prolonged into an external, strong vertical spine, three-bladed. Lateral and dorsal spines extending briefly through the upper part of the thoracic wall. Collar stricture not marked. Pores subcircular, of various sizes, in irregular order. Termination ragged.

Remarks. Assignment of this species to the genus *Lophophaena* is not entirely satisfying. Like all *Lophophaena* species, its cephalis has a small ovoid shape with slightly marked dorso-lateral lobes that coalesce with the upper part of the thorax. However, the apical horn and the vertical spine are well-developed, like those of *Lithomelissa* and *Psilomelissa* representatives, but the cephalis is smaller, and lateral and dorsal spines do not protrude as external spines or feet.

Name. *Thaumasias* (Greek: peculiar).

Occurrences. The FCO is in Sample 119-744A-12H-3, 53–55 cm (Oligocene/Miocene boundary). The LCO is unknown. Rare to common.

Dimensions. Length of the apical horn: 30–40 μm ; of the vertical spine: 20 μm ; of the cephalis: 30–40 μm ; of the thorax: 95–100 μm . Maximum breadth of the cephalis: 45–55 μm ; of the thorax: 100–105 μm .

Types. Holotype (MNHN no. F61384), Sample 119-744A-12H-3, 53–55 cm, 1-Z26 (Pl. 2, Fig. 5). Paratypes (MNHN no. F61385 and MNHN no. F61386), Samples 119-744A-12H-3, 53–55 cm, 1-T41/3 (Pl. 2, Fig. 6), and 29-278-33-6, 48–52 cm, 3-G43.

Genus *PSEUDODICTYOPHIMUS* Petrushevskaya, 1971a

Type species. *Dictyophimus gracilipes* Bailey, 1856, pl. 1, fig. 8.

Pseudodictyophimus galeatus n. sp.
(Pl. 2, Figs. 9, 10)

Description. Shell two-segmented, thick-walled, spongy. Cephalis well-developed. Internal spicules stout, free inside the cephalis. Apical and vertical spines protrude outward as three-bladed apical and vertical horns. Apical horn longer than vertical spine. Lateral and dorsal spines prolonged within thoracic wall, and protrude downward as oblique terminal feet of the same length as the apical horn. No collar stricture. Thorax smaller than the cephalis. Pore irregular in size and distribution. Termination ragged.

Remarks. The internal structure of this form is typical of the genus *Pseudodictyophimus*, as described by Petrushevskaya (1971a). It is distinguished from other species in the genus by its large size and spongy external envelope. It is distinguished from *L. dupliphysa* by its stout internal spicule and the lateral and dorsal feet.

Name. *Galeatus* (Latin: helmeted).

Occurrences. The first occurrence is in Sample 119-744H-738B-4H-1, 53–55 cm (early Oligocene). The last occurrence is in Sample 119-744A-15H-1, 53–55 cm (early/late Oligocene boundary). Although rare, it is easy to recognize.

Dimensions. Length of cephalic horn: 70–75 μm ; of vertical spine: 35–40 μm ; of cephalis: 75–80 μm ; of thorax: 75–95 μm . Maximum breadth of cephalis: 100–115 μm ; of thorax: 150–170 μm .

Types. Holotype (MNHN no. F61387), Sample MD 81310, 0.43 cm, 3-C29 (late Eocene) (Pl. 2, Fig. 9). Paratype (MNHN no. F61388), Sample 119-744A-15H-5, 53–55 cm, 5-X49/1 (Pl. 2, Fig. 10).

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

Genus *LAMPROCYCLAS* Haeckel, 1881, emend. Nigrini, 1967

Type species. *Lamprocyclus nuptialis* Haeckel, 1887, p. 1390, pl. 74, fig. 15.

Lamprocyclus inexpectata n. sp.
(Pl. 3, Figs. 2, 3)

Description. Three-segmented shell, conical to ovate, quite smooth and rather thin-walled. Cephalis trilobular including two prominent dorso-lateral lobes, with irregularly arranged circular pores, and bearing a stout three-bladed apical horn, three to four times as long as the cephalis. Transition from cephalis to apical horn continuous. Primary lateral and dorsal spines continue as short ribs in the thoracic wall, and may project outward as small thorns. Collar stricture not pronounced. Thorax thin-walled, conical, irregularly inflated by shoulder-like protuberances. Circular pores generally regular in size, subcircular, and in longitudinal rows. No ribs. Lumbar stricture distinct. Abdomen broader than thorax, with larger pores. In complete specimens abdomen constricted distally with a smooth termination, but most specimens are incomplete.

Remarks. This species is placed in the genus *Lamprocyclus* mainly because no thoracic ribs (common in *Pterocorys*) were observed on any specimens. However, no differentiated peristome (characteristic of *Lamprocyclus*) was observed. Thus, *L. inexpectata* could be considered as a member of the *Pterocorys* group (Caulet and Nigrini, 1988). As the lack of peristome may be related to poor preservation, it seems more appropriate, for the moment, to place this species in the *Lamprocyclus* group. This species differs from the other members of the group because it lacks a true peristome with teeth, and has a long apical horn. Many morphological characters of this species appear to be common to both *Pterocorys* and *Lamprocyclus*. As very few representatives of these genera have been observed in Paleogene assemblages, it is difficult to propose an evolutionary lineage between *L. inexpectata* and other Pterocorythidae.

Name. *Inexpectatus* (Latin: unexpected).

Occurrences. It has a short stratigraphical range in the Oligocene of Site 744: the FCO is in Sample 119-744A-15H-3, 53–55 cm (Early to middle Oligocene), and the LCO in Sample 119-744A-14H-1, 53–55 cm (early late Oligocene). Rare.

Dimensions. Length of the apical horn: 75–90 μm ; of the cephalis: 40–45 μm ; of the thorax: 70–85 μm ; of the abdomen: 90 μm . Maximum breadth of the thorax: 95–100 μm ; of the abdomen: 120–130 μm .

Types. Holotype (MNHN no. F61389), Sample 119-744A-15H-3, 53–55 cm, 3-P50/1 (Pl. 3, Fig. 2). Paratype (MNHN no. F61390), Sample 119-744A-15H-1, 53–55 cm, 3-H34/1 (Pl. 3, Fig. 3).

Lamprocyclus prionotocodon n. sp.
(Pl. 3, Figs. 4, 5)

Lamprocyclus sp. Caulet, 1985, pl. 4, fig. 7.

Description. Three-segmented shell, conical to ovate. Cephalis large, ovate, with small subcircular pores. Apical horn stout, oblique, thorny. Vertical spine short, protruding outward as a thorn. Lateral and dorsal spines extending like “shoulders” in the wall of the upper thorax, prolonged into external thorns. Collar stricture distinct. Thorax conical, with longitudinal rows of subcircular pores of nearly the same size.

Lumbar stricture not pronounced. Abdomen shorter than thorax. Peristome is a poreless band with a few short indentations.

Remarks. This species is distinguished from other representatives of *Lamprocyclus* by its stout oblique apical horn, large cephalis and poreless peristome. It is distinguished from *L. margatensis* by a shorter abdomen. It is probably the ancestor of *L. margatensis*.

Name. *Prionotos* (Greek: jagged), *kodon* (Greek: bell).

Occurrences. The FCO is in upper Oligocene (Sample 119-744A-12H-3, 53–55 cm). Rare specimens occur in the early Miocene at Site 744, but in middle Miocene at DSDP Site 594 (Leg 90). The LCO was not observed.

Dimensions. Length of the cephalic horn: 45–50 μm ; of the cephalis: 40–45 μm ; of the thorax: 50–55 μm ; of the abdomen: 40–45 μm . Maximum breadth of the thorax: 95–100 μm ; of the abdomen: 100–110 μm .

Types. Holotype (MNHN no. F61391), Sample 119-744A-12H-3, 53–55 cm, 1-Z21, Oligocene (Pl. 3, figs. 4–5). Paratype (MNHN no. F61392), Sample 119-744A-11H-6, 53–55 cm, 1-L29, early Miocene.

Family ARTOSTROBIDAE Riedel, 1967b, emend. Foreman, 1973

Genus *BOTRYOSTROBUS* Haeckel, 1887, emend. Nigrini, 1977

Type species. *Lithostrobos botryocytis* Haeckel, 1887, p. 1475, pl. 79, figs. 18, 19.

Botryostrobos kerguelensis n. sp.

(Pl. 3, Figs. 6–8)

Description. Shell cylindrical, thick-walled, rough-surfaced. Cephalis spherical, small, half sunken into the thorax with a few circular pores. Cephalis wall always thorny. Thorn-like apical horn, as long as the cephalis. Short cylindrical vertical tube directed obliquely upward. Secondary outer spines on the cephalis. Collar stricture not pronounced. Thorax conical, thick-walled, with small circular pores increasing in size toward the lumbar stricture. Small thorns arise from the inter-pore spaces. Third segment (abdomen), being the largest in both length and breadth, inflated with 5–6 transverse rows of subcircular pores. Base of third segment sometimes more inflated. Stricture between third and fourth segment distinct. Subsequent segments, smaller, with two transverse rows of subcircular pores. Termination ragged.

Remarks. The individuals included in this species may be quite variable from the Eocene to the early Miocene. In all of them, however, the first three segments appear to be more consistent than the subsequent ones, producing a conical outline with no well-marked strictures. All these segments are thorny. The small size is also distinctive. Eocene and Oligocene specimens are smaller, with pores distributed in more regular patterns. Miocene representatives are more robust, with a more cylindrical shell. This species is probably related to *B. joides*, but the lack of a stout apical horn and the general shape of the shell make it really distinctive.

Name. Geographic occurrence on the Kerguelen Plateau (shortened).

Occurrences. Although common in Oligocene samples it is rare to very rare in the Eocene (Sample 119-738B-5H-4, 53–55 m) and middle Miocene (Sample 119-744A-10H-5, 55–57 cm) to late Miocene (Sample DSDP 29-278-14-4, 82–86 cm). The FCO is not well defined and is probably in the late Eocene. LCO was not recognized.

Dimensions. Length of the apical horn: 10–15 μm ; of the cephalis: 20 μm ; of the thorax: 25–30 μm ; of the abdomen: 40–45 μm . Maximum breadth of the thorax: 40–45 μm ; of the abdomen: 55–60 μm ; of the fourth segment: 45–50 μm .

Types. Holotype (MNHN no. F61393), Sample 119-744A-10H-5, 55–57 cm, 1-V49/4, early Miocene (Pl. 3, Fig. 6). Paratypes (MNHN no. F61394 and F61395), Samples 119-744A-16H-4, 53–55 cm, 1-N45/4, Oligocene (Pl. 3, Fig. 7), and DSDP 29-278-11-4, 82–86 cm, 3-O33, middle Miocene (Pl. 3, Fig. 8).

Botryostrobos rednosus n. sp.

(Pl. 3, Figs. 9, 10)

Description. Shell robust, thick-walled, spindle-shaped with more than 5 post-cephalic segments. Cephalis, small, thick-walled, hemispherical with few small pores. Apical horn short, needle-like, and often broken. Vertical tube short, generally indistinct. No distinct collar stricture. Thorax small, thick-walled, with 2 or 3 rows of small irregular pores. Lumbar stricture well-marked, but no poreless band. Two transverse rows of circular pores on the third segment. Stout secondary thorns, often developed on sinuous ribs, on the first three segments, giving a typical leafy aspect to the cephalic end of the shell. Post-abdominal seg-

ments separated by distinct strictures, with 2–3 transverse rows of subcircular pores. The fifth and the sixth segments are broader than the others. The sixth segment, and subsequent ones, have few large pores irregularly distributed. Strictures are poreless bands on the terminal part of the shell. Shell narrows distally, terminating in a smooth, poreless peristome.

Remarks. The external outline and the thickness of the shell are somewhat similar in *B. aquilonaris*, but the extremely thorny primary segments are more related to the *B. kerguelensis*, or the *B. joides* group.

Name. In honor of all the "rednoses" of ODP Leg 119 cruise.

Occurrences. This species has a short stratigraphic range: mostly late Eocene to early Oligocene. Its first appearance datum (FAD) is in Sample 119-738B-5H-3, 53–55 cm (late Eocene), FCO in Sample 119-738B-4H-2, 53–55 cm (Eocene/Oligocene boundary), and LCO in Sample 119-744A-14H-1, 53–55 cm (early late Oligocene). Abundant in late early Oligocene assemblages.

Dimensions. Length of the cephalic horn: 10 μm ; of the cephalis: 10 μm ; of the thorax: 12 μm ; of the abdomen: 15 μm . Maximum breadth of the thorax: 20–25 μm ; of the abdomen: 30–35 μm ; of the fifth segment: 50–55 μm .

Types. Holotype (MNHN no. F61396), Sample 119-744A-15H-1, 53–55 cm, 3-Q36 (Pl. 3, Fig. 9). Paratype (MNHN no. F61397), Sample 119-744A-16-2, 53–55 cm, 1-U39/1 (Pl. 3, Fig. 10).

Genus *DICTYOPRORA* Haeckel, 1881, emend. Nigrini, 1977

Type species. *Dictyocephalus amphora* Haeckel, 1887, p. 1305, pl. 62, fig. 4.

Dictyoprora physothorax n. sp.

(Pl. 3, Fig. 11)

Description. Shell three-segmented, smooth, rather thick-walled. Cephalis hemispherical with small circular pores. No apical horn. Vertical tube short, cylindrical, laterally directed. Collar stricture indistinct. Thorax inflated with three irregular transverse rows of small circular pores. Internal lateral spines may project outward as external spines or wings. Lumbar stricture distinct. Abdomen as inflated as the thorax. Four to six widely spaced transverse rows of circular pores. Pores not widely spaced. Distal opening small with a tubular, well-differentiated and poreless peristome.

Remarks. This species is distinguished from *D. urceolus* (and of all other members of the genus) by a larger thorax, as wide as the abdomen. Pores also are more abundant than in *D. urceolus*. The genus *Dictyoprora* is restricted to the Eocene in tropical areas (Nigrini, 1977). This form may be the first observed Oligocene descendant of the group.

Name. *Physao* (Greek: swollen), *thorax* (Greek: thorax).

Occurrences. The FCO is in Sample 119-738B-3H-5, 53–55 cm (early Oligocene). The LCO is in Sample 119-744A-15H-3, 53–55 cm (late early Oligocene). Common to abundant.

Dimensions. Length of the cephalis: 15 μm ; of the thorax: 30 μm ; of the abdomen: 60–70 μm . Maximum breadth of the thorax: 45–55 μm ; of the abdomen: 55–60 μm .

Types. Holotype (MNHN no. F61398), Sample 119-744A-15H-3, 53–55 cm, 3-T47 (Pl. 3, Fig. 11). Paratype (MNHN no. F61399), Sample 119-744A-12H-3, 53–55 cm, 1-F21/1.

Family THEOPERIDAE Haeckel, 1881, emend. Riedel, 1967a

Genus *EUCYRTIDIUM* Ehrenberg, 1847b, emend. Nigrini, 1967

Type species. *Lithocampe acuminata* Ehrenberg, 1844a, p. 84.

Eucyrtidium antiquum n. sp.

(Pl. 4, Figs. 1, 2)

Lithocampe subligata Stöhr, in Petrushevskaya, 1975, partim., pl. 14, fig. 7

?*Eucyrtidium montiparum* Ehrenberg, 1873, p. 230; 1875, pl. 9, fig. 11.

Description. Multisegmented shell cylindrical, thick-walled, thorny. Cephalis subspherical, small, with rare small pores. Collar stricture indistinct. Apical horn, small, thorny, often broken. Thorax conical, thick-walled. Thoracic length greater than thoracic breadth. Pores circular, small, more or less regularly distributed. Primary lateral and dorsal spines may extend through the thoracic wall, and protrude outward. Lumbar stricture well marked. Third segment twice as broad as long. Subsequent segments of the same breadth. Subcircular pores in longitudinal rows on all post-thoracic segments. All strictures between segments well marked. Termination never observed.

Remarks. Although they look similar to the species described as *E. montiparum* by Ehrenberg (1873), these ancient representatives of the genus *Eucyrtidium* are given a new species name herein for several reasons. First, in the original description, the cephalis of *E. montiparum* is said to be poreless (*hyalinum* in Latin), which is obviously not the case here. Secondly, two specimens from the equatorial Atlantic figured by Petrushevskaya and Kozlova under the name of *E. aff. montiparum* (1972, pl. 26, figs. 2-4) have a distinct poreless cephalis and long post-thoracic segments. The first abdominal segment is comparatively short in *E. antiquum*. A true representative of this species is probably figured by Petrushevskaya (1975, pl. 14, fig. 7) under the name of *Stichopodium subligata*. Finally, as the specific name of *subligata* was created by Stöhr (1880) for Miocene forms clearly related to the genus *Stichocorys*, it seems more convenient to give a new name to this old *Eucyrtidium* until a comprehensive description of Eocene representatives of the genus is published. This species is distinguished from Neogene species mostly by a robust and thorny shell, similar to the shell of members of the genus *Stichocorys*. However, its cephalis has a structure obviously related to the genus *Eucyrtidium* (small, with pores, and a thorny fragile apical horn; lateral wings may extend through the thoracic wall).

Name. *Antiquum* (Latin: very old).

Occurrences. The FAD is in Sample 119-738B-4H-6, 53-55 cm (Eocene/Oligocene boundary). The FCO is in Sample 119-738B-4H-4, 53-55 cm and the LCO is in Sample 744A-14H-1, 53-55 cm (early late Oligocene). Rare to abundant.

Dimensions. Length of the cephalis: 15 μm ; of the thorax: 40 μm ; of the abdomen: 45-50 μm . Maximum breadth of the thorax: 60-65 μm ; of the abdomen: 50-100 μm ; of the fifth segment: 100-125 μm .

Types. Holotype (MNHN no. F61400), Sample DSDP 28-274-35-2, 100-104 cm, 1-M39/4 (Pl. 4, Fig. 1). Paratype (MNHN no. F61401), Sample 119-744A-14H-1, 53-55 cm, 5-N52/1 (Pl. 4, Fig. 2).

Eucyrtidium(?) mariae n. sp.
(Pl. 4, Figs. 3, 4)

Eucyrtidium sp. A, Petrushevskaya, 1975, p. 581, pl. 14, figs. 21, 22.

Description. Multi-segmented shell, cylindrical, robust. Cephalis subspherical, small, with rare small circular pores. Collar stricture indistinct. Apical horn, stout, longer than the cephalis, three-bladed near the cephalic wall. Vertical spine protruding slightly as a vertical thorn. Lateral and dorsal spines extending in the thoracic walls, protruding rarely as thorny wings. Thoracic length greater than thoracic breadth. Circular pores of uniform size in longitudinal rows. Lumbar stricture well marked. Post-thoracic segments of variable length and breadth, delimited by irregular internal rings, spiral rather than transverse. Pores, circular, in regular longitudinal rows on the upper abdominal segments, irregular on the lower part of the shell.

Remarks. The main morphologic characters of this species (a stout, long apical horn, and sinuous rings between post-thoracic segments) were observed by Petrushevskaya (1975). The generic assignment to *Eucyrtidium* is still questionable, mainly because representatives of the genus generally have small apical horns. This form could be a transitional morphotype. More data are needed before a definite generic status can be given to this form.

Name. In honor of Maria Petrushevskaya who first observed this species in DSDP Leg 29 material.

Occurrences. The FCO was not observed (barren samples), but occurs in the upper Eocene (see Table 4). The LCO is in Sample 119-744A-15H-5, 53-55 cm (early Oligocene). Rare to abundant. In her written description, Petrushevskaya (1975) gives a late Miocene to Pliocene stratigraphic range to this species (p. 581) but her figured specimens (pl. 14, figs. 21, 22) come from Eocene/Oligocene levels.

Dimensions. Length of apical horn: 25 μm ; of cephalis: 20 μm ; of thorax: 45-50 μm . Maximum breadth of thorax: 65-70 μm ; of abdomen: 80-90 μm .

Types. Holotype (MNHN no. F61402), Sample MD 83481, 2.15 m, 2-Y21 (Pl. 4, Fig. 3). Paratype (MNHN no. F61403), Sample MD 83481, 3.25 m, 2-U24/1 (Pl. 4, Fig. 4).

Genus *EURYSTOMOSKEVOS* n. gen.

Definition. Theoperid with two segments; cephalis indistinct with pores, bearing a long, stout apical horn; vertical spine small; thorax flared, irregular pores increasing in size toward a ragged opening; pri-

mary lateral and dorsal spines extending through the thoracic wall, and protruding outward.

Type species. *E. petrushevskae* (by monotypy).

Derivation of name. *Eurystomos* (Greek: flared), *skeuos*, pronounced skevos (Greek: vase).

Eurystomoskevos petrushevskae n. sp.
(Pl. 3, Figs. 14, 15)

Diplocyclus sp. A, Petrushevskaya and Kozlova, 1972, p. 541, pl. 33, figs. 14-16; Petrushevskaya, 1975, p. 587, pl. 24, fig. 4.

Description. Shell two-segmented, thick-walled. Cephalis conical with small circular pores. Apical horn robust of variable length, but always longer than the cephalis. Vertical spine small, never protruding outward. Collar stricture indistinct. Upper thorax cylindrical, with small secondary thorns and three transverse rows of subcircular pores. Primary lateral and dorsal spines extend through the walls of the upper thorax, and protrude outward as external wings. Lower thorax flared with progressively large sub-polygonal pores. No termination.

Remarks. A new genus is created for this species because no similar morphologic characters exist in previously erected genera. Petrushevskaya (1975) has figured, and briefly described, this form as a member of the genus *Diplocyclus*. However, the type species of *Diplocyclus* (*D. bicorona* Haeckel, 1887, p. 1392, pl. 59, fig. 8) has a well-organized peristome and a strong vertical spine protruding as a long cephalic horn. The type species of *Coniforma* (*C. antiochensis* Pessagno, 1969, p. 397, figs. 9-12) has a shell with a similar external outline, but with a complex cephalic structure including massive internal elements.

Name. In honor of Maria Petrushevskaya who first figured this species.

Occurrences. Rare in some Oligocene levels at DSDP Site 140 (equatorial Atlantic), it is common to abundant in Eocene to Oligocene sediments of DSDP Sites 280 and 281 (south Tasman Sea). Its FAD is in Sample 119-738B-22X-4, 53-55 cm (early middle Eocene) and LCO in Sample 119-744A-14H-3, 53-55 cm (early late Oligocene). Rare in middle Eocene, it is common to abundant in early Oligocene. Some morphological gradations can be observed between the Eocene and Oligocene forms.

Dimensions. (Measured on holotype, paratypes and specimens of the same age). Length of cephalic horn: 35-70 μm ; of cephalis: 20-25 μm ; of thorax: 75-90 μm . Maximum breadth of thorax: 75-110 μm .

Types. Holotype (MNHN no. F61404), Sample 119-744A-15H-3, 53-55 cm, 5-N28/4 (Pl. 3, Fig. 14). Paratype (MNHN no. F61505), Sample 119-744A-14-3, 53-55 cm, 1-Y48/1 (Pl. 3, Fig. 15).

Genus *CYMAETRON* n. gen.

Definition. Two-segmented shell with a sinuous outline. Cephalis small with a robust internal cephalic structure. Apical spine extending outward as a strong rough apical horn. Vertical spine extruding as a small thorn. Dorsal and lateral spines prolonged as ribs on the upper part of the thorax. Thorax constricted in false segments. Opening wide open.

Type species. *C. sinolampas* (by monotypy).

Derivation of name. *Kyma* (Greek: wave), *etron* (Greek: abdomen).

Cymaetron sinolampas n. sp.
(Pl. 4, Figs. 10-12)

Theoperid, gen. et sp. indet., Riedel and Sanfilippo, 1977, pl. 7, fig. 7.

Description. Two-segmented shell, thick-walled, with a sinuous outline. Cephalis subspherical, small, bearing few circular pores. Internal spines short, but robust. Arches "ap" and apical spines like ribs on the cephalic wall. Apical horn rough, longer than the cephalis. Lateral and dorsal spines extending through the upper thoracic wall as smooth ribs, protruding slightly outward as thorns. Collar stricture distinct. Upper thorax very short, conical, with small subcircular pores. Transition to lower thorax marked only by a widening of the shell. Lower thorax undulated, with two strictures of the shell, not subdivided into segments by internal rings. Pores irregular in size and distribution, larger than the pores on the upper thorax. Termination restricted and ragged.

Remarks. At first sight, the shell appears to be multisegmented with a typical "eucyrtidioid" cephalis, but no internal rings can be observed between the different "segments" of the post-cephalic part of the shell.

Moreover, internal parts of the main spicule are very robust, arches are clearly marked on the cephalic wall, and the apical horn is robust and tuberculated. This species could be assigned to the genus *Sethoconus* Haeckel 1887, because the genus (p. 1290) was erected for two-segmented conical forms with wide open mouths and a cephalis bearing one or two horns. However, the type species (*Eucyrtidium trochus* Ehrenberg) of *Sethoconus* is also the type species of *Conarachnium* Haeckel (1881). Thus *Sethoconus* is a junior synonym of *Conarachnium*. Using *Conarachnium* as a generic term for this species is not correct because *C. trochus* is a multisegmented form apparently related to the Pterocorythidae. An undetermined form (from the *Thyrsocytis triacantha* Zone, middle Eocene) has been figured by Riedel and Sanfilippo (1977, pl. 7, fig. 7) and looks similar to *C. sinolampas*.

Name. *Sinensis* (Latin: Chinese), *lampas* (Latin: lantern).

Occurrences. The FCO is in Sample 119-738B-5H-1, 53–55 cm (Eocene/Oligocene boundary). The LCO is in Sample 119-744A-15H-7, 53–55 cm (early Oligocene). Rare to few.

Dimensions. Length of cephalis: 20 μm ; of thorax: 150–160 μm . Maximum breadth of upper thorax: 40–45 μm ; of middle thorax: 90–95 μm ; of lower thorax: 100–110 μm .

Types. Holotype (MNHN no. F61406), Sample 119-744A-16H-2, 53–55 cm, 2-Z34/4 (Pl. 4, Fig. 11). Paratype (MNHN no. F61407), Sample 119-744A-16H-4, 53–55 cm (Pl. 4, Fig. 10).

SPECIES LIST

- Acanthodesmia viniculata* (Müller). *Lithocircus viniculatus* Müller, 1857, p. 484. *Acanthodesmia viniculata* (Müller) in Müller, 1858, p. 30, pl. 1, figs. 1–7.
- Actinomma delicatulum* (Dogel), nov. comb. *Heliosoma delicatulum* Dogel, in Dogel and Reshetnyak, 1952, p. 7, fig. 2. This species has been given different generic names (*Echinomma*, *Hexacantium*) by Petrushevskaya (Petrushevskaya and Kozlova, 1979). However, the same author (Petrushevskaya and Kozlova, 1979, p. 97) remarks that “the Antarctic forms are distinguished (from Arctic specimens) by more numerous (9–14) radial beams”, which is characteristic of the genus *Actinomma*.
- Actinomma golownini* Petrushevskaya, 1975, p. 569, pl. 2, fig. 16.
- Actinomma medusa* (Ehrenberg). *Haliomma medusa* Ehrenberg, 1844a, p. 83; 1854a, pl. 22, fig. 33. *Actinomma medusa* (Ehrenberg) emend. gr. in Petrushevskaya, 1975, p. 568, pl. 2, figs. 6–8.
- Actinomma popofskii* (Petrushevskaya), nov. comb. *Echinomma popofskii* Petrushevskaya, 1967, p. 23, fig. 12, I–III. Following Björklund (1977), the genus *Echinomma* is considered as a synonym of the genus *Actinomma*.
- Amphicraspedum prolixum* group Sanfilippo and Riedel, 1973, p. 524, pl. 11, figs. 1–5, pl. 28, fig. 5.
- Amphipternis clava* (Ehrenberg). *Lithocampe clava* Ehrenberg, 1873, p. 238; 1875, pl. 4, fig. 2. *Amphipternis clava* (Ehrenberg) in Foreman, 1973, p. 430, pl. 7, figs. 16, 17, pl. 9, figs. 2, 7.
- Amphymenium challengerae* Weaver, 1983, p. 675, pl. 6, figs. 1–2.
- Amphymenium splendarmatum* Clark and Campbell, 1942, p. 46, pl. 1, figs. 12, 14.
- Antarctissa cylindrica* Petrushevskaya, 1972, figs. 1, 8; 1975, p. 591, pl. 11, figs. 19, 20. (= *Antarctissa ewingi* Chen).
- Antarctissa denticulata* (Ehrenberg). *Lithobotrys(?) denticulata* Ehrenberg, 1844b, p. 203. *Antarctissa denticulata* (Ehrenberg) in Petrushevskaya, 1967, p. 87, fig. 49, I–IV.
- Antarctissa robusta* Petrushevskaya, 1975, p. 591, pl. 11, figs. 21, 22. (= *Antarctissa antedenticulata* Chen).
- Antarctissa strelkovi* Petrushevskaya, 1967, p. 89, fig. 51, III–VI.
- Anthocyrta(?) callopsima* Caulet, 1986, p. 227, pl. 1, figs. 1, 2.
- Anthocyrta mespilus* (Ehrenberg). *Anthocyrta mespilus* Ehrenberg, 1847b, p. 55, fig. 9; 1854a, pl. 36, fig. 13. *Anthocyrta mespilus* (Ehrenberg) in Petrushevskaya and Kozlova, 1972, p. 541.
- Anthocyrta spatiosa* (Ehrenberg). *Cycladophora spatiosa* Ehrenberg, 1873, p. 222; 1875, pl. 18, figs. 5, 6. *Anthocyrta spatiosa* (Ehrenberg) in Petrushevskaya and Kozlova, 1972, p. 541, pl. 33, figs. 1–3.
- Anthocyrta ehrenbergi* (Stöhr). *Anthocyrta ehrenbergi* Stöhr, 1880, p. 100, pl. 3, figs. 21a, 21b. *Anthocyrta ehrenbergi* (Stöhr) in Nigrini and Caulet, 1988, p. 347, pl. 1, figs. 3, 4.
- Anthocyrta plicocnica* (Seguenza). *Anthocyrta ehrenbergi* Stöhr var. *plicocnica* Seguenza, 1880, p. 232. *Anthocyrta plicocnica* (Seguenza) in Nigrini and Caulet, 1988, p. 355, pl. 2, figs. 5–6.
- Artobotrys auriculaleporis* (Clark and Campbell). *Lophophaena auriculaleporis* Clark and Campbell, 1942, p. 89, pl. 8, figs. 20, 27–29.
- Artobotrys auriculaleporis* (Clark and Campbell) in Petrushevskaya and Kozlova, 1979, p. 137.
- Artobotrys biaurita* (Ehrenberg) group. *Eucyrtidium biaurita* Ehrenberg, 1873, p. 226; 1875, p. 70, pl. 10, figs. 7, 8. *Artobotrys biaurita* (Ehrenberg) in Petrushevskaya and Kozlova, 1979, p. 136.
- Astrophacus inca* (Clark and Campbell), nov. comb. *Heliodiscus inca* Clark and Campbell, 1942, p. 38, pl. 3, fig. 17. The species *H. inca* is reassigned to the genus *Astrophacus* as to follow the emendation of the genera *Heliodiscus* and *Astrophacus* by Sanfilippo and Riedel (1973, p. 522).
- Axoprimum pierinae* (Clark and Campbell) group. *Lithatractus pierinae* Clark and Campbell, 1942, p. 34, pl. 5, fig. 25. *Axoprimum pierinae* (Clark and Campbell) group in Sanfilippo and Riedel, 1973, p. 488, pl. 1, figs. 6–12, pl. 23, fig. 3.
- Botryopera deflandrei* Petrushevskaya, 1975, p. 592, pl. 11, figs. 30–32.
- Botryopera triloba* (Ehrenberg). *Lithobotrys triloba* Ehrenberg, 1844a, p. 84; 1854a, pl. 19, fig. 55, pl. 22, fig. 30a, 30b. *Botryopera triloba* (Ehrenberg) in Petrushevskaya, 1975, p. 591, pl. 11, figs. 27–29, 36–39, pl. 20, figs. 3, 4.
- Botryostrobus auritus/australis* (Ehrenberg) gr. *Lithocampe australe* Ehrenberg, 1844a, p. 187; 1854a, pl. 35A, 21, fig. 18. *Botryostrobus auritus/australis* (Ehrenberg) gr. in Nigrini, 1977, p. 246, pl. 1, figs. 2–5.
- Botryostrobus bramlettei tumidulus* (Bailey). *Eucyrtidium tumidulus* Bailey, 1856, p. 5, pl. 1, fig. 11. *Botryostrobus bramlettei tumidulus* (Bailey) in Caulet, 1979, p. 131, pl. 1, fig. 9.
- Botryostrobus joides* Petrushevskaya, 1975, p. 585, pl. 10, fig. 37; Björklund, 1976, pl. 23, figs. 7–14.
- Calocyclus asperum* (Ehrenberg). *Eucyrtidium asperum* Ehrenberg 1873, p. 226; 1875, pl. 15. *Calocyclus asperum* (Ehrenberg) in Petrushevskaya and Kozlova, 1972, p. 548, pl. 28, figs. 16–18.
- Calocyclus semipolita* group Clark and Campbell, 1942, p. 83, pl. 8, figs. 12, 14, 17–19, 21–23.
- Carpocanistrum brevispina* Vinassa de Regny, 1900, pl. 2, fig. 23.
- Carposphaera subbotinae* (Borisenko). *Cenosphaera subbotinae* Borisenko, 1958, p. 85, pl. 5, figs. 5–7. *Carposphaera subbotinae* (Borisenko) in Sanfilippo and Riedel, 1973, p. 490, pl. 4, fig. 3, pl. 23, figs. 4–5.
- Cenosphaera(?) oceanica* Clark and Campbell, 1945, p. 7, pl. 1, figs. 2, 3, 9. Good picture in Petrushevskaya, 1975, pl. 1, figs. 12, 13.
- Ceratocyrtis amplus* (Popofsky). *Helotholus amplus* Popofsky, 1908, p. 283, pl. 34, fig. 4. *Ceratocyrtis amplus* (Popofsky) group in Petrushevskaya, 1975, p. 590, pl. 11, figs. 3–6, 13, pl. 19, fig. 2.
- Ceratocyrtis cucullaris* (Ehrenberg). *Cornutella(?) cucullaris* Ehrenberg, 1873, p. 221; 1875, pl. 2, fig. 7. *Ceratocyrtis cucullaris* (Ehrenberg) in Bütschli, 1882, p. 536, fig. 36.
- Ceratocyrtis histicosa* (Jörgensen). *Helotholus histicosa* Jörgensen, 1905, p. 137, pl. 16, figs. 86–88. *Ceratocyrtis histicosa* (Jörgensen) in Petrushevskaya, 1971b, p. 98, fig. 52, 2–4.
- Ceratocyrtis mashae* Björklund, 1976, p. 1125, pl. 17, figs. 1–5.
- Ceratocyrtis stigi* (Björklund), nov. comb. *Lithomelissa stigi* Björklund, 1976, p. 1125, pl. 15, figs. 12–17. This species cannot be related to the genus *Lithomelissa* (Petrushevskaya and Kozlova, 1979), but there are no such differences between the holotype and the paratypes as to give a new name to the last ones (*Ceratocyrtis panicula* Petrushevskaya, Petrushevskaya and Kozlova, 1979, p. 115).
- Circodiscus(?) circularis* (Clark and Campbell). *Porodiscus circularis* Clark and Campbell, 1942, p. 42, pl. 2, figs. 2, 6, 10. *Circodiscus(?) circularis* (Clark and Campbell) in Petrushevskaya, 1975, p. 575.
- Circodiscus ellipticus* (Stöhr). *Trematodiscus ellipticus* Stöhr, 1880, p. 108, pl. 4, fig. 16. *Circodiscus ellipticus* (Stöhr) in Petrushevskaya, 1975, p. 575, pl. 6, figs. 1–6.
- Clathrocyclas aurelia* Clark and Campbell, 1945, p. 46, pl. 6, fig. 30. (Illustrated herein, Pl. 2, Fig. 8).
- Clathrocyclas universa nova* Clark and Campbell, 1945, p. 45, pl. 6, fig. 27.
- Cycladophora antiqua* Abelman, (1990), pl. 7, figs. 13a, 13b.
- Cycladophora bicornis bicornis* (Popofsky). *Pterocorys bicornis* Popofsky, 1908, p. 288, pl. 34, figs. 7, 8. *Cycladophora b. bicornis* (Popofsky) in Lombardi and Lazarus, 1988, p. 106, pl. 5, fig. 12.
- Cycladophora cabrilloensis subhumerus* Lombardi and Lazarus, 1988, p. 120, pl. 8, figs. 7–12.

- Cycladophora campanula* Lombardi and Lazarus, 1988, p. 123, pl. 10, figs. 1–12.
- Cycladophora conica* Lombardi and Lazarus, 1988, p. 105, pl. 3, figs 1–16.
- Cycladophora cosma cosma* Lombardi and Lazarus, 1988, p. 104, pl. 1, figs. 1–6.
- Cycladophora davisiana* Ehrenberg, 1861, p. 297; 1873, pl. 2, fig. 11.
- Cycladophora gollii gollii* (Chen). *Lophocyrtis gollii* Chen, 1975, p. 461, pl. 12, figs. 4, 5. *Cycladophora gollii gollii* (Chen) in Lombardi and Lazarus, 1988, p. 124, pl. 11.
- Cycladophora gollii regipileus* (Chen). *Lophocyrtis regipileus* Chen, 1975, p. 461, pl. 12, figs. 6–7. *Cycladophora gollii regipileus* (Chen) in Lombardi and Lazarus, 1988, p. 124, pl. 11.
- Cycladophora humerus* (Petrushevskaya). *Clathrocyclos humerus* Petrushevskaya, 1975, p. 586, pl. 15, figs. 22, 23, pl. 43, figs. 1, 2. *Cycladophora humerus* (Petrushevskaya) in Lombardi and Lazarus, 1988, p. 123, pl. 9, figs. 1–6.
- Cycladophora pliocenica* (Hays). *Clathrocyclos bicornis* Hays, 1965, p. 179, pl. 3, fig. 3. *Cycladophora pliocenica* (Hays) in Lombardi and Lazarus, 1988, p. 104. (= *Clathrocyclos antebicornis* Petrushevskaya).
- Cycladophora spongothorax* (Chen). *Theocalypra bicornis spongothorax* Chen, 1975, p. 462, pl. 12, figs. 1–3. *Cycladophora spongothorax* (Chen) in Lombardi and Lazarus, 1988, p. 122, pl. 9, figs. 7–12.
- Cyrtocapsella cornuta* (Haeckel). *Cyrtocapsa* (*Cyrtocapsella*) *cornuta* Haeckel, 1887, p. 1513, pl. 78, fig. 9. *Cyrtocapsella cornuta* (Haeckel) in Sanfilippo and Riedel, 1970, p. 453, pl. 1.
- Cyrtocapsella japonica* (Nakaseko). *Eusyringium japonicum* Nakaseko, 1963, p. 193, pl. 4, figs. 1–3. *Cyrtocapsella japonica* (Nakaseko) in Sanfilippo and Riedel, 1970, p. 452, pl. 1, figs. 13–15.
- Cyrtocapsella longithorax* (Petrushevskaya), nov. comb. *Theocorys longithorax* Petrushevskaya, 1975, p. 580, pl. 8, figs. 17, 18, pl. 22, fig. 2. (= *Cyrtocapsella isopera* Chen). *C. isopera* Chen is a junior synonym of *T. longithorax* Petrushevskaya (Lazarus, 1990). The species is very different from *Theocorys morchellula* Rüst (1885, p. 308, pl. 37, fig. 6), type species of the genus *Theocorys*.
- Cyrtocapsella robusta* Abelmann, (1990), Plate 5, figs. 10, 11.
- Cyrtocapsella tetrapera* (Haeckel). *Cyrtocapsa* (*Cyrtocapsella*) *tetrapera* Haeckel, 1887, p. 1512, pl. 75, fig. 12. *Cyrtocapsella tetrapera* (Haeckel) in Sanfilippo and Riedel, 1970, p. 453, pl. 1, figs. 16–18.
- Cyrtolagena laguncula* Haeckel, 1887, p. 1451, pl. 75, fig. 10.
- Dendrosphyris megalcephalis* Chen, 1975, p. 455, pl. 14, figs. 3–5.
- Desmosphyris rhodospyroides* Petrushevskaya, 1975, p. 593, pl. 10, figs. 27–29, 31, 32. (= *Dendrosphyris haysi* Chen).
- Desmosphyris spongiosa* Hays, 1965, p. 173, pl. 2, fig. 1.
- Dictyophimus* (?) *archipilium* Petrushevskaya, 1975, p. 583, pl. 25, figs. 1, 2.
- Dictyophimus* (?) *callosus* Petrushevskaya, in Petrushevskaya and Kozlova, 1979, p. 143, figs. 256, 257.
- Dictyophimus* (?) *mawsoni* Riedel, 1958, p. 234, pl. 3, figs. 6, 7.
- Dictyophimus pocillum* Ehrenberg, 1873, p. 223; 1875, pl. 5, fig. 6.
- Dictyoprora amphora* (Haeckel). *Dictyocephalus amphora* Haeckel, 1887, p. 1305, pl. 62, fig. 4. *Dictyoprora amphora* (Haeckel) in Nigrini, 1977, p. 250, pl. 4, figs. 1, 2.
- Dorcadospyrus argisca* (Ehrenberg). *Petalospyris argiscus* Ehrenberg, 1873, p. 246; 1875, pl. 22, figs. 1, 2. *Dorcadospyrus argisca* (Ehrenberg) in Goll, 1969, p. 336, pl. 56, figs. 9–11, text fig. 2.
- Eucyrtidium biconicum* (Vinassa de Regny) nov. comb. *Lithocampe biconicum* (Vinassa de Regny) in Petrushevskaya, 1975, p. 581, pl. 14, figs. 25–27, pl. 22, fig. 7. The holotype of the genus *Stichopodium* (*S. dictyopodium*) has three lattice feet (Haeckel, 1887, pl. 75, fig. 6) which is obviously not the case here. For many years, Maria Petrushevskaya has been considering that the differences between *Eucyrtidium* and *Stichopodium* are mostly in the shape of the thorax (Petrushevskaya and Kozlova, 1972; 1979), but she never emended the definition of *Stichopodium*. (= *Eucyrtidium calvertense* Martin, sensu Hays, 1965).
- Eucyrtidium calvertense* Martin, 1904, p. 450, pl. 130, fig. 5.
- Eucyrtidium cienkowski* Haeckel gr. Haeckel, 1887, p. 1493, pl. 80, fig. 9.
- Eucyrtidium inflatum* Kling, 1973, p. 636, pl. 11, figs. 7, 8, pl. 15, figs. 7, 10.
- Eucyrtidium punctatum* (Ehrenberg). *Lithocampe punctata* Ehrenberg, 1844a, p. 84. *Eucyrtidium punctatum* (Ehrenberg) in Ehrenberg, 1847b, p. 43; 1854a, pl. 22, fig. 24.
- Eucyrtidium teuscheri orthoporus* Caulet, 1985, p. 851, pl. 5, fig. 4.
- Eucyrtidium teuscheri teuscheri* Caulet, 1985, p. 851, pl. 5, figs. 5–8.
- Eucyrtidium teuscheri* (Haeckel) gr. *Eucyrtidium teuscheri* Haeckel, 1887, p. 1491, pl. 77, fig. 5. emend. in Caulet, 1985, p. 850, pl. 5, figs. 1–8.
- Eucyrtidium* sp. aff. *E. montiparum* Ehrenberg, in Petrushevskaya and Kozlova, 1972, p. 548, pl. 26, figs. 2–4.
- Gondwanaria dogieli* (Petrushevskaya). *Sethoconus* (?) *dogieli* Petrushevskaya, 1967, p. 95, pl. 53, figs. 1, 2. *Gondwanaria dogieli* (Petrushevskaya), in Petrushevskaya, 1975, p. 585.
- Gondwanaria hister* Petrushevskaya, 1975, p. 585, pl. 9, fig. 19, pl. 21, fig. 3.
- Haliometta miocenica* (Campbell and Clark). *Heliosphaera miocenica* Campbell and Clark, 1944, p. 16, pl. 2, figs. 10–14. *Haliometta miocenica* (Campbell and Clark), in Petrushevskaya and Kozlova, 1972, p. 517, pl. 9, figs. 8, 9.
- Helotholus praevema* Weaver, 1983, p. 677, pl. 3, figs. 1, 5–15.
- Lamprocyrtis heteroporos* (Hays). *Lamprocyrtis heteroporos* Hays, 1965, p. 179, pl. 3, fig. 1. *Lamprocyrtis heteroporos* (Hays), in Kling, 1973, p. 639, pl. 5, figs. 19–21, pl. 15, figs. 4, 5.
- Lithapium plegmacantha* Riedel and Sanfilippo, 1970, p. 520, pl. 4, figs. 2, 3.
- Litharachnium tentorium* Haeckel, 1862, p. 281, pl. 4, figs. 7–10.
- Lithelius* aff. *Lithelius foremanae* Sanfilippo and Riedel, 1973, p. 522, pl. 7, figs. 1–6, pl. 26, figs. 4, 5.
- Lithelius nautiloides* Popofsky, 1908, p. 230, pl. 27, fig. 4.
- Lithocarpium fragilis* (Stöhr). *Ommatodiscus fragilis* Stöhr, 1880, p. 116, pl. 6, fig. 10. *Lithocarpium fragilis* (Stöhr) in Petrushevskaya, 1975, p. 572, pl. 4, figs. 2–4.
- Lithomelissa ehrenbergi* Bütschli, 1882, p. 519, fig. 21.
- Lithomelissa haeckeli* Bütschli, 1882, p. 519, fig. 23.
- Lithomelissa robusta* Chen, 1975, p. 457, pl. 9, figs. 1, 2.
- Lithomelissa sphaerocephalis* Chen, 1975, p. 457, pl. 8, figs. 1, 2.
- Lophocyrtis* (*Lophocyrtis*) *jacchia* (Ehrenberg). *Thyrsocyrtis jacchia* Ehrenberg, 1873, p. 261; 1875, pl. 12, fig. 7. *Lophocyrtis* (*Lophocyrtis*) *jacchia* (Ehrenberg) in Sanfilippo, in press, pl. 1, figs. 5–10, pl. 3, fig. 6.
- Lophocyrtis* (*Paralampterium*) *dumitricai* Sanfilippo, in press, pl. 3, figs. 7–13.
- Lophocyrtis* (*Paralampterium*) *longiventer* (Chen). *Cyclampterium* (?) *longiventer* Chen, 1975, p. 459, pl. 10, fig. 7. *Lophocyrtis* (*Paralampterium*) *longiventer* (Chen) in Sanfilippo, in press, pl. 3, figs. 1–5.
- Lophophaenoma radians* (Ehrenberg). *Lophophaena radians* Ehrenberg, 1873, p. 243; 1875, pl. 8, figs. 7–9. *Lophophaenoma radians* (Ehrenberg) in Haeckel, 1887, p. 1304 (as subgenus of *Lophophaena*). See also the emendation of the genus *Lophophaenoma* by Petrushevskaya (1971a, p. 117).
- Lychnocanium grande* gr. Campbell and Clark, 1944, p. 42, figs. 3–6.
- Lychnocanoma amphitrite* Foreman, 1973, p. 437, pl. 11, fig. 10.
- Lychnocanoma babylonis* (Clark and Campbell) group. *Dictyophimus babylonis* Clark and Campbell, 1942, p. 67, pl. 9, figs. 32, 36. *Lychnocanoma babylonis* (Clark and Campbell) in Foreman, 1973, p. 437, pl. 2, fig. 1.
- Lychnocanoma bellum* (Clark and Campbell). *Lychnocanium bellum* Clark and Campbell, 1942, p. 72, pl. 9, figs. 35, 39. *Lychnocanoma bellum* (Clark and Campbell) in Foreman, 1973, p. 437, pl. 1, fig. 17, pl. 11, fig. 9.
- Lychnocanoma conica* (Clark and Campbell). *Lychnocanium conicum* Clark and Campbell, 1942, p. 71, pl. 9, fig. 38. *Lychnocanoma conica* (Clark and Campbell) in Abelmann (1990), pl. 6, fig. 8.
- Lychnocanoma elongata* (Vinassa de Regny). *Tetrahedrina globosa* Vinassa de Regny, 1900, p. 243, pl. 2, fig. 30. *Lychnocanoma elongata* (Vinassa de Regny) in Sanfilippo et al., 1973, p. 221, pl. 5, figs. 19, 20.
- Lychnocanoma tripodium* (Ehrenberg). *Lychnocanium tripodium* Ehrenberg, 1875, pl. 7, fig. 2. *Lychnocanoma tripodium* (Ehrenberg), in Haeckel, 1887, p. 1229.
- Mitrocalpis araneafera* Popofsky, 1908, p. 273, pl. 30, fig. 11.
- Perichlamidium praetextum* gr. Ehrenberg, 1847b, p. 43; 1854a, pl. 22, fig. 21 (non 20).
- Periphaena decora* Ehrenberg, 1873, p. 246; 1875, pl. 28, fig. 6.
- Periphaena heliasteriscus* (Clark and Campbell). *Heliodiscus heliasteriscus* Clark and Campbell, 1942, p. 39, pl. 3, figs. 10, 11. *Periphaena heliasteriscus* (Clark and Campbell) in Sanfilippo and Riedel, 1973, p. 523, pl. 9, figs. 1–6, pl. 27, figs. 8, 9.
- Phormostichoartus fistula* Nigrini, 1977, p. 153, pl. 1, figs. 11–13.

- Phormostichoartus furcaspiculata* (Popofsky). *Lithamphora furcaspiculata* Popofsky, 1913, p. 408, text figs. 138, 139. *Phormostichoartus furcaspiculata* (Popofsky) in Caulet, 1985, p. 853.
- Phormostichoartus marylandicus* (Martin). *Lithocampe marylandica* Martin, 1904, p. 450, pl. 130, fig. 4. *Phormostichoartus marylandicus* (Martin) in Nigrini, 1977, p. 253, pl. 2, figs. 1-3.
- Phormostichoartus multiseriatus* (Ehrenberg). *Eucyrtidium multiseriatum* Ehrenberg, 1860, p. 768. *Phormostichoartus multiseriatus* (Ehrenberg) in Caulet, 1985, p. 853.
- Phormostichoartus pitomorphus* Caulet, 1985, p. 850, pl. 3, figs. 3, 4, 9, 10, 12.
- Phorticum clevei* (Jørgensen). *Tetrapylonium clevei* Jørgensen, 1900, p. 64. *Phorticum clevei* (Jørgensen) in Petrushevskaya, 1967, p. 58, figs. 32-34.
- Prunopyle antarctica* Dreyer, 1889, p. 24, pl. 5, fig. 75.
- Prunopyle buspingerum* Hays, 1965, p. 171, pl. 2, fig. 2.
- Prunopyle frakesi* Chen, 1975, p. 454, pl. 10, figs. 1-3.
- Prunopyle hayesi* Chen, 1975, p. 454, pl. 9, figs. 3-5.
- Prunopyle monikae* (Petrushevskaya) nov. comb. *Lithocarpium monikae* Petrushevskaya, 1975, p. 572, pl. 4, figs. 6-10, pl. 30, figs. 1-7. Petrushevskaya (1975, p. 572) proposes an emendation of the genus *Lithocarpium* Stöhr as to include in it all ellipsoidal skeletons with a pylom tube, but with the same type species as Stöhr (1880). As this type species (*L. pyriforme*) was originally considered as a carpocaniidae (Stöhr, 1880), it could be less confusing, for the moment, to use the genus *Prunopyle* Dreyer. This new combination is provisorily proposed, before a detailed study of pylom bearing actinommids can be published.
- Prunopyle polyacantha* (Clark and Campbell) nov. comb. *Larnacantha polyacantha* Campbell and Clark, 1944, p. 30, pl. 5, fig. 4. *Lithocarpium polyacantha* gr. (Campbell and Clark) in Petrushevskaya, 1975, p. 572, pl. 3, figs. 6-8, pl. 29, fig. 6. Same remarks as above.
- Prunopyle tetrapila* Hays, 1965, p. 172, pl. 2, fig. 5.
- Prunopyle titan* Campbell and Clark, 1944, p. 20, pl. 3, figs. 1-3.
- Pseudocubus vema* (Hays). *Helotholus vema* Hays, 1965, p. 176, pl. 2, fig. 3, text fig. A. *Pseudocubus vema* (Hays) in Petrushevskaya, 1971a, p. 46, fig. 24, I-IV.
- Pterocanium trilobum* (Haeckel). *Dictyopodium trilobum* Haeckel, 1860b, p. 839; 1862, p. 340, pl. 8, figs. 6-10. *Pterocanium trilobum* (Haeckel) in Haeckel, 1887, p. 1333.
- Pterocorys clausus* (Popofsky). *Lithornithium clausum* Popofsky, 1913, p. 393, text fig. 11. *Pterocorys clausus* (Popofsky) in Petrushevskaya and Kozlova, 1972, p. 545, pl. 36, figs. 16-18.
- Pteropilius* sp. aff. *Pterocanium contiguum* Ehrenberg. *Pterocanium contiguum* Ehrenberg, 1873, p. 255; 1875, pl. 17, fig. 7. *Pteropilius*(?) sp. group aff. *Pterocanium contiguum* Ehrenberg in Petrushevskaya and Kozlova, 1972, p. 553, pl. 29, figs. 8-10.
- Rhabdolithis pipa* Ehrenberg, 1854a, pl. 36, fig. 59; 1875, p. 159, pl. 1, fig. 27.
- Rhizosphaera antarctica* (Haeckel). *Spongoplegma antarctica* Haeckel, 1887, p. 90. *Rhizosphaera antarcticum* (Haeckel) in Caulet, 1985, p. 853.
- Saccospyris antarctica* Haecker, 1907, p. 124, fig. 10; 1908, pl. 84, fig. 584.
- Saccospyris conithorax* Petrushevskaya, 1965, p. 98, fig. 11.
- Saturnalis circularis* Haeckel, 1887, p. 131.
- Schizodiscus codrant* Petrushevskaya, 1975, p. 574, pl. 38, figs. 1-7.
- Siphocampe arachnea* (Ehrenberg) group. *Eucyrtidium lineatum arachneum* Ehrenberg, 1861, p. 299. *Lithomitra arachnea* (Ehrenberg) in Riedel, 1958, p. 242, pl. 4, figs. 7, 8. *Siphocampe arachnea* (Ehrenberg) gr. in Nigrini, 1977, p. 255, pl. 3, figs. 7, 8.
- Siphocampe imbricata* (Ehrenberg). *Eucyrtidium imbricatus* Ehrenberg, 1873, p. 229; 1875, pl. 11, fig. 22. *Siphocampe imbricata* (Ehrenberg) in Nigrini, 1977, p. 255.
- Siphocampe pachyderma* (Ehrenberg) nov. comb. *Eucyrtidium pachyderma* Ehrenberg, 1873, p. 231; 1875, pl. 11, fig. 21. *E. pachyderma* is the type species of the genus *Lithomitra* Bütschli (1882, p. 529) which is considered as a junior synonym of the genus *Siphocampe* (Nigrini, 1977, p. 254).
- Siphocampe*(?) *quadrata* (Petrushevskaya and Kozlova). *Lithamphora sacculifera quadrata* Petrushevskaya and Kozlova, 1972, p. 539, pl. 30, figs. 4-6. *Siphocampe*(?) *quadrata* (Petrushevskaya and Kozlova) in Nigrini, 1977, p. 257, pl. 3, fig. 12.
- Spongodiscus americanus* Kozlova, in Kozlova and Gorbovets, 1966, p. 88, pl. 14, figs. 1, 2.
- Spongodiscus craticulatus* (Stöhr). *Spongotrochus craticulatus* Stöhr, 1880, p. 118, pl. 6, fig. 12. *Spongodiscus craticulatus* (Stöhr) in Petrushevskaya, 1975, p. 574, pl. 5, figs. 9, 10.
- Spongodiscus cruciferus* (Clark and Campbell). *Spongasteriscus cruciferus* Clark and Campbell, 1942, p. 50, pl. 1, figs. 1-6, 8, 10, 11, 16-18. *Spongodiscus cruciferus* (Clark and Campbell) in Sanfilippo and Riedel, 1973, p. 524, pl. 11, figs. 14-17, pl. 28, figs. 10, 11.
- Spongodiscus osculosus* (Dreyer). *Spongopyle osculosa* Dreyer, 1889, p. 42, figs. 99, 100. *Spongodiscus osculosus* (Dreyer) in Petrushevskaya, 1967, p. 42, figs. 20-22.
- Spongodiscus rhabdostylus* (Ehrenberg). *Spongosphaera rhabdostyla* Ehrenberg, 1873, p. 256; 1875, pl. 26, figs. 1-2. *Spongodiscus rhabdostylus* (Ehrenberg) in Sanfilippo and Riedel, 1973, p. 525, pl. 13, figs. 1-3, pl. 30, figs. 1-2.
- Spongodiscus setosus* (Dreyer). *Spongopyle setosa* Dreyer, 1889, p. 43, pl. 6, figs. 97, 98. *Spongodiscus*(?) *setosus* (Dreyer) in Petrushevskaya, 1967, p. 39, fig. 20, III-V.
- Spongomelissa cucumella* Sanfilippo and Riedel, 1973, p. 530, pl. 19, figs. 6, 7, pl. 34, figs. 7-10.
- Spongomelissa dilli* Chen, 1975, p. 458, pl. 13, figs. 6, 7.
- Spongotrochus glacialis* Popofsky, 1908, p. 228, pl. 27, fig. 1, pl. 28, fig. 2.
- Stauraxiphos communis* Carnevale, 1908, p. 15, pl. 2, fig. 9.
- Stichocorys delmontensis* (Campbell and Clark). *Eucyrtidium delmontensis* Campbell and Clark, 1944, p. 56, pl. 7, figs. 19, 20. *Stichocorys delmontensis* (Campbell and Clark) in Sanfilippo and Riedel, 1970, p. 451, pl. 1, fig. 9.
- Stichocorys peregrina* (Riedel). *Eucyrtidium elongatum peregrinum* Riedel, 1953, p. 812, pl. 85, fig. 2. *Stichocorys peregrina* (Riedel) in Sanfilippo and Riedel, 1970, p. 451, pl. 1, fig. 10.
- Stichocorys* sp. aff. *L. radícula* (Ehrenberg). *Lithocampe radícula* Ehrenberg, 1838, p. 130, pl. 4, fig. 11. This species is identical to the specimen described as *L. radícula* by Ehrenberg (1838) from the Miocene of Sicily, but the description of the genus *Lithocampe* is so imprecise that many different forms have been assigned to this genus by Ehrenberg himself (Ehrenberg, 1854a).
- Streblacantha circumtexta* (Jørgensen). *Sorolarcus circumtextus* Jørgensen, 1900, p. 65. *Streblacantha circumtexta* (Jørgensen) in Jørgensen, 1905, p. 121, pl. 11, 12, fig. 46.
- Stylatractus univertus* Hays, 1965, p. 215, pl. 1, figs. 1, 2.
- Stylodictya hastata* Ehrenberg, 1873, p. 257; 1875, pl. 23, fig. 5.
- Stylodictya ocellata* Ehrenberg, 1873, p. 258; 1875, pl. 23, fig. 7.
- Stylodictya targaiformis* (Clark and Campbell). *Staurodictya targaiformis* Clark and Campbell, 1942, p. 43, pl. 3, fig. 6. *Stylodictya targaiformis* (Clark and Campbell) in Petrushevskaya and Kozlova, 1972, p. 526, pl. 18, fig. 10.
- Stylosphaera angelina* Campbell and Clark, 1944, p. 12, pl. 1, figs. 15, 20.
- Stylosphaera coronata* Ehrenberg, 1873, p. 258; 1875, pl. 25, fig. 4.
- Stylosphaera hispida* Ehrenberg, 1854b, p. 246; 1854a, pl. 36, fig. 26, C right.
- Stylosphaera minor* Clark and Campbell, 1942, p. 27, pl. 5, figs. 1, 2.
- Stylosphaera radiosa* Ehrenberg, 1854b, p. 246; 1875, pl. 24, fig. 5.
- Stylosphaera spinulosa* Ehrenberg, 1873, p. 259; 1875, pl. 25, fig. 8.
- Stylotrochus nitidus* Sanfilippo and Riedel, 1973, p. 525, pl. 13, figs. 9-14, pl. 30, figs. 7-10.
- Theocorys redondoensis* (Campbell and Clark). *Theocorys redondoensis* Campbell and Clark, 1944, p. 49, pl. 7, fig. 4. *Theocorys redondoensis* (Campbell and Clark) in Kling, 1973, p. 638, fig. 26-28.
- Theocorys diabloensis* Clark and Campbell, 1942, p. 90, pl. 8, fig. 13.
- Theocorys robusta* (Clark and Campbell) nov. comb. *Calocyclus semipolita robusta* Clark and Campbell, 1942, p. 84, pl. 8, fig. 21. *Theocorys robusta* (Clark and Campbell) in Petrushevskaya, 1975, p. 580, pl. 8, fig. 9, pl. 22, fig. 1. This species is temporarily placed in the genus *Theocorys* because it is obviously a descendant of *T. diabloensis*.
- Thyrsoyrtis bromia* Ehrenberg, 1873, p. 260; 1875, pl. 12, fig. 2.
- Thyrsoyrtis clausa* Chen, 1975, p. 463, pl. 14, figs. 1, 2.
- Triceraspyris antarctica* (Haecker). *Phormospyris antarctica* Haecker, 1907, p. 124, fig. 9. *Triceraspyris antarctica* (Haecker) in Haecker, 1908, p. 445, pl. 84, fig. 586.
- Triceraspyris coronata* Weaver, 1976, p. 580, pl. 2, figs. 4-5, pl. 6, figs. 8, 9.
- Tripilidium clavipes* Clark and Campbell, 1942, p. 64, pl. 9, fig. 29; Clark and Campbell, 1945, p. 34, pl. 7, fig. 30.

SUMMARY

This study represents the first detailed analysis of late Eocene/Oligocene fauna from the subantarctic area. Paleogene assemblages from the Kerguelen Plateau are unique in many ways: they illustrate the transition between tropical or temperate fauna toward endemic Antarctic assemblages, they contain many new morphotypes with very short stratigraphic ranges, and transitional forms are abundant and evolve rapidly.

Most of the data are related to the Oligocene, but the evolution of Antarctic assemblages starts in the early Eocene and is not achieved before the early Miocene.

Additional studies are now needed to describe more accurately the early to middle Eocene faunas and to characterize more precisely the evolutionary lineages at the beginning of the Neogene.

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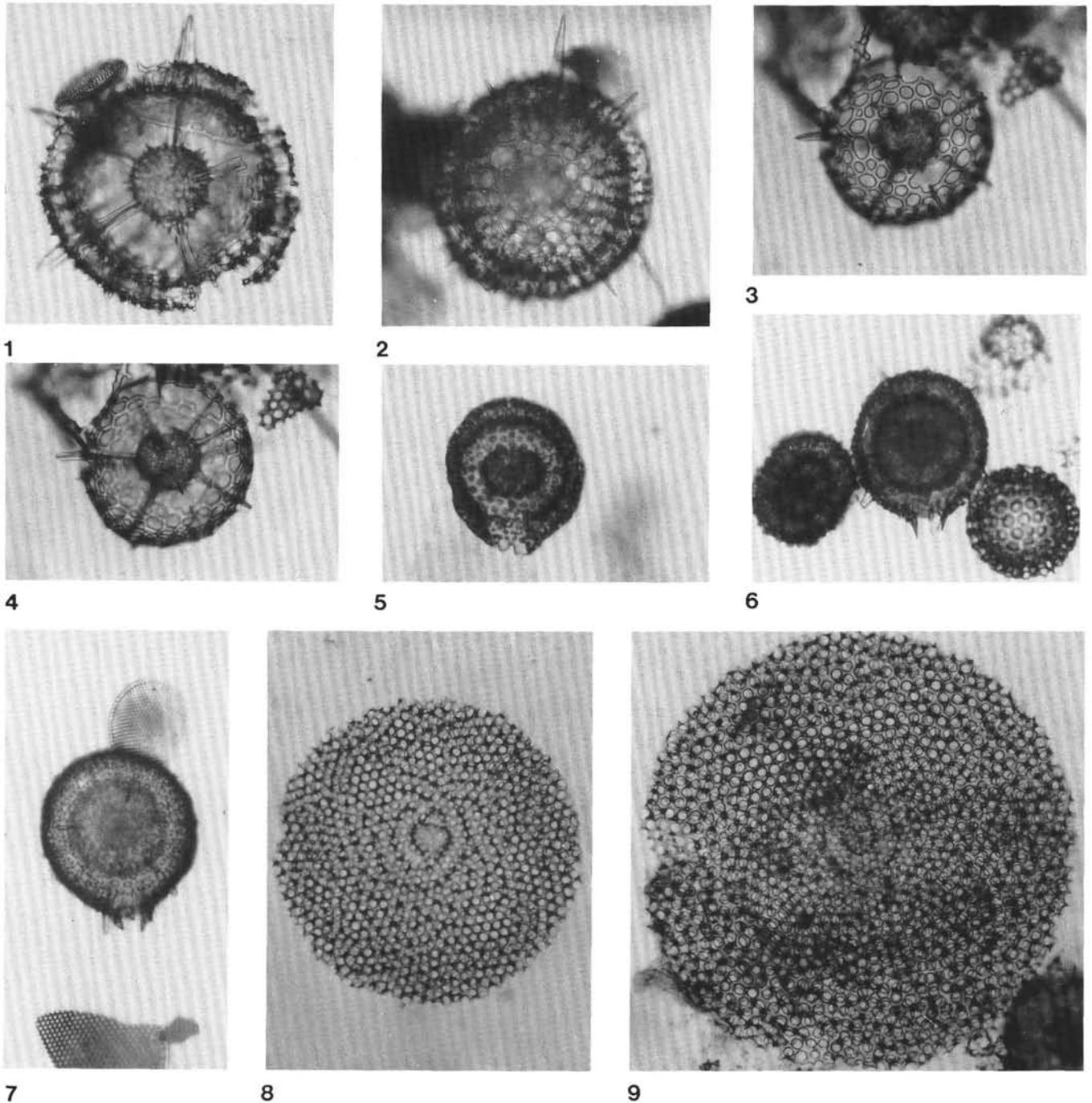


Plate 1. 1-2. *Actinomma kerguelensis* n. sp., (1) holotype (MNHN no. F61368), Sample 119-744A-15H-1, 53-55 cm, 3-Z50/4, $\times 140$; (2) paratype (MNHN no. F61369), Sample MD 83481, 3.40 m, 1-V27/3, $\times 130$. 3-4. *Actinomma campilacantha* n. sp., holotype (MNHN no. F61371), Sample 119-744A-14H-3, 53-55 cm, 5-C32, $\times 270$. 5-7. *Prunopyle trypopyrena* n. sp., (5) Sample 119-744A-10-5, 55-57 cm, early Miocene, $\times 210$; (6) holotype (MNHN no. F61374), Sample DSDP 29-278-32-4, 103-107 cm, Oligocene, $\times 185$; (7) paratype (MNHN no. F61375), Sample 119-744A-14H-1, 53-55 cm (early late Oligocene), $\times 185$. 8-9. *Stylodictya tainemplekta* n. sp., (8) holotype (MNHN no. F61377), Sample 119-738B-18X-2, 52-55 cm, 1-G50/2, $\times 190$; (9) paratype (MNHN no. F61378), Sample 119-738B-17X-1, 52-54 cm, 1-S30/1, $\times 190$.

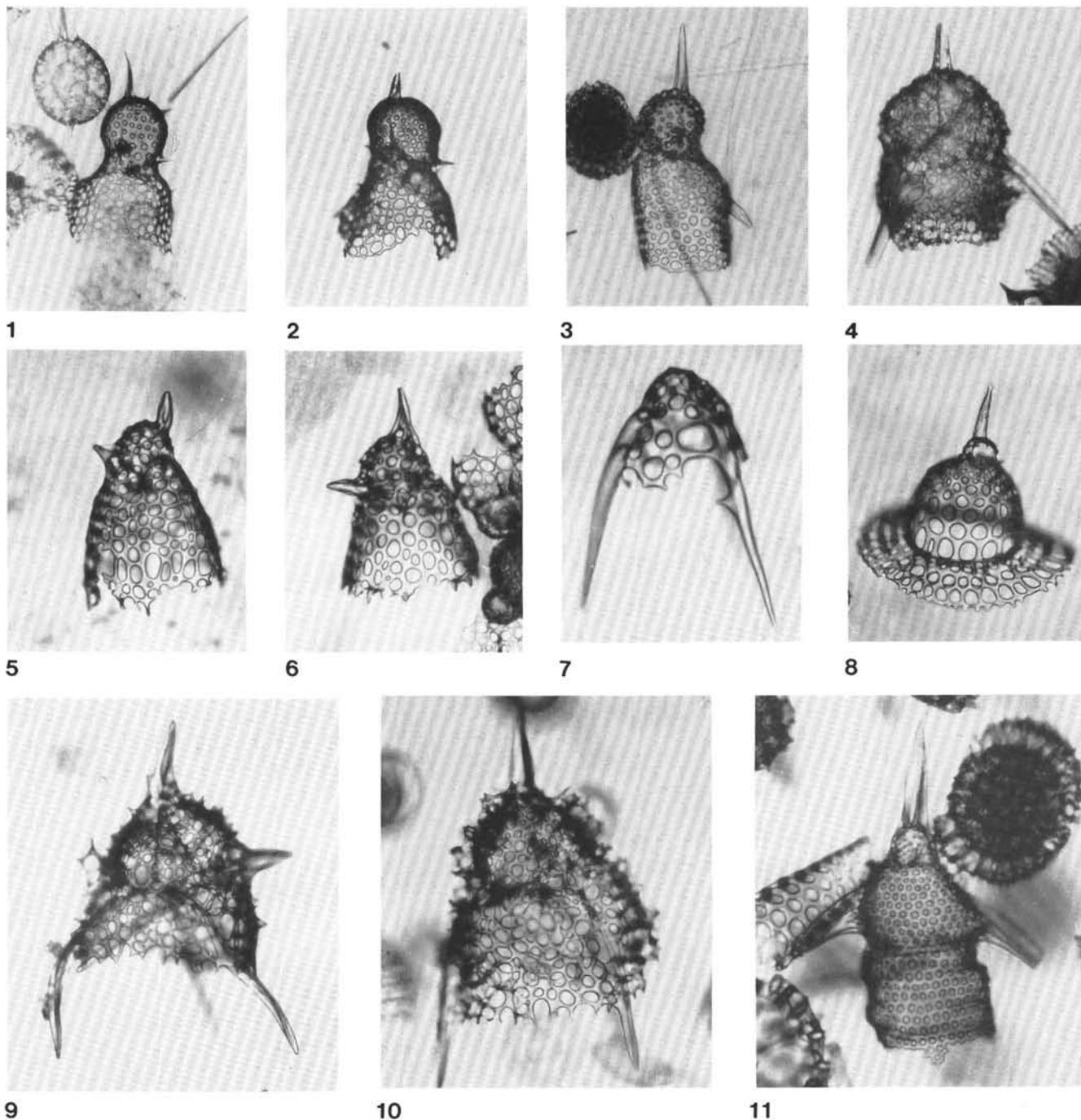


Plate 2. 1-2. *Lithomelissa cheni* n. sp., (1) holotype (MNHN no. F61380), Sample DSDP 90-594-52-2, 84-86 cm, 1-R42/3, $\times 190$; (2) paratype (MNHN no. F61381), Sample DSDP 90-594-52-2, 84-86 cm, 2-B50/3, $\times 190$. 3. *Lithomelissa ehrenbergi* Bütschli, Sample DSDP 29-278-32-4, 103-107 cm, 1-M42, $\times 190$; 4. *Lithomelissa dupliphysa* n. sp., holotype (MNHN no. F61382), Sample 119-744A-15H-3, 53-55 cm, 3-B49/3, $\times 190$. 5-6. *Lophophaena(?) thaumasia* n. sp., (5) holotype (MNHN no. F61384), Sample 119-744A-12H-3, 53-55 cm, 1-Z26, $\times 215$; (6) paratype (MNHN no. F61385), same sample, 1-T41/3, $\times 215$. 7. *Archipilium* sp. Sample 119-738B-4H-3, 53-55 cm, 2-Z26/1 (early Oligocene), $\times 250$. 8. *Clathrocyclas aurelia* Clark and Campbell, Sample MD 83513, 0.25 cm, 5-V45/3 (middle Eocene), $\times 185$. 9-10. *Pseudodictyophimus galeatus* n. sp., (9) holotype (MNHN no. F61387), Sample MD 81310, 0.43 cm, 3-C29 (late Eocene), $\times 190$; (10) paratype (MNHN no. F61388), Sample 119-744A-15H-5, 53-55 cm, 5-X49/1 $\times 190$. 11. *Pteropilium contiguum* (Ehrenberg), Sample 119-744A-16H-4, 53-55 cm, 1-L31/3, $\times 230$.

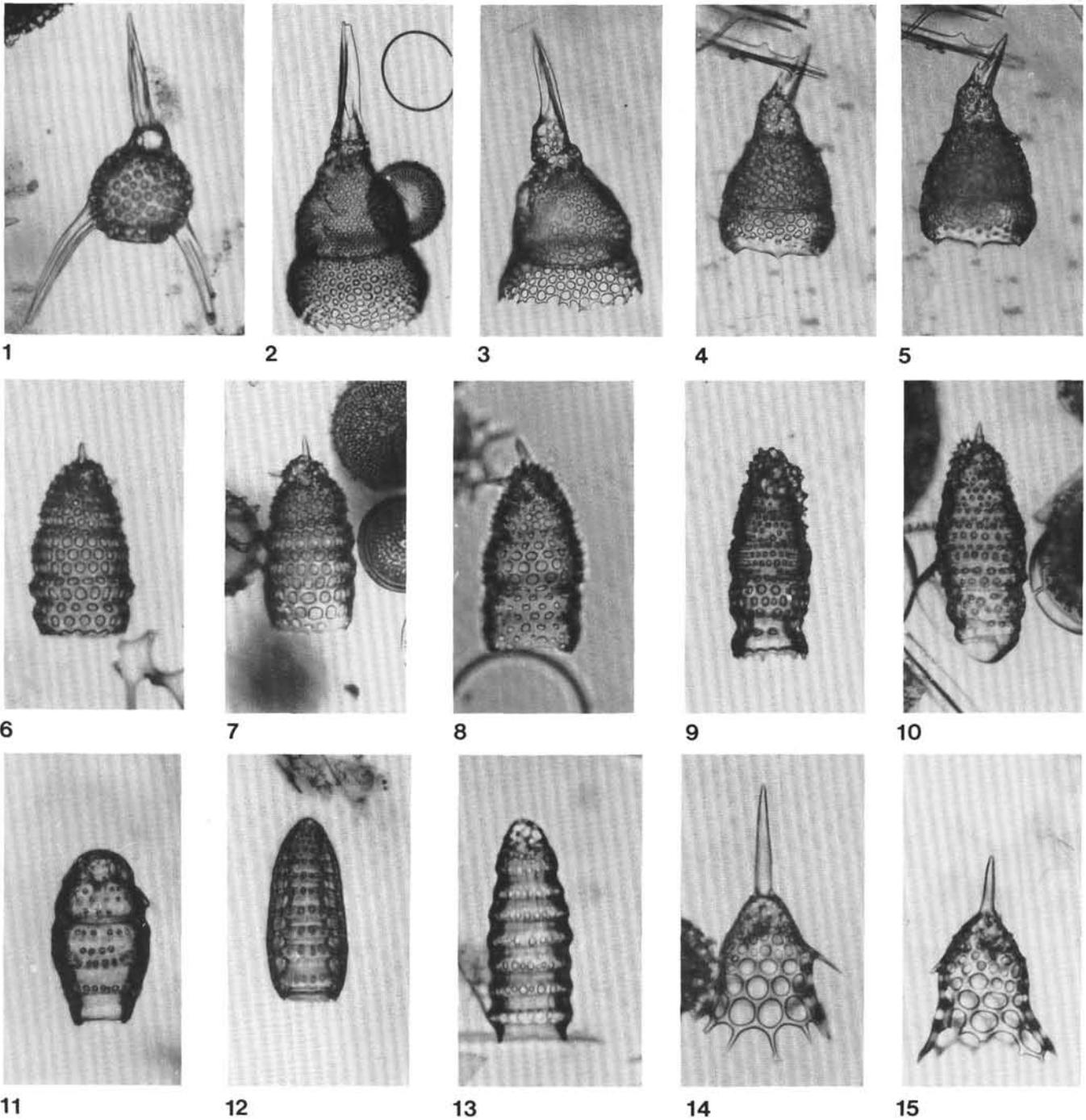


Plate 3. 1. *Lychnocanoma* sp. Sample MD 83487, CC, (middle Eocene), 4-Z41, $\times 100$. 2-3. *Lamprocyclas inexpectata* n. sp., (2) holotype (MNHN no. F61389), Sample 119-744A-15H-3, 53-55 cm, 3-P50/1, $\times 100$; (3) paratype (MNHN no. F61390), Sample 119-744A-15H-1, 53-55 cm, 3-H34/1, $\times 100$. 4-5. *Lamprocyclas prionotocodon* n. sp., holotype (MNHN no. F61391), Sample 119-744A-12H-3, 53-55 cm, 1-Z21, $\times 200$. 6-8. *Botryostrobos kerguelensis* n. sp., (6) holotype (MNHN no. F61393), Sample 117-744A-10H-5, 53-55 cm, 1-V49/4, $\times 295$; (7) paratype (MNHN no. F61394), Sample 119-744A-16H-4, 53-55 cm, 1-N45/4, $\times 285$; (8) paratype (MNHN no. F61395), Sample DSDP 29-278-11-4, 82-86 cm, 3-O33, $\times 285$. 9-10. *Botryostrobos rednosus* n. sp., (9) holotype (MNHN no. F61396), Sample 119-744A-15H-1, 53-55 cm, 3-Q36, $\times 236$; (10) paratype (MNHN no. F61397), Sample 119-744A-16H-2, 53-55 cm, 1-U39/1, $\times 236$. 11. *Dictyoprora physothorax* n. sp., holotype (MNHN no. F61398), Sample 119-744A-15H-3, 53-55 cm, 3-T47, $\times 280$. 12. *Siphocampe pachyderma* (Ehrenberg), Sample MD 83513, 0.25, 2-C37/4 (middle Eocene), $\times 220$. 13. *Siphocampe imbricata* (Ehrenberg), Sample DSDP 29-278-33-1, 97-101 cm, 3-M25/4 (Oligocene), $\times 233$. 14-15. *Eurystomoskevos petrushevskae* gen. n., n. sp., (14) holotype (MNHN no. F61404), Sample 119-744A-15H-3, 53-55 cm, 5-N28/4, $\times 268$; (15) paratype (MNHN no. F61505), Sample 119-744A-14H-3, 53-55 cm, 1-Y48/1, $\times 268$.

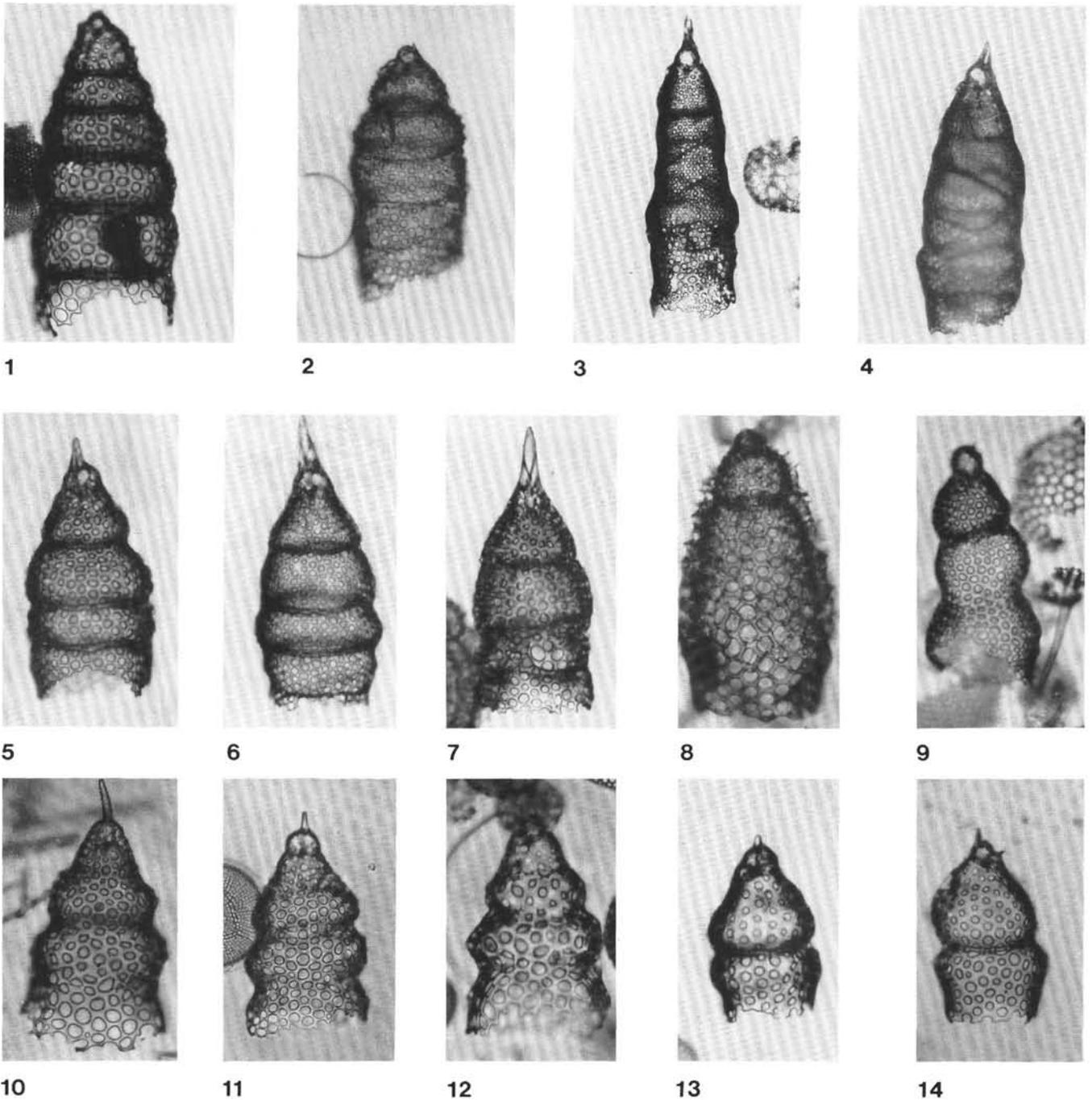


Plate 4. 1-2. *Eucyrtidium antiquum* n. sp., (1) holotype (MNHN no. F61400), Sample DSDP 28-274-35-2, 100-104 cm, 1-M39/4, $\times 140$; (2) paratype (MNHN no. F61401), Sample 119-744A-14H-1, 53-55 cm, 5-N52/1, $\times 140$. 3-4. *Eucyrtidium(?) mariae* n. sp., (3) holotype (MNHN no. F61402), Sample MD 83481, 2.15 m, 2-Y21, $\times 190$; (4) paratype (MNHN no. F61403), Sample MD 83481, 3.25 m, 2-U24/1, $\times 190$. 5-7. *Eucyrtidium(?)* sp. aff. *E. montiparum* Ehrenberg, (5) Sample 119-744A-15H-7, 53-55 cm, 3-K32/3, $\times 230$; (6) Sample 119-738B-5H-2, 53-55 cm, 1-J36, $\times 230$; (7) Sample 119-738B-5H-1, 53-55 cm, 1-R39/4, $\times 230$. 8. *Calocyclus asperum* (Ehrenberg), Sample 119-744A-15H-5, 53-55 cm, 5-C27/3, $\times 250$. 9. *Calocyclus semipolita* Clark and Campbell, Sample MD 83492, 1.5 m (late Eocene), 2-Z20/4, $\times 197$. 10-12. *Cymaetron sinolampas* gen. n., n. sp., (10) paratype (MNHN no. F61407), Sample 119-744A-16H-4, 53-55 cm, $\times 217$; (11) holotype (MNHN no. F61406), Sample 119-744A-16H-2, 53-55 cm, 2-Z34/4, $\times 217$; (12) same sample, 2-V38/3, $\times 217$. 13. *Theocyrtis diabloensis* Clark and Campbell, Sample DSDP 29-278-26-4, 97-101 cm, 3-D48/4, $\times 265$. 14. *Theocyrtis robusta* (Clark and Campbell), Sample DSDP 29-278-25-4, 108-112 cm, 3-Y30/2, $\times 190$.