

8. SPYRIDS, ARTOSTROBIIDS, AND CRETACEOUS RADIOLARIANS FROM THE WESTERN PACIFIC, DEEP SEA DRILLING PROJECT LEG 61¹

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ABSTRACT

Investigations have been carried out on Mesozoic and Cenozoic radiolarians of Site 462. Mesozoic species, when identifiable, were used to determine ages. Cenozoic forms occur abundantly from middle Eocene to Pliocene, and show a moderate to good state of preservation. In these series, sphyrids and artostrobiids are especially considered with a view to their possible pertinence in establishing biostratigraphic successions.

INTRODUCTION

Only one site was drilled during Leg 61 of the Deep Sea Drilling Project; its location is 7°14.25'N, 165°01.83'E, and water depth is 5181 meters.

Radiolarians are present throughout the sediment cores of Hole 462, although their state of preservation is variable, so that they are sometimes useless for biostratigraphic identification. In Cores 1 to 39, the radiolarians are abundant and usually well preserved, and they make up the most abundant biogenic component in Cores 23 to 39. In Cores 41 to 60, the abundances vary considerably, but generally are less than in the cores above; moreover, the state of preservation is poor at best and, in most cases, so poor that only a few general outlines are visible. Commonly the radiolarians are calcified and the test has been filled and/or replaced by calcite and zeolite.

In material from Hole 462A, radiolarians are abundant and well preserved in the Neogene cores (Cores 1 and 2). As in Hole 462, they are absent in the Paleogene (Cores 3 to 6) and rare to common, but always poorly preserved, in the Mesozoic sediments.

Aboard the drilling vessel, samples for radiolarian investigation were taken at roughly fixed intervals in the cores. Because most of the sediments are turbidites, it is apparent that the samples are unequally spaced through time. For this reason, samples are much more numerous in some of the time intervals represented. When possible, samples have been taken preferably in red or brown clays.

All the radiolarian samples were processed, aboard the *Glomar Challenger*, with hydrogen peroxide and Calgon, and with 10% hydrochloric acid when necessary. The residues were sieved on a 63- μ m sieve.

SCOPE OF INVESTIGATION

A survey of the occurrence of Cenozoic forms of known stratigraphic utility is given in another chapter of this volume (see Sanfilippo et al.). The part of the present chapter dealing with Cenozoic radiolarians surveys

the sphyrids and artostrobiids to determine whether some forms not previously used stratigraphically show promise of stratigraphic utility and whether some others are clearly useless.

Mesozoic radiolarians have been investigated for all the samples in which they were identifiable, in order to determine ages.

CENOZOIC RADIOLARIANS

Results

For the Cenozoic sequence of Hole 462, occurrences and abundances of sphyrids and artostrobiids have been tabulated in stratigraphic order, as far as possible (Table 1). Species are numbered consecutively, and these numbers are included in the species list.

In the tabulation, as in the paper by Sanfilippo et al. (this volume), indications of abundance and preservation and five columns for reworking are given. The existence of turbidites limits the usefulness of this arrangement, so in order to have a stratigraphic order of species less influenced by the reworking, two other tables (2 and 3) are presented, taking into account only the samples with less than 1% of the specimens reworked, accordingly to the percentages shown in Table 1.

Letters and symbols in the tables are defined as follows:

Preservation:	G	Good
	M	Moderate
	P	Poor
Abundance:	A	Abundant (more than 500 specimens counted)
	C	Common (51 to 500 specimens counted)
	F	Few (11 to 50 specimens counted)
	R	Rare (4 to 10 specimens counted)
	+	Very rare (less than 4 specimens per slide)
	?	Uncertain identification

From Table 2, it appears that several species are definitely useless for stratigraphic purposes; these in-

¹ Initial Reports of the Deep Sea Drilling Project, Volume 61.

Table 1. Cenozoic radiolarians, Hole 462. (See text for explanation.)

Chronostratigraphy	Sample (interval in cm)	Abundance	Preservation	Percentage of Specimens Reworked					Cretaceous	1. <i>Giraffosyrus angulata</i> 2. <i>Giraffosyrus circumflexa</i> 3. <i>Tholosyrus cortinisca</i> 4. <i>Dendrosyrus bimaperionis</i> 5. <i>Liriosyrus clathrata</i> 6. <i>Giraffosyrus laterispina</i> 7. <i>Liriosyrus muturaria</i> 8. <i>Liriosyrus geniculosa</i> 9. <i>Tholosyrus anthopora</i> 10. <i>Dendrosyrus entocyrtoidea</i> 11. <i>Siphosichoartus corona</i> 12. <i>Botrysostrobilus aquilonaris</i> 13. <i>Botrysostrobilus auritus australis</i> 14. <i>Tholosyrus scaphipes</i> 15. <i>Dendrosyrus damaecornis</i> 16. <i>Dendrosyrus stabilis</i> 17. <i>Dendrosyrus acuta</i> 18. <i>Dorcadopsyrus confluens</i> 19. <i>Dictyoprora urceolus</i> 20. <i>Siphocampe lineata</i> gp 21. <i>Phormostichoartus marylandicus</i> 22. <i>Dorcadopsyrus pennigona</i> 23. <i>Giraffosyrus annulispina</i> 24. <i>Siphocampe arachnea</i> gp 25. <i>Phormostichoartus dollolum</i> 26. <i>Botrysostrobilus bramlettei</i> 27. <i>Liriosyrus elevata</i> 28. <i>Liriosyrus stauropora</i> 29. <i>Tholosyrus mammillaris</i> 30. <i>Siphocampe nodosaria</i>				
				Pliocene	Miocene	Oligocene	Eocene							
				M	M	M	M							
Pleistocene	2,CC	M	1	0	0		F R + + +	R + R R +	+ + R					
Pliocene	3,CC 4,CC	M M		0	0		R C F +	F + R + + R	F + R R +	R + R R C	+ F + + +			
Upper Miocene-Pliocene	5,CC 6-1, 56-58 6-3, 65-67 7-1, 117-119 7-3, 119-121 8-1, 107-109 8-3, 118-120	M M M M M M G	5 5 1 5 1	0 0 1 0 1 0	0 1 1 1 0 0		R R R F + R R C F F F F F F F F F C F C	F F F R F C C C R C C C R C C C R C C C	R R R R + R R R + F R C + C C C	R R R R R R R R R R R R R R R R R R R R	F F F F F F F F F F F F F F F F F F F F	+ R + + R + + R + + R + + R + + R +		
Middle-Upper Miocene	10-2, 67-69 10-5, 50-52 11-1, 147-149 11-2, 77-79 12-1, 39-41 12-5, 23-25	M M M M P P		0 0	0 1		F F F F F C F F + C C F + F C C	F F F F F C C F + C C C C C C C	R R R R C C C C C C C C R C C C	R R R R F R C C F R C C C C C C	R R R R R R C C R R C C R C C C	F F F F F F F F F F F F F F F F	+ R + + R + + R + + R + + R + + R +	
Middle Miocene	13-2, 88-90 13-5, 88-90 14-2, 86-88 14-5, 109-111 15,CC	M M M M M		1 0 1 1 0	1 1 1 1		R + R + R + R + R + R + R + R + R + R +	C C C C R C C C R C C C R C C C R C C C	+ R + + R + + R + + R + + R +	C C C C F F F F F F F F F F F F F F F F	C C C C C C C C C C C C C C C C C C C C	C C C C C C C C C C C C C C C C C C C C	+ R + + R + + R + + R + + R +	
Lower Miocene	16-2, 68-70 17-2, 104-106 17-3, 55-57 18-3, 85-87 18-5, 74-76	P M M P P		1 1 0 1 1	1 1 0 1 1		R R R R R R R R R R R R R R R R R R R R	+ F F F + C C C + F F F + C C C + F F F	+ R R R + R R R + R R R + R R R + R R R	+ R R R + R R R + R R R + R R R + R R R	R R R R R R R R R R R R R R R R R R R R	+ F F F + F F F + F F F + F F F + F F F	+ R R R + R R R + R R R + R R R + R R R	
Upper Oligocene	19-2, 142-144 19-6, 23-25 20-4, 25-27 21-1, 35-37 22-3, 106-108 23-1, 131-133 23-4, 67-69 24-2, 81-83 25-1, 142-144 25-4, 141-143	P M M M M M M M M M	0		20 0 5 10 5 20 20	0	+ R F F R R R R + R R R + R R R + R R R + R R R + R R R	F F	R R	+ C C F + C C F + C C F + C C F + C C F + C C F + C C F + C C F	+ C C F + C C F + C C F + C C F + C C F + C C F + C C F + C C F	C C	C C	+ R R R + R R R + R R R + R R R + R R R + R R R + R R R + R R R
Upper Eocene-Lower Oligocene	26-2, 62-64 26-4, 33-35 27-1, 116-118 27-4, 47-49 28-2, 109-111 28-6, 99-101 29-1, 109-111 29-5, 70-72 30-3, 14-16 32-4, 60-62 31-2, 23-25 33-1, 77-79 33-2, 24-26	P P M M M M M M M M M M			10 1 1 1	10		F R C F + F R C + F R C + F R C + F R C + F R C + F R C + F R C + F R C + F R C + F R C + F R C	F F	+ C C F + C C F + C C F + C C F + C C F + C C F + C C F + C C F + C C F + C C F + C C F	+ C C F + C C F + C C F + C C F + C C F + C C F + C C F + C C F	C C	C C	+ R R R + R R R + R R R + R R R + R R R + R R R + R R R + R R R
Upper Eocene	34,CC 35-1, 15-17 36-1, 77-79 36-2, 103-105 37-2, 42-44 37-5, 65-67	M M M M M M		50 1 1 10 30			+ F R + F R + F R + F R + F R	F F F R F F F R F F F R F F F R F F F R	+ F F + + F F + + F F + + F F + + F F +	+ F F + + F F + + F F + + F F + + F F +	+ F F + + F F + + F F + + F F + + F F +	+ F F + + F F + + F F + + F F + + F F +		
Middle Eocene	38-2, 100-102 38-5, 66-68 39-2, 104-106 39-5, 9-11 41,CC	M M M M		10 20 ?	?		+ F R + F R + F R + F R	C C C C C C C C C C C C C C C C	+ F F + + F F + + F F + + F F +	+ F F + + F F + + F F + + F F +	+ F F + + F F + + F F + + F F +			

Table 1. (Continued).

31. <i>Spirocyrus giroslaris</i>																					
32. <i>Giraffospyris diliceros</i>																					
33. <i>Dendrospyris stylophora</i>																					
34. <i>Dendrospyris pododendros</i>																					
35. <i>Giraffospyris toxaria</i>																					
36. <i>Liriospyris reticulata</i>																					
37. <i>Dictyoprora ovata</i>																					
38. <i>Spirocyrus subsularis</i>																					
39. <i>Tristylospyris triceros</i>																					
40. <i>Tholospyris kantiana</i>																					
41. <i>Siphostichoartus praecorona</i>																					
42. <i>Dorcadospyrus forcipata</i>																					
43. <i>Dorcadospyrus ateuclus</i>																					
44. <i>Dorcadospyrus costatescens</i>																					
45. <i>Dendrospyris fragoides</i>																					
46. <i>Phormostichoartus fistula</i>																					
47. <i>Dorcadospyrus alata</i>																					
48. <i>Tholospyris procera</i>																					
49. <i>Rabdolithis pipa</i>																					
50. <i>Dictyoprora mongoliferi</i>																					
51. <i>Botryostrobilus miralestensis</i>																					
52. <i>Liriospyris parkerae</i>																					
53. <i>Dorcadospyrus dentata</i>																					
54. <i>Rhabdolithis ellida</i>																					
55. <i>Spirocyrus subtilis</i>																					
56. <i>Dictyoprora amphora</i>																					
57. <i>Giraffospyris haeckelii</i>																					
58. <i>Liriospyris spinulosa</i>																					
59. <i>Dendrospyris pannosa</i>																					
60. <i>Dorcadospyrus argisca</i>																					
61. <i>Giraffospyris cyrillium</i>																					
62. <i>Siphocampe acephala</i>																					
63. <i>Dendrospyris turriturica turriturica</i>																					
64. <i>Phormostichoartus corbula</i>																					
65. <i>Dorcadospyrus simplex</i>																					
66. <i>Siphocampe elizabethae</i>																					
67. <i>Dorcadospyrus papilio</i>																					
68. <i>Dorcadospyrus platycantha</i>																					
69. <i>Siphocampe(?) quadrata</i>																					
70. <i>Dorcadospyrus circulus</i>																					
71. <i>Dorcadospyrus pseudopapilio</i>																					
72. <i>Dictyoprora pirum</i>																					
73. <i>Dorcadospyrus praeforcipata</i>																					
74. <i>Dendrospyris inferispina</i>																					
75. <i>Dorcadospyrus quadrupes</i>																					
76. <i>Dictyoprora armadillo</i>																					
77. <i>Giraffospyris lata</i>																					
78. <i>Dictyospiris gigas</i>																					
79. <i>Dorcadospyrus riedeli</i>																					
80. <i>Dendrospyris turriturica dasyotus</i>																					
81. <i>Dictyospiris discus</i>																					

clude *Tholospyris cortinisca*, *Liriospyris mutuaria*, *Tholospyris anthopora*, *Dendrospyris damaecornis*, *Dorcadospyris confluens*, *Dictyoprora urceolus*, *Siphostichoartus lineata* group, *Dorcadospyris pentagona*, and, to a lesser extent, *Phormostichoartus marylandicus*.

Some other species, having short ranges and distinct upper and lower limits, seem to be promising. These are, for example, *Liriospyris parkerae* (middle Miocene), *L. stauropora* (middle Miocene to upper part of lower Miocene), *Siphostichoartus praecorona* (Oligocene to lower Miocene), *Siphostichoartus elizabethae* (upper Eocene to Oligocene), and *Dictyoprora armadillo* (Eocene). Even if one section is not sufficiently significant, we may note that first occurrences of some species correspond to last occurrences of others: *Dictyoprora ovata* and *Dorcadospyris simplex* disappear (Sample 462-14-5, 109–111 cm with the first occurrence of *L. parkerae*, and the same pertains to *Dendrospyris inferispina*, *Dictyoprora gigas*, *Dorcadospyris riedeli*, and *Dorcadospyris praeforcipata* (Sample 462-29-1, 109–111 cm).

In order to avoid a long discussion—which might be confusing and which could be taken more seriously than I would like, because of the limited number of samples taken in account—Tables 2 and 3 present the different species arranged in stratigraphic order corresponding to the tops (last occurrences, Table 2) and bottoms (first occurrences, Table 3). Tables 2 and 3 permit easy comparison of the tops and bottoms for different species.

Comparisons with Previous Work

Only a few authors have previously made detailed surveys of sphyrids and artostrobiids. The most detailed work on sphyrids is that by Goll (1968, 1969, 1972), and Nigrini (1977) has recently reviewed tropical artostrobiids, so it may be interesting to see how our results fit with theirs.

The ranges of artostrobiids surveyed here correlate well with those established by Nigrini (1977, p. 247). Several remarks, however, seem worthwhile: (1) *Siphostichoartus praecorona* seems to have a longer range at Hole 462, occurring in some sediments older than those in which it was found by Nigrini (1977). The same is true of *Botryostrobus auritus-australis*, which occurs rarely from upper Oligocene to Pliocene. (2) *Siphocampe acephala*, *S. elizabethae*, *Dictyoprora ovata*, *D. amphora*, and *D. mongolfieri* have a few occurrences younger than those given by Nigrini (1977), but they may result from reworking. (3) Reworking could be the reason also for the range of *Dictyoprora urceolus*, but this is not likely, because the occurrences of this form are very frequent.

Comparing the results presented here with Goll's results, the following remarks are pertinent:

1) For my results to be comparable with Goll's, it is necessary to add the ranges of species from his 1968–1969 papers with those of 1972; taken singly, his ranges seem too restricted.

2) Leaving aside the younger occurrences of several species here, to avoid setting up differences where perhaps they are only a consequence of reworking, sev-

eral differences between my ranges and Goll's are apparent. The main differences are as follows: (A) *Giraffospyris angulata* occurs in Hole 462 from lower Miocene to Pleistocene (upper Miocene–Pliocene, according to Goll). (B) *Liriospyris mutuaria* occurs from upper Eocene to Pleistocene (lower Miocene to Pliocene, according to Goll). (C) *Tholospyris cortinisca* occurs from upper Eocene to Pleistocene (middle Miocene to Pliocene, according to Goll). (D) *T. scaphipes* occurs from upper Oligocene to Pliocene (middle Miocene to Pliocene, according to Goll). (E) *T. mammillaris* occurs from upper Eocene–lower Oligocene to upper Miocene–Pliocene (upper Oligocene to Pliocene, according to Goll). (F) *Giraffospyris circumflexa* occurs from upper Oligocene to Pleistocene (middle Miocene to Pliocene, according to Goll).

LIST OF CENOZOIC SPECIES

The purpose of this listing is to provide bibliographic references to the taxa mentioned in this report and in its accompanying tables. When the published literature contains several different concepts of the limits of a species, the reference cited conforms to the concept as applied here. For each species, this list gives at least one recent reference containing appropriate species descriptions and illustrations, thereby enabling the reader to determine the criteria which have been applied in identifying the taxa in this report.

- Botryostrobus aquilonaris* (Bailey). Nigrini, 1977, p. 246, pl. 1, fig. 1. Table 1, number 12; Tables 2, 3, number 1'.
- Botryostrobus auritus-australis* (Ehrenberg) group. Nigrini, 1977, p. 246, pl. 1, figs. 2–5. Table 1, number 13; Tables 2, 3, number 5'.
- Botryostrobus bramlettei* (Campbell and Clark). Nigrini, 1977, p. 248, pl. 1, figs. 7, 8. Table 1, number 26; Tables 2, 3, number 24'.
- Botryostrobus miralestensis* (Campbell and Clark). Nigrini, 1977, p. 249, pl. 1, fig. 9. Table 1, number 51; Tables 2, 3, number 39'.
- Ceratospyrus articulata* Ehrenberg, 1873, p. 218. Sanfilippo and Riedel, 1973, p. 526, pl. 15, figs. 1–3; pl. 31, figs. 8, 9.
- Dendrospyris acuta* Goll. Sanfilippo and Riedel, 1973, p. 526, pl. 15, fig. 5; pl. 31, fig. 11. (This chapter: Pl. 2, Fig. 9.) Table 1, number 17; Tables 2, 3, number 13'.
- Dendrospyris anthocyrtoides* (Butschli). Riedel and Sanfilippo, 1971, p. 1590, pl. 5, figs. 5–7. Table 1, number 10; Tables 2, 3, number 6'.
- Dendrospyris binapertensis* Goll, 1968, p. 1420, pl. 173, figs. 5, 6, 10, 11; text-fig. 8. (This chapter: Pl. 3, Fig. 4.) Table 1, number 4; Tables 2, 3, number 10'.
- Dendrospyris damaecornis* (Haeckel). Goll, 1968, p. 1420, pl. 173, figs. 1–4; text-fig. 8. (This chapter: Pl. 3, Fig. 3.) Table 1, number 15; Tables 2, 3, number 16'.
- Dendrospyris fragoides* Sanfilippo and Riedel, 1973, pl. 526, pl. 15, figs. 8–13; pl. 31, figs. 13, 14. Table 1, number 45; Tables 2, 3, number 32'.
- Dendrospyris inferispina* Goll, 1968, p. 1421, pl. 174, figs. 5–8, 10; text-fig. 8. Table 1, number 74; Tables 2, 3, number 70'.
- Dendrospyris pannosa* Goll, 1968, p. 1421, pl. 173, figs. 13, 15, 19; text-fig. 8. Table 1, number 59; Tables 2, 3, number 54'.
- Dendrospyris pododendros* (Carnevale). Goll, 1968, p. 1422, pl. 174, figs. 1–4; text-fig. 8. Table 1, number 34; Tables 2, 3, number 60'.
- Dendrospyris stabilis* Goll, 1968, p. 1422, pl. 173, figs. 16–18, 20; text-fig. 8. (This chapter: Pl. 2, Fig. 4.) Table 1, number 16; Tables 2, 3, number 15'.
- Dendrospyris stylophora* (Ehrenberg). Goll, 1968, p. 1423, pl. 173, figs. 21–24; text-fig. 8. Table 1, number 33.
- Dendrospyris turrurcica-dasyotus* Sanfilippo and Riedel, 1973, p. 527, pl. 16, fig. 3; pl. 32, fig. 3. Table 1, number 80; Tables 2, 3, number 69'.
- Dendrospyris turrurcica-turrurcica* Sanfilippo and Riedel, 1973, p. 527, pl. 16, fig. 1; pl. 31, fig. 15; pl. 32, fig. 1. Table 1, number 63; Tables 2, 3, number 56'.
- Dictyoprora amphora* (Haeckel) group. Nigrini, 1977, p. 250, pl. 4, figs. 1, 2. (This chapter: Pl. 4, Fig. 6.) Table 1, number 56; Tables 2, 3, number 46'.

- Dictyoprora armadillo* (Ehrenberg). Nigrini, 1977, p. 250, pl. 4, fig. 4. (This chapter: Pl. 4, Fig. 5.) Table 1, number 76; Tables 2, 3, number 74'.
- Dictyoprora mongolfieri* (Ehrenberg). Nigrini, 1977, p. 250, pl. 4, fig. 7. (This chapter: Pl. 4, Figs. 8–10.) Table 1, number 50; Tables 2, 3, number 38'.
- Dictyoprora ovata* (Haeckel). Nigrini, 1977, p. 251, pl. 4, figs. 5, 6. Table 1, number 37; Tables 2, 3, number 58'.
- Dictyoprora pirum* (Ehrenberg). Nigrini, 1977, p. 251, pl. 4, fig. 8. (This chapter: Pl. 4, Fig. 7.) Table 1, number 72; Tables 2, 3, number 66'.
- Dictyoprora urceolus* (Haeckel). Nigrini, 1977, p. 251, pl. 4, figs. 9, 10. (This chapter: Pl. 4, Fig. 14.) Table 1, number 19; Tables 1, 2, number 18'.
- Dictyospyris discus* Sanfilippo and Riedel, 1973, p. 527, pl. 16, figs. 4–8; pl. 32, figs. 4–7. Table 1, number 81; Tables 2, 3, number 76'.
- Dictyospyris gigas* Ehrenberg. Sanfilippo and Riedel, 1973, p. 527, pl. 16, figs. 9, 10; pl. 32, figs. 10, 11. Table 1, number 78; Tables 2, 3, number 72'.
- Dorcadospyrus alata* (Riedel), Riedel and Sanfilippo, 1970, p. 523, pl. 14, fig. 5; 1971, pl. 2D, fig. 1; Moore, 1971, pl. 11, figs. 3, 4. Table 1, number 47.
- Dorcadospyrus argisca* (Ehrenberg). Goll, 1969, pl. 56, figs. 9–11; text-fig. (This chapter: Pl. 2, Fig. 12.) Table 1, number 60; Tables 2, 3, number 51'.
- Dorcadospyrus atechus* (Ehrenberg). Riedel and Sanfilippo, 1970, p. 523, pl. 15, fig. 4; 1971, p. 1590, pl. 2D, fig. 6; pl. 3A, figs. 9, 10. Table 1, number 43; Tables 2, 3, number 30'.
- Dorcadospyrus(?) or Petalospyrus(?) atechus* (Ehrenberg), Petrushevskaya and Kozlova, 1972, p. 532 (in Nigrini, 1977).
- Dorcadospyrus circulus* (Haeckel). Moore, 1971, p. 739, pl. 8, figs. 3–5. (This chapter: Pl. 3, Fig. 9.) Table 1, number 70.
- Dorcadospyrus confluens* (Ehrenberg). Goll, 1969, p. 337, pl. 58, figs. 9–12; Sanfilippo and Riedel, 1973, p. 528, pl. 17, figs. 6–10; pl. 33, fig. 1. (This chapter: Pl. 2, Fig. 8.) Table 1, number 18; Tables 2, 3, number 20'.
- Dorcadospyrus costatascens* Goll, 1969, p. 337, pl. 57, figs. 1–4; text-fig. 2. Table 1, number 44; Tables 2, 3, number 31'.
- Dorcadospyrus dentata* Haeckel, 1887, p. 1040, pl. 85, fig. 6. Riedel, 1957, p. 79, pl. 1, fig. 4. (This chapter: Pl. 3, Fig. 7.) Table 1, number 53; Tables 2, 3, number 41'.
- Dorcadospyrus forcipata* (Haeckel). Riedel and Sanfilippo, 1970, p. 523, pl. 15, fig. 7; Moore, 1971, p. 740, pl. 10. (This chapter: Pl. 3, Fig. 8.) Table 1, number 42; Tables 2, 3, number 29'.
- Dorcadospyrus papilio* (Riedel). Riedel and Sanfilippo, 1970, p. 523, pl. 15, fig. 5; Moore, 1971, p. 739, pl. 8, figs. 6, 7. Table 1, number 67; Tables 2, 3, number 62'.
- Dorcadospyrus pentagona* (Ehrenberg). Goll, 1969, p. 338, pl. 59, figs. 8, 10, 12; text-fig. 2. (This chapter: Pl. 1, Fig. 9.) Table 1, number 22; Tables 2, 3, number 21'.
- Dorcadospyrus platyacantha* (Ehrenberg). Sanfilippo and Riedel, 1973, p. 528, pl. 17, figs. 11–15; pl. 33, fig. 2. Table 1, number 68; Tables 2, 3, number 67'.
- Dorcadospyrus praeforcipata* Moore, 1971, p. 738, pl. 9, figs. 4–7. Table 1, number 73; Tables 2, 3, number 65'.
- Dorcadospyrus pseudopapilio* Moore, 1971, p. 738, pl. 6, figs. 7, 8. (This chapter: Pl. 3, Fig. 6.) Table 1, number 71; Tables 2, 3, number 64'.
- Dorcadospyrus quadripes* Moore, 1971, p. 738, pl. 7, figs. 3–5. Table 1, number 75; Tables 2, 3, number 63'.
- Dorcadospyrus riedeli* Moore, 1971, p. 739, pl. 9, figs. 1–3. Table 1, number 79; Tables 2, 3, number 73'.
- Dorcadospyrus simplex* (Riedel). Riedel and Sanfilippo, 1970, pl. 15. (This chapter: Pl. 3, Fig. 5.) Table 1, number 65; Tables 2, 3, number 59'.
- Dorcadospyrus spinosa* Moore, 1971, p. 739, pl. 7, figs. 1, 2. (This chapter: Pl. 3, Fig. 10.)
- Giraffospyris angulata* (Haeckel). Goll, 1969, p. 331, pl. 59, figs. 4, 6, 7, 9; text-fig. 2. Table 1, number 1; Tables 2, 3, number 3'.
- Giraffospyris annulispina* Goll, 1969, p. 331, pl. 57, figs. 11, 12, 15, 17; text-fig. 2. Table 1, number 23; Tables 2, 3, number 22'.
- Giraffospyris circumflexa* Goll, 1969, p. 332, pl. 60, figs. 1–4; text-fig. 2. (This chapter: Pl. 1, Figs. 1, 2.) Tables 2, 3, number 4'.
- Giraffospyris cyrillium* Sanfilippo and Riedel, 1973, p. 528, pl. 18, figs. 1–3; pl. 33, fig. 3. (This chapter: Pl. 2, Fig. 7.) Table 1, number 61; Tables 2, 3, number 52'.
- Giraffospyris didiceros* (Ehrenberg). Goll, 1969, p. 332, pl. 60, figs. 5–7, 9; text-fig. 2. (This chapter: Pl. 2, Fig. 13.) Table 1, number 32; Tables 2, 3, number 36'.
- Giraffospyris haeckelii* (Bütschli). Goll, 1969, p. 334, pl. 57, figs. 5–8; text-fig. 2. Table 1, number 57; Tables 2, 3, number 48'.
- Giraffospyris lata* Goll, 1969, p. 334, pl. 58, figs. 22, 24–26; text-fig. 2; Sanfilippo and Riedel, 1973, p. 529, pl. 18, figs. 3–7; pl. 33, fig. 4. (This chapter: Pl. 2, Fig. 5.) Table 1, number 77; Tables 2, 3, number 71'.
- Giraffospyris laterispina* Goll, 1969, p. 334, pl. 58, figs. 15, 16, 20, 21; text-fig. 2. Table 1, number 6; Tables 2, 3, number 12'.
- Giraffospyris toxaria* (Haeckel). Goll, 1969, p. 334, pl. 56, fig. 1, 2, 4, 7; text-fig. 2. Table 1, number 35.
- Liriospyris clathrata* (Ehrenberg). Goll, 1968, p. 1426, pl. 175, Figs. 12, 13, 16, 17; text-fig. 9. (This chapter: Pl. 1, Fig. 8.) Table 1, number 5; Tables 2, 3, number 11'.
- Liriospyris elevata* Goll, 1968, p. 1426, pl. 175, figs. 4, 5, 8, 9; text-fig. 9. Table 1, number 27; Tables 2, 3, number 34'.
- Liriospyris geniculosa* Goll, 1968, p. 1427, pl. 175, figs. 21–24; text-fig. 9. (This chapter: Pl. 1, Fig. 6.) Table 1, number 8.
- Liriospyris mutuarua* Goll, 1968, p. 1428, pl. 175, figs. 6, 10, 11, 14; text-fig. 9. (This chapter: Pl. 2, Fig. 1.) Table 1, number 7; Tables 2, 3, number 7'.
- Liriospyris ovalis* Goll, 1968, p. 1429, pl. 176, figs. 4, 6, 7; text-fig. 9. (This chapter: Pl. 2, Fig. 3.)
- Liriospyris parkerae* Riedel and Sanfilippo, 1971, p. 1590, pl. 2C, fig. 15; pl. 5, fig. 4. (This chapter: Pl. 1, Fig. 11.) Table 1, number 52; Tables 2, 3, number 40'.
- Liriospyris reticulata* (Ehrenberg). Goll, 1968, p. 1429, pl. 176, figs. 9, 11, 13; text-fig. 9. Table 1, number 36; Tables 2, 3, number 26'.
- Liriospyris spinulosa* (Ehrenberg). Goll, 1968, p. 1430, pl. 176, figs. 15, 18–20; text-fig. 9. (This chapter: Pl. 1, Fig. 4.) Table 1, number 58; Tables 2, 3, number 68'.
- Liriospyris stauropora* (Haeckel). Goll, 1968, p. 1431, pl. 175, figs. 1–3, 7; text-fig. 9. (This chapter: Pl. 1, Figs. 12, 13.) Table 1, number 28; Tables 2, 3, number 27'.
- Petalospyrus tricerus* (Ehrenberg) group. Petrushevskaya and Kozlova, 1972, p. 532, pl. 40, fig. 9; Nigrini, 1974, p. 1066, pl. 2B, figs. 5, 6. Table 1, number 39; Tables 2, 3, number 50'.
- Phormostichoartus corbula* (Harting). Nigrini, 1977, p. 252, pl. 1, fig. 10. Table 1, number 64; Tables 2, 3, number 57'.
- Phormostichoartus doliolum* (Riedel and Sanfilippo). Nigrini, 1977, p. 252, pl. 1, fig. 14. Table 1, number 25; Tables 2, 3, number 23'.
- Phormostichoartus fistula* Nigrini, 1977, p. 253, pl. 1, figs. 11–13. Table 1, number 46; Tables 2, 3, number 33'.
- Phormostichoartus marylandicus* (Martin). Nigrini, 1977, p. 253, pl. 2, figs. 1–3. (This chapter: Pl. 4, Fig. 15.) Table 1, number 21; Tables 2, 3, number 17'.
- Rhabdolithis ellida* Sanfilippo and Riedel, 1973, p. 529, pl. 18, figs. 8–11; pl. 33, figs. 5–8. Table 1, number 54; Tables 2, 3, number 42'.
- Rhabdolithis pipa* Ehrenberg, 1854, pl. 36, fig. 59; 1875, p. 159, pl. 1, fig. 27. Sanfilippo and Riedel, 1973, p. 529, pl. 18, figs. 12–16; pl. 33, figs. 9, 10. Table 1, number 49; Tables 2, 3, number 45'.
- Siphocampe acephala* (Ehrenberg). Nigrini, 1977, p. 254, pl. 3, fig. 5. (This chapter: Pl. 4, Fig. 12.) Table 1, number 62; Tables 2, 3, number 55'.
- Siphocampe arachnea* (Ehrenberg) group. Nigrini, 1977, p. 255, pl. 3, figs. 7, 8. Table 1, number 24; tables 2, 3, number 25'.
- Siphocampe elizabethae* (Clark and Campbell). Nigrini, 1977, p. 256, pl. 3, fig. 6. (This chapter: Pl. 4, Fig. 11.) Table 1, number 66; Tables 2, 3, number 61'.
- Siphocampe lineata* (Ehrenberg) group. Nigrini, 1977, p. 256, pl. 3, figs. 9, 10. (This chapter: Pl. 4, Fig. 13.) Table 1, number 20; Tables 2, 3, number 19'.
- Siphocampe nodosaria* (Haeckel). Nigrini, 1977, p. 256, pl. 3, fig. 11. Table 1, number 30; Tables 2, 3, number 47'.

Table 2. Cenozoic radiolarians, Hole 462, in samples with less than 1% reworked specimens. (See text for explanation.)

Chronostratigraphy	Sample (interval in cm)	Abundance	Preservation	Percentage of Specimens Reworked	Taxa																																		
					Pliocene	Miocene	Oligocene	Eocene	Cretaceous	Taxa																													
										1'	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	16'	17'	18'	19'	20'	21'	22'	23'	24'	25'	26'	27'	28'	29'	30'
Pleistocene	2, CC	M		1 0 0																																			
Pliocene	3, CC 4, CC	M M		0 0 0 0																																			
Upper Miocene-Pliocene	7-1, 117-119 8-1, 107-109 8-3, 118-120	M M G		1 1 1 1 0 1 0 0																																			
Middle-Upper Miocene	10-2, 67-69 10-5, 50-52 11-1, 147-149 11-2, 77-79 12-1, 39-41	M M M M P		0 0 0 1																																			
Middle Miocene	13-5, 88-90 14-2, 86-88 14-5, 109-111 15, CC	M M M M		0 1 1 1 1 0 1																																			
Lower Miocene	16-2, 68-70 17-2, 104-106 17-3, 55-57 18-3, 85-87 18-5, 74-76	P M M P P		1 1 1 0 1 1 1																																			
Upper Oligocene	19-6, 23-25 24-2, 81-83 25-1, 142-144 25-4, 141-143	M M M M		0 1																																			
Upper Eocene-Lower Oligocene	26-4, 33-35 27-1, 116-118 28-2, 109-111 28-6, 99-101 29-1, 109-111 29-5, 70-72 30-3, 14-16 31-2, 23-25 32-4, 60-62 33-1, 77-79 33-2, 24-26	P M M M M M M M M M M		1 1 1																																			
Upper Eocene	35-1, 15-17 36-1, 77-79 36-2, 103-105	M M M		1 1																																			
Middle Eocene	39-2, 104-106 39-5, 9-11	M M		? ?																																			

Siphocampe(?) quadrata (Petrushevskaya and Koslova). Nigrini, 1977, p. 257, pl. 3, fig. 12. Table 1, number 69; Tables 2, 3, number 75'.
Siphostichoartus corona (Haeckel). Nigrini, 1977, p. 257, pl. 2, figs. 5, 6. (This chapter: Pl. 4, Fig. 3.) Table 1, number 11; Tables 2, 3, number 2.
Siphostichoartus praecorona Nigrini, 1977, p. 258, pl. 2, figs. 8, 9. (This chapter: Pl. 4, Fig. 4.) Table 1, number 41; Tables 2, 3, number 53'.
Spiroclytis gyroscalaris Nigrini, 1977, p. 258, pl. 2, figs. 10, 11. Table 1, number 31; Tables 2, 3, number 35'.
Spiroclytis subscalaris Nigrini, 1977, p. 259, pl. 3, figs. 1, 2. Table 1, number 38; Tables 2, 3, number 43'.
Spiroclytis subtilis Petrushevskaya, Petrushevskaya and Kozlova, 1972, p. 540, pl. 24, figs. 22-24. Nigrini, 1977, p. 260, pl. 3, fig. 3.

(This chapter: Pl. 4, Figs. 1, 2.) Table 1, number 55; Tables 2, 3, number 49'.
Tholospyris anthropora (Haeckel). Goll, 1969, p. 324, pl. 55, figs. 1-4; text-fig. 1. (This chapter: Pl. 1, Fig. 3.) Table 1, number 9; Tables 2, 3, number 9'.
Tholospyris cortinisca (Haeckel). Goll, 1969, p. 325, pl. 56, figs. 3, 5, 6, 8; text-fig. 1. (This chapter: Pl. 3, Fig. 2.) Table 1, number 3; Tables 2, 3, number 8'.
Tholospyris kantiana (Haeckel). Goll, 1969, p. 327, pl. 58, figs. 17-19, 23; text-fig. 1. (This chapter: Pl. 2, Fig. 6.) Table 1, number 40; Tables 2, 3, number 37'.
Tholospyris mammillaris (Haeckel). Goll, 1969, p. 327, pl. 55, figs. 5, 6; text-fig. 1. (This chapter: Pl. 1, Fig. 5.) Table 1, number 29; Tables 2, 3, number 28'.

Table 2. (Continued).

31'. <i>Dorcadospyrus costatiscens</i>																								
32'. <i>Dendrospyrus fragoides</i>																								
33'. <i>Phormostichoartus fistula</i>																								
34'. <i>Liriospyris elevata</i>																								
35'. <i>Spirocyrtis gyrosularis</i>																								
36'. <i>Giraffospyris diduceros</i>																								
37'. <i>Tholospyris kantiana</i>																								
38'. <i>Dictyo-prora mongolfieri</i>																								
39'. <i>Botryostrobus miralstenensis</i>																								
40'. <i>Liriospyris parkerae</i>																								
41'. <i>Dorcadospyrus dentata</i>																								
42'. <i>Rhabdolithis ellida</i>																								
43'. <i>Spirocyrtis subscalaris</i>																								
44'. <i>Tholospyris procera</i>																								
45'. <i>Rhabdolithis pipa</i>																								
46'. <i>Dictyo-prora amphora</i>																								
47'. <i>Siphocampe nodosaria</i>																								
48'. <i>Giraffospyris haeckelii</i>																								
49'. <i>Spirocyrtis subtilis</i>																								
50'. <i>Petalospyris triceros</i>																								
51'. <i>Dorcadospyrus argisca</i>																								
52'. <i>Giraffospyris cyrtillum</i>																								
53'. <i>Siphostichoartus praecorona</i>																								
54'. <i>Dendrospyrus pannosa</i>																								
55'. <i>Siphocampe acephala</i>																								
56'. <i>Dendrospyrus turriturica turriturica</i>																								
57'. <i>Phormostichoartus corbula</i>																								
58'. <i>Dictyo-prora ovata</i>																								
59'. <i>Dorcadospyrus simplex</i>																								
60'. <i>Dendrospyrus pododendros</i>																								
61'. <i>Siphocampe elizabethae</i>																								
62'. <i>Dorcadospyrus papilio</i>																								
63'. <i>Dorcadospyrus quadrupes</i>																								
64'. <i>Dorcadospyrus pseudopapilio</i>																								
65'. <i>Dorcadospyrus praeformipata</i>																								
66'. <i>Dictyo-prora pirum</i>																								
67'. <i>Dorcadospyrus plathyacantha</i>																								
68'. <i>Liriospyris spinulosa</i>																								
69'. <i>Dendrospyrus turriturica dasyotus</i>																								
70'. <i>Dendrospyrus inferispina</i>																								
71'. <i>Giraffospyris lata</i>																								
72'. <i>Dictyo-prora gigas</i>																								
73'. <i>Dorcadospyrus riedeli</i>																								
74'. <i>Dictyo-prora armadillo</i>																								
75'. <i>Siphocampe(?) quadrata</i>																								
76'. <i>Dictyo-prora discus</i>																								

Tholospyris procera Goll, 1969, p. 328, pl. 59, figs. 8, 10-12; text-fig. 1. Table 1, number 48; Tables 2, 3, number 44'.

Tholospyris scaphipes (Haeckel). Goll, 1969, p. 328, pl. 58, figs. 1-8, 13, 14; text-fig. 1. (This chapter: Pl. 3, Fig. 1.) Table 1, number 14; Tables 2, 3, number 14'.

MESOZOIC RADIOLARIANS

Mesozoic radiolarians, even when common, were, except rarely, too poorly preserved to be useful for stratigraphic purposes. They were generally encountered in layers of claystone interbedded in eruptive rocks. It was therefore never possible to obtain a sequence of Mesozoic radiolarians showing evolutionary changes.

The original skeletons of the radiolarians have been replaced and filled with crystalline silica in the best cases, or recrystallized in calcite and/or zeolite, leaving only the gross external features preserved.

These poorly preserved forms cannot be identified to the species level, and seldom can be identified even to the genus level. Names cannot be used with great precision, and they are used conservatively without implying taxonomic agreement or disagreement. In order to provide bibliographic references to the species mentioned here, they are listed. When the published literature con-

Table 3. Cenozoic radiolarians, Hole 462, in samples with less than 1% reworked specimens. (See text for explanation.)

Chronostratigraphy	Samples (interval in cm)	Abundance	Preservation	Percentage of Specimens Reworked				Cretaceous	22'. <i>Giraffospyris annulispina</i> 23'. <i>Phormostichoartus dolotolum</i> 24'. <i>Boiryostrobos bramlettei</i> 39'. <i>Boiryostrobos miralestensis</i> 1'. <i>Boiryostrobos aquilonaris</i>	34'. <i>Liriospyris elevata</i> 26'. <i>Liriospyris reticulata</i> 42'. <i>Rhabdolithis ellida</i> 37'. <i>Tholospyris kantiana</i> 44'. <i>Tholospyris procera</i>	33'. <i>Phormostichoartus fistula</i> 52'. <i>Giraffospyris cyrillium</i> 40'. <i>Liriospyris parkerae</i> 56'. <i>Dendrosyris turriturica turriturica</i> 57'. <i>Phormostichoartus corbula</i>	41'. <i>Dorcadospys dentata</i> 3'. <i>Giraffospyris angulata</i> 2'. <i>Siphostichoartus corona</i> 27'. <i>Liriospyris stauropora</i> 13'. <i>Dendrosyris acuta</i>	35'. <i>Spirocyclytis gyrosularis</i> 60'. <i>Dendrosyris pododendros</i> 43'. <i>Spirocyclytis subscalaris</i> 62'. <i>Dorcadospys papilio</i> 4'. <i>Giraffospyris circumflexa</i>	5'. <i>Boiryostrobos auritus-australis</i> 14'. <i>Tholospyris scaphipes</i> 64'. <i>Dorcadospys pseudopapilio</i> 63'. <i>Dorcadospys quadripes</i> 53'. <i>Siphostichoartus praecorona</i>	
				Pliocene	Miocene	Oligocene	Eocene								
Pleistocene	2,CC		M		1	0	0								
Pliocene	3,CC 4,CC		M M			0	0								
Upper Miocene-Pliocene	7-1, 117-119 8-1, 107-109 8-3, 118-120		M M G		1 1	1 0	1 1								
Middle-Upper Miocene	10-2, 67-69 10-5, 50-52 11-1, 147-149 11-2, 77-79 12-1, 39-41		M M M M P			0	0								
Middle Miocene	13-5, 88-90 14-2, 86-88 14-5, 109-111 15,CC		M M M M			0	1								
Lower Miocene	16-2, 68-70 17-2, 104-106 17-3, 55-57 18-3, 85-87 18-5, 74-76		P M M P P			1	1								
Upper Oligocene	19-6, 23-25 24-2, 81-83 25-1, 142-144 25-4, 141-143		M M M M				0								
Upper Eocene-Lower Oligocene	26-4, 33-35 27-1, 116-118 28-2, 109-111 28-6, 99-101 29-1, 109-111 29-5, 70-72 30-3, 14-16 31-2, 23-25 32-4, 60-62 33-1, 77-79 33-2, 24-26		P M M M M M M M M M				1								
Upper Eocene	35-1, 15-17 36-1, 77-79 36-2, 103-105 39-2, 104-106 39-5, 9-11		M M M M M				1 1 ? ?								

tains several different concepts of the limits of a species, the reference cited conforms to the concept as applied here.

In Hole 462, identification of radiolarians from the Cretaceous interval is nearly impossible because the tests have been replaced by zeolite and calcite, which crystallizes in large crystals that distort the specimens. However, Cores 51 (Section 3) and 55 (Section 4) provided somewhat better preserved specimens.

Similarly, in Hole 462A samples, as because of the poor preservation of the radiolarians (replaced by calcite and zeolite) and their distortion, only a few vague high-level taxa can be identified. In Core 43 (Sections 1 and 2), Core 46 (Section 1), and Core 80 (Section 1), however, some identifications were attempted.

The ages attributed to the samples are based on the works of Riedel and Sanfilippo (1974), Foreman (1975), and Pessagno (1977).

The samples yielding the best radiolarians are as follows:

Samples 462-51-3, 41-43 cm: *Alievum gallowayi*?, *Dictyomitra torquata*, *Dictyomitra duodecimcostata*, *Dictyomitra lilyae*, and *Dictyomitra* sp. aff. *D. koslovae*, suggest that this sample belongs to the Upper Cretaceous (Senonian).

Sample 462-55-4, 55-59 cm: *Archaeospongoprimum* sp., *Alievum* sp., *Dictyomitra duodecimcostata*, *Dictyomitra lilyae*, *Dictyomitra somphedia*, and *Dictyomitra torquata*: same as previous sample (Senonian).

Sample 462A-43-1, 36-40 cm: *Dictyomitra lacrimula*.

Table 3. (Continued).

65'. <i>Dorcadospyrus praeforcipata</i>																				
69'. <i>Dendrospyrus turriturca dasyotus</i>																				
71'. <i>Giraffospyris lata</i>																				
48'. <i>Giraffospyris haeckelii</i>																				
29'. <i>Dorcadospyrus forcipata</i>																				
73'. <i>Dorcadospyrus rietdelti</i>																				
7'. <i>Liriospyris mutuaia</i>																				
6'. <i>Dendrospyrus anthocytroides</i>																				
47'. <i>Siphocampe nodosaria</i>																				
61'. <i>Siphocampe elizabethae</i>																				
17'. <i>Phormostichoartus marylandicus</i>																				
25'. <i>Siphocampe arachnea</i> gp.																				
8'. <i>Tholospyris cortinisca</i>																				
16'. <i>Dendrospyrus damaecornis</i>																				
15'. <i>Dendrospyrus stabilis</i>																				
18'. <i>Dictyoprora urceolus</i>																				
31'. <i>Dorcadospyrus costataescens</i>																				
49'. <i>Spirocypris subtilis</i>																				
46'. <i>Dictyoprora amphora</i>																				
68'. <i>Liriospyris spinulosa</i>																				
55'. <i>Siphocampe acephala</i>																				
72'. <i>Dictyospyris gigas</i>																				
9'. <i>Tholospyris anthopora</i>																				
21'. <i>Dorcadospyrus pentagona</i>																				
28'. <i>Tholospyris mammillaris</i>																				
74'. <i>Dictyoprora armadillo</i>																				
19'. <i>Siphocampe lineata</i> gp.																				
45'. <i>Rabdolithus pipa</i>																				
59'. <i>Dorcadospyrus simplex</i>																				
75'. <i>Siphocampe(?) quadrata</i>																				
10'. <i>Dendrospyrus binapertonis</i>																				
11'. <i>Liriospyris clathrata</i>																				
12'. <i>Giraffospyris laterispina</i>																				
20'. <i>Dorcadospyrus confluentis</i>																				
36'. <i>Giraffospyris didiceros</i>																				
58'. <i>Dictyoprora ovata</i>																				
50'. <i>Petalospyris tricerus</i>																				
30'. <i>Dorcadospyrus atuechus</i>																				
32'. <i>Dendrospyrus fragoides</i>																				
38'. <i>Dictyoprora mongoliferi</i>																				
54'. <i>Dendrospyrus pannosa</i>																				
51'. <i>Dorcadospyrus argisca</i>																				
67'. <i>Dorcadospyrus plathyacantha</i>																				
66'. <i>Dictyoprora pirum</i>																				
76'. <i>Dictyospyris discus</i>																				

Sample 462A-43-2, 50–54 cm: *Acanthocircus* sp. (*A. trizonalis?*), *Dictyomitra lacrimula*, *Emiluvia* sp., *Eucyrtis tenuis*, *Hagiastriidae*, *Hemicryptocapsa* spp. cf. *H. capita*, *Mirifusus mediodilatatus*, *Thanarla elegantissima*, *Sethocapsa cetia?*, *Sethocapsa* sp., *spumellarians*. These forms suggest the *Eucyrtis tenuis* Zone, which is Barremian to Albian p. p., according to Riedel and Sanfilippo (1975), and Valanginian to lower Aptian, according to Foreman, 1975. The specimens are probably Barremian.

Sample 462A-46-1, 1–3 cm: *Acanthocircus carinatus?*, *Crucella* sp., *Dictyomitra lacrimula*, *Emiluvia pessagnoii?*, *Emiluvia* sp. (*E. chica?*), *Hagiastrium* sp., *Podobursa* sp., spongosaturnalids, *Staurosphaera se-*

decimporata. These radiolarians belong to the *E. tenuis* Zone, and, as for the previously mentioned sample, are probably Barremian.

Some radiolarians from the *E. tenuis* Zone again occur in the red-brown claystone interval (Sample 462A-80-1, 16–17 cm), and suggest the same age. The following radiolarians were recognized: *Crucella* sp., *Dictyomitra lacrimula*, *Eucyrtis micropora(?)*, *Sethocapsa* sp., *Thanarla elegantissima*, *Thanarla* sp. aff. *T. conica*, and *Mirifusus mediodilatatus*.

LIST OF MESOZOIC SPECIES

Acanthocircus carinatus Foreman, 1975, p. 610, pl. 2C, fig. 8; pl. 4, fig. 12.

- Acanthocircus trizonalis* (Rüst). Foreman, 1975, p. 610, pl. 20, figs. 1-4.
- Alieyum gallowayi* (White). Pessagno, 1963, p. 202, pl. 2, figs. 1, 3, 6; pl. 4, figs. 2, 5, 7; pl. 7, figs. 2, 4.
- Dictyomitra duodecimcostata* (Squinabol). Foreman, 1975, p. 614, pl. 1G, figs. 5, 6; pl. 7, fig. 11; pl. 16, fig. 3.
- Dictyomitra koslovae* Foreman, 1975, p. 614, pl. 7, fig. 4.
- Dictyomitra lacrimula* Foreman, 1973b, p. 263, pl. 10, fig. 11.
- Dictyomitra lilyae* Tan Sin Hok, 1927, p. 55, pl. 10, fig. 83.
- Dictyomitra somphedia* Foreman, 1975, p. 614, pl. 7, figs. 11-13.
- Dictyomitra torquata* Foreman, 1971, p. 1676, pl. 3, fig. 4.
- Emiluvia chica* Foreman s. l., Foreman, 1978, p. 744, pl. 1, fig. 4.
- Emiluvia pessagnoii* Foreman, 1973b, p. 262, pl. 8, fig. 6.
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- Eucyrtis tenuis* (Rüst), Foreman, 1975, p. 615, pl. 2I, figs. 7-9.
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- ACKNOWLEDGMENTS**
- I thank the Deep Sea Drilling Project curatorial staff at Scripps Institution of Oceanography (La Jolla, California) for supplying supplementary samples, and A. Schaaf, who reviewed the manuscript. Special thanks are due to W. R. Riedel, who, as usual, kindly offered useful discussions and assistance, and reviewed the manuscript.
- Financial support for this investigation was provided in part by C.N.R.S. (France)—A.T.P. 3236.
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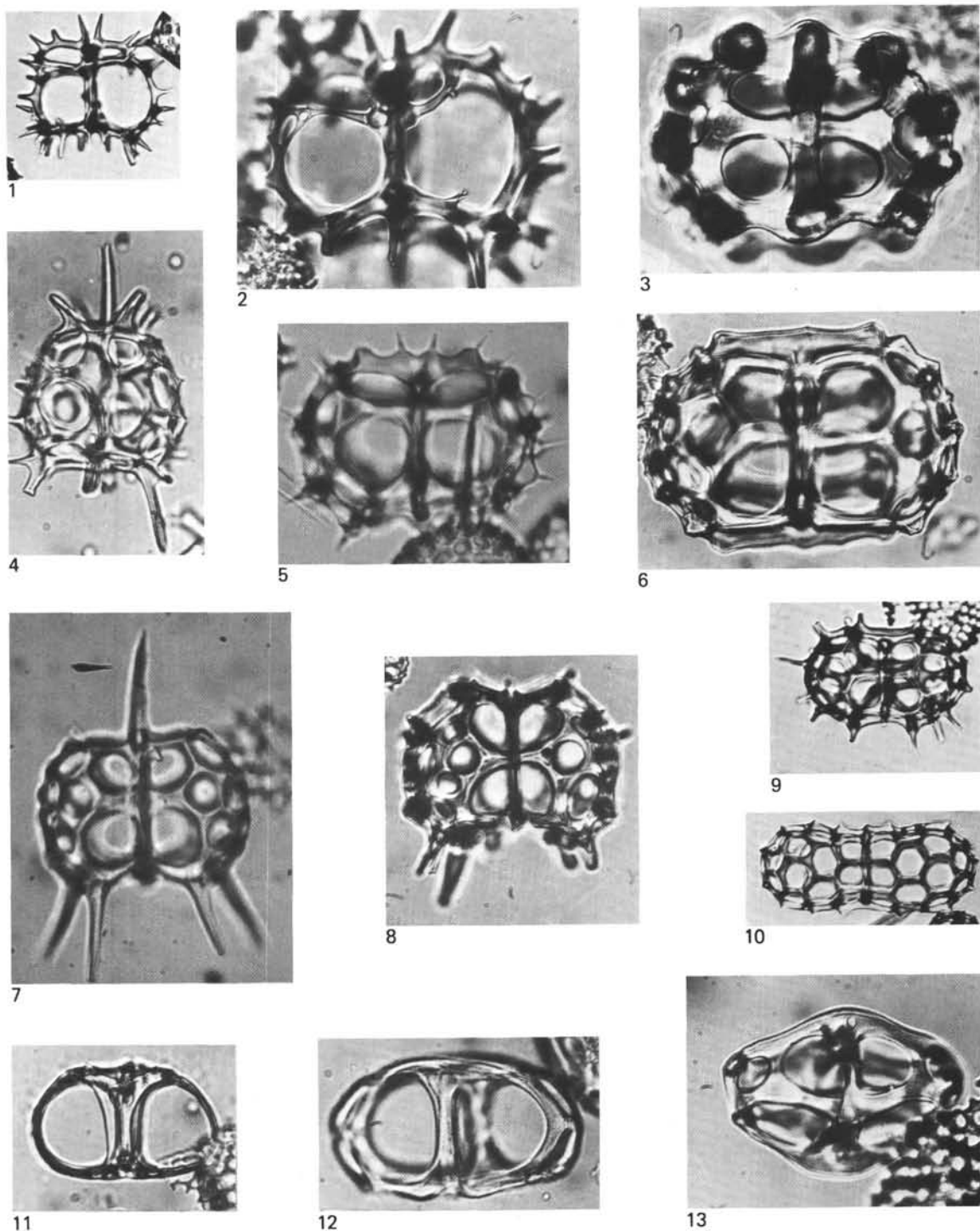


Plate 1. Cenozoic radiolarians, Hole 462.

Figures 1, 2. *Giraffospyris circumflexa* Goll. Fig. 1. Sample 462-7-3, 119-121 cm. L 42/4 \times 200. Fig. 2. Sample 462-10-2, 67-69 cm. F 21/3 \times 400.

Figure 3. *Tholospyris anthopora* (Haeckel). Sample 462-7-3, 119-121 cm. M 27/4 \times 400.

Figure 4. *Liriospyris spinulosa* (Ehrenberg). Sample 462-30-3, 14-16 cm. E 15/4 \times 400.

Figure 5. *Tholospyris mammillaris* (Haeckel). Sample 462A-2, CC \times 260.

Figure 6. *Liriospyris geniculosa* Goll. Sample 462-7-3, 119-121 cm. R 18/2 \times 400.

Figure 7. *Sphyrid* sp. Sample 462-15, CC. D 10/0 \times 420.

Figure 8. *Liriospyris clathrata* (Ehrenberg). Sample 462-7-1, 117-119 cm. O 23/0 \times 400.

Figure 9. *Dorcadospyris pentagona* (Ehrenberg). Sample 462-11-2, 77-79 cm. P 14/4 \times 200.

Figure 10. *Sphyrid*. Sample 462-7-3, 119-121 cm. O 20/0 \times 200.

Figure 11. *Liriospyris parkerae* Riedel and Sanfilippo. Sample 462-11-1, 147-149 cm. R 17/0 \times 400.

Figures 12, 13. *Liriospyris stauopora* (Haeckel). Fig. 1. Sample 462-7-3, 119-121 cm. P 17/2 \times 400. Fig. 2. Sample 462-7-3, 119-121 cm. P 17/3 \times 400.

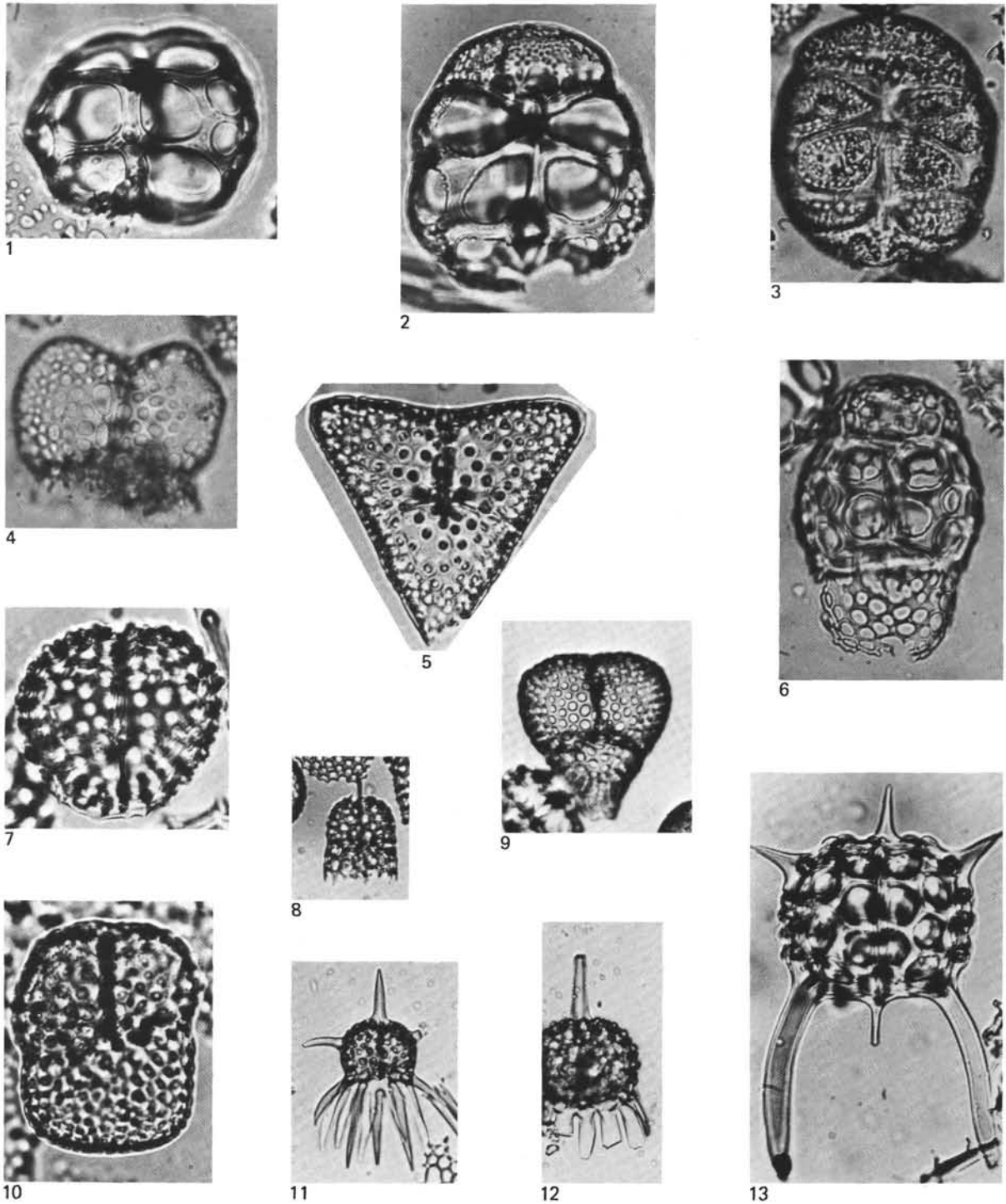


Plate 2. Cenozoic radiolarians, Hole 462.

Figure 1. *Liriospyris mutuaria* Goll. Sample 462-7-3, 119-121 cm. P 18/0 \times 400.

Figure 2. *Liriospyris* sp. aff. *L. reticulata*. Sample 462-7-1, 117-119 cm. K 25/0 \times 400.

Figure 3. *Liriospyris ovalis*. Sample 462-11-1, 147-149 cm. G 19/1 \times 400.

Figure 4. *Dendrospyris stabilis* Goll. Sample 462-2, CC. \times 420.

Figure 5. *Giraffospyris lata* Goll. Sample 462-23-4, 67-69 cm. L 39/0 \times 400.

Figure 6. *Tholospyris kantiana* (Haeckel). Sample 462-7-3, 119-121 cm. K 22/1 \times 400.

Figure 7. *Giraffospyris cyrillium* Sanfilippo and Riedel. Sample 462-29-5, 70-72 cm. U 17/4 \times 400.

Figure 8. *Dorcadospyris confluens* (Ehrenberg). Sample 462-30-3, 14-16 cm. R 19/0 \times 200.

Figure 9. *Dendrospyris acuta* Goll. Sample 462-13-5, 88-90 cm. T 21/0 \times 200.

Figure 10. *Dendrospyris* sp. Sample 462-3, CC. D 17/2 \times 400.

Figure 11. Spyrid. Sample 462-30-3, 14-16 cm. K 19/1 \times 200.

Figure 12. *Dorcadospyris argisca* (Ehrenberg). Sample 462-39-5, 9-11 cm. J 17/2 \times 200.

Figure 13. *Giraffospyris didiceros* (Ehrenberg). Sample 462-29-5, 70-72 cm. P 20/0 \times 400.

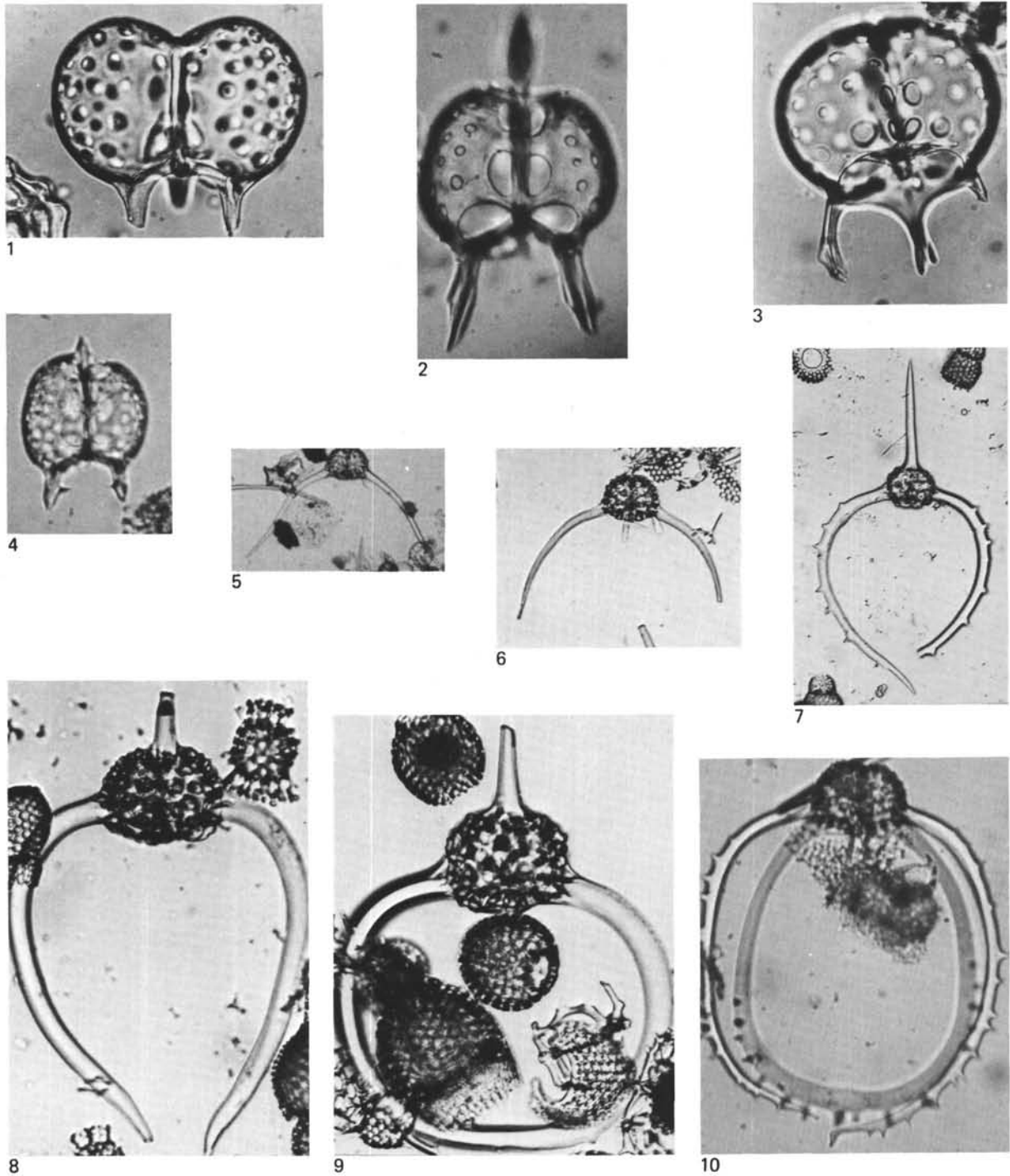


Plate 3. Cenozoic radiolarians, Hole 462.

Figure 1. *Tholospyris scaphipes* (Haeckel). Sample 462-7-3, 119-121 cm. L 20/1 \times 400.

Figure 2. *Tholospyris cortinisca* (Haeckel). Sample 462-15, CC. B 33/1 \times 420.

Figure 3. *Dendrospyris damaecornis* (Haeckel). Sample 462-7-3, 119-121 cm. D 20/0 \times 400.

Figure 4. *Dendrospyris binapertoris* Goll. Sample 462-2, CC. \times 260.

Figure 5. *Dorcadospyris simplex* (Riedel). Sample 462-2, CC. \times 82.

Figure 6. *Dorcadospyris pseudopapilio* Moore. Sample 462-30-3, 14-16 cm. P 17/4 \times 100.

Figure 7. *Dorcadospyris dentata* Haeckel. Sample 462-15, CC. U 16/4 \times 100.

Figure 8. *Dorcadospyris forcipata* (Haeckel). Sample 462-13-5, 88-90 cm. F 21/2 \times 200.

Figure 9. *Dorcadospyris circulus* (Haeckel). Sample 462-22-3, 106-108 cm. J 22/0 \times 200.

Figure 10. *Dorcadospyris spinosa* Moore. Sample 462-23, CC. \times 160.

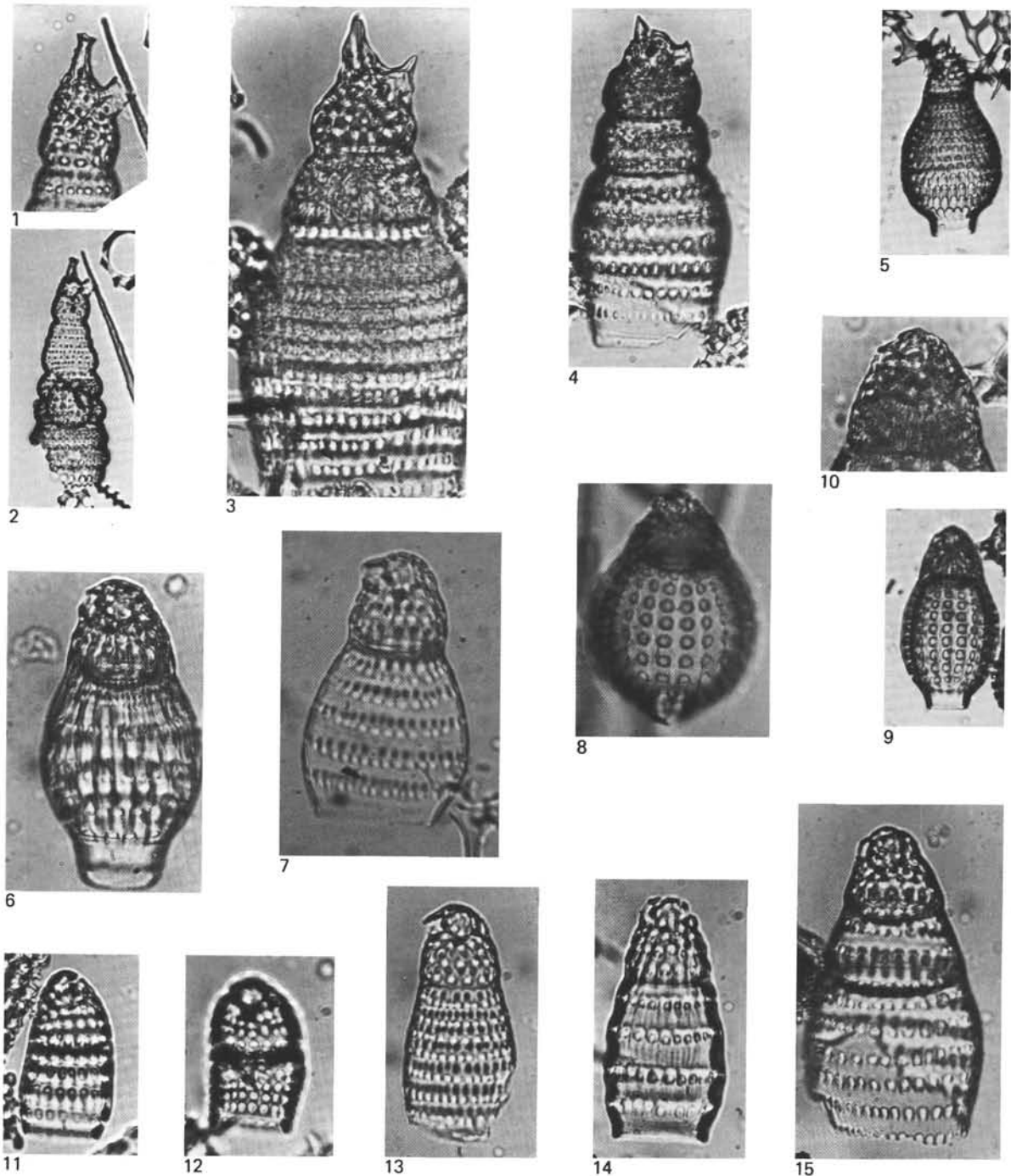


Plate 4. Cenozoic radiolarians, Hole 462.

- Figure 1. *Spirocyrtis subtilis* Petrushevskaya. Sample 462-18-5, 74-76 cm. V 23/1 \times 400.
 Figure 2. *Spirocyrtis subtilis* Petrushevskaya. Sample 462-18-5, 74-76 cm. V 23/1 \times 200.
 Figure 3. *Siphostichoartus corona* (Haeckel). Sample 462-10-5, 50-52 cm. O 19/4 \times 400.
 Figure 4. *Siphostichoartus praecorona* Nigrini. Sample 462-17-3, 55-57 cm. Q 19/3 \times 400.
 Figure 5. *Dictyoprora armadillo* (Ehrenberg). Sample 462-30-3, 14-16 cm. D 19/0 \times 200.
 Figure 6. *Dictyoprora amphora* group (Haeckel). Sample 462-3, CC. D 17/2 \times 400.
 Figure 7. *Dictyoprora pirum* (Ehrenberg). Sample 462A-2, CC. P 10/3 \times 420.

- Figure 8. *Dictyoprora mongolfieri* (Ehrenberg) group. Sample 462A-2, CC. L 12/4 \times 260.
 Figure 9. *Dictyoprora mongolfieri* (Ehrenberg) group. Sample 462-30-3, 14-16 cm. D 19/0 \times 200.
 Figure 10. *Dictyoprora mongolfieri* (Ehrenberg) group. Sample 462-30-3, 14-16 cm. D 19/0 \times 400.
 Figure 11. *Siphocampe elizabethae* (Clark and Campbell). Sample 462-25-1, 142-144 cm. G 19/0 \times 400.
 Figure 12. *Siphocampe acephala* (Ehrenberg). Sample 462-25-1, 142-144 cm. G 19/1 \times 400.
 Figure 13. *Siphocampe lineata* (Ehrenberg) group. Sample 462-7-1, 117-119 cm. S 23/0 \times 400.
 Figure 14. *Dictyoprora urceolus* (Haeckel). Sample 462-7-3, 119-121 cm. L 42/0 \times 400.
 Figure 15. *Phormostichoartus marylandicus* (Martin). Sample 462-7-1, 117-119 cm. H 23/0 \times 400.