23. RADIOLARIA FROM THE NORTH PACIFIC, DEEP SEA DRILLING PROJECT, LEG 32

Helen P. Foreman, Oberlin College, Oberlin, Ohio

CONTENTS

INTRODUCTION

Radiolaria were recovered from 7 of the 10 sites investigated on DSDP Leg 32. Their localities are as follows:

Site 303—40°48.50'N, 154°27.07'E; water depth 5609 meters.

Site 304—39°20.27'N, 155°04.19'E; water depth 5630 meters.

Site 305—32°00.13'N, 157°51.00'E; water depth 2903 meters.

Site 306—31°52.02'N, 157°28.71'E; water depth 3399 meters.

Site 307—28°35.26'N, 161°00.28'E; water depth 5696 meters.

Site 310—36°52.11'N, 176°54.09'E; water depth 3516 meters.

Site 313—20°10.52'N, 170°57.15'W; water depth 3484 meters.

Sites 305 and 306 were drilled on the Shatsky Rise, Site 310 on Hess Rise, and Site 313 in a basin of the Mid-Pacific mountains. The remaining sites, 303, 304, and 307, were drilled at abyssal depths.

Radiolaria were recovered in significant amounts as follows: Early Cretaceous, Sites 303-307; Late Cretaceous, Site 303, 307, 310, and 313; Paleogene, Site 313; Neogene, Sites 303-306 and 310.

The long sequences of Cretaceous Radiolaria frequently co-occurring with calcareous fossils are of considerable significance, and the main body of this report concerns these Cretaceous occurrences.

Also investigated but with less detail are the early Eocene Radiolaria at Site 313 and the Neogene occurrences, with particular emphasis on the long sequence at Site 310.

PRESENTATION OF RESULTS

As stated above, the main body of this chapter concerns the Cretaceous Radiolaria. With the exception of the Late Cretaceous Radiolaria at Site 313, the Cretaceous Radiolaria selected for study have been described, tabulated at each site, their upper and lower limits arranged in an events list, and their ranges presented in a chart. A synchronopticon comprising 17 plates illustrates in horizontal rows species which cooccur, and in vertical rows species ranges and evolutionary relationships.

For the Paleogene and Neogene Radiolaria, only a few species have been described. In general, the Systematic Section gives only references to papers where the species mentioned are fully described or which contain more complete synonymies. For the Paleogene at Site 313, selected species are tabulated, and a list of events compares the Leg 32 sequence with that found on Leg 10 in the Gulf of Mexico. For the Neogene, the Radiolaria in the long sequence at Site 310 have been tabulated. A range chart presents these results.

Unless otherwise stated, ranges are considered to be morphological.

In the Systematic Section families are arranged alphabetically within the orders Spumellaria and Nassellaria and species are arranged alphabetically under each family. This order is maintained on the tabulation tables. For a variety of reasons (paucity of forms, unreliability of information, etc.), some of these species are not included on the range charts where the species are arranged according to age. In order to facilitate finding a species on these charts and to indicate when they have been omitted, the species have been numbered consecutively on the range charts and these numbers are given, along with the descriptions, in the Systematic Section and in the list of events.

The following abbreviations are used on the tables which record the relative abundance and the quality of preservation of the Radiolaria in each sample: A, abundant; C, common; F, few; and R, rare; G, good; M, moderate; and P, poor.

The abundances for individual species are indicated as follows:

For the Cenozoic, where there are generally more recognizable species on a slide: C, common, more than 29 specimens on a slide; F, few, 10-29 specimens; R, 3-9 specimens; +, 1-2 specimens; ·, a single isolated specimen.

For the Cretaceous, where preservation is such that there are frequently fewer individuals and among them fewer recognizable forms than in the Cenozoic: C, common, more than 19 specimens on a slide; F, few, 6-19 specimens; R, 2-5 specimens; +, one specimen on a number of slides; ·, a single isolated specimen. For the synchronopticon, lower-case letters define the same relative abundances.

RADIOLARIA FROM EACH SITE

Radiolaria from Site 303 with Table 1

Neogene

Only siliceous fossils are present in Cores 1-4 recovered from Site 303. Radiolaria are common and well-preserved in all of them.

Core 1, at a depth of 0-12 meters below the sediment surface, is late Quaternary (*Artostrobium tumidulum* Zone). Core 2, at a depth of 62-71 meters, is early Pliocene (*Sphaeropyle langii* Zone). Cores 3 and 4, at depths of 117-126 and 173-182 meters, respectively, are below the range of the Hays (1970) zonation for the North Pacific and the age determination is made on the basis of the Riedel and Sanfilippo (1971) equatorial zonation: Core 3 is late Miocene, (*Stichocorys peregrina* Zone) and Core 4 is mid-Miocene (*Cannartus petterssonii* Zone).

Cretaceous

Samples of both pelagic clay and chert were examined. In general, the Radiolaria are better preserved in the chert and, unless otherwise stated, age assignments have been made from these samples.

Radiolaria were recovered from Core 5 in Hole 303 and Cores 1A-8A in Hole 303A, and age assignments are made on the basis of correlations with radiolarian events in Holes 305 and 306 which have calcareous fossil control (see Figure 1). No other siliceous fossils were observed.

Cores 5 and 1A at depths of 211-220 meters, and Core 2A at 220-229 meters, contain few poorly to moderately preserved Radiolaria which are considered to be Cenomanian or late Albian, and late Albian, respectively. All belong to the *Dictyomitra somphedia* Zone. Cores 3A (229-238 m) with few, poorly preserved Radiolaria, and 4A (238-247 m) with common, moderately preserved Radiolaria, are Albian, and Aptian or Barremian, and are assigned to the *Acaeniotyle umbilicata* Zone. An abrupt change in the fauna from Cores 4A to 5A marks the transition to the *Eucyrtis tenuis* Zone. The remaining Cores 6A to 8A all belong to this zone. Cores 5A (247-257 m) with common poorly preserved and 6A (257-266 m) with common moderately preserved Radiolaria are Aptian to Barremian and Aptian to Barremian or Hauterivian, respectively. Cores 7A (266-275 m) and 8A (275-284 m) contain a fauna similar to but sparser and more poorly preserved than that in Core 6A.

TABLE 1
Occurrence and Abundance of Cretaceous Radiolaria at Site 303

Radiolarian Zones	Species / Sample (Interval in cm)	Abundance	Preservation	*Acaeniotyle diaphorogona*	*Acaeniotyle helicta*	*Acaeniotyle umbilicata*	*Cenosphaera* sp.	*Dicroa periosa*	*Dicroa* sp. A	*Sphaerostylus lanceola* group	*Staurosphaera septemporata*	*Triactoma echiodes*	*Triactoma* sp. cf. *T. echiodes*	*Triactoma hybum*	*Triactoma tithonianum*	*Acanthocircus carinatus* s.s.	*Acanthocircus dicranacanthos*	*Acanthocircus trizonalis*	*Acanthocircus variabilis*	*Spongosaturnalis* (?) *eidalimus*	*Spongosaturnalis horridus*	*Spongosaturnalis hueyi*	*Spongosaturnalis hueyi* group	*Spongosaturnalis* (?) *ichikawai*	*Spongosaturnalis* (?) *moorei*	*Spongosaturnalis* (?) *preclarus*	*Spongosaturnalis squinaboli*	*Spongosaturnalis* (?) *yaoi*	*Spongosaturnalis* (?) spp.	*Crucella cachensis*	*Paronaella* (?) *diamphidia*	*Paronaella* (?) *hipposidericus*	*Emiluvia chica*
				21	41	19	1	43	31	16	28	26	39	38	3	36	12	18		53	42	5	51	59	64	52	62	54	27	67	17	40	4
D. somph	5, CC	F	P																	+	–		R	–	–	R	–	–	F	–			
	2A, CC	F	M															–		–			+			–			R				
A. umbil.	3A, CC	F	P	–		–		–										·					–						R				
	4A, CC	C	M	R	–	+		R	–	–	–	–	–	–				R			–					(R)			F				
	5A, CC	C	P	R	R	F		–	+	C	–	–	+	–		–	–	R			–								R				
E. tenuis	6A-1, 98-100	C	M	F	F	F		–	–	C	–	·	·	+		–	–	R	–		–								+		–	–	
	7A, CC	F	P	R	+	R	–	–	R	C	–	·	·	–		–	–	+			–								R				
	8A, CC*	R	P	R		R			+	C	·							+											R				

Note: * Absences have not been reported from Sample 8A, CC because of the poor preservation and paucity of forms.
○ Suspected downward contamination.

Radiolaria from Site 304 with Table 2

Neogene

Radiolaria are common and well preserved in Core 1. Core 2 contains only fish teeth, except for a sample of moderate yellowish-brown pelagic clay (Core 2, Section 1, 80-82 cm) probably representing cavings from uphole, which contained common well-preserved Radiolaria. No calcareous fossils are present in the Neogene section recovered from Hole 304.

Core 1, at a depth of 106-115 meters below the sediment surface, is late Miocene (*Stichocorys langii* Zone) and the cavings of Core 2, at a depth of 216 meters, are mid-Miocene (*Cannartus petterssonii* Zone).

Cretaceous

No siliceous fossils other than Radiolaria were recovered from samples of pelagic clay, mudstone, and chert in Cores 3-15. In general, the samples of mudstone contain common, well-preserved Radiolaria. Abundance of Radiolaria in the cherts varies from common to very rare and preservation varies from moderate to very poor. No consistent pattern of abundance or preservation in relation to the color of the chert could be discerned. Cores 12-15 contain calcareous fossils in the lower part of the hole. Radiolaria in these cores are rare to very rare, and poor to very poorly preserved, except in Core 13, for which the recovery was very poor, and in which Radiolaria are entirely absent.

The age assignments for the Radiolaria are based on correlations with the Radiolaria in Holes 305 and 306.

Core 3, at a depth of 235-244 meters, is late Albian (*Dictyomitra somphedia* Zone). Core 4 (244-253 m) is Albian to Aptian (*Acaeniotyle umbilicata* Zone). Cores 5-7, at depths of 253-281 meters, are considered to be Aptian to Barremian, and Cores 8-9 (281-299 m) Aptian to Barremian and Barremian to Hauterivian-Valanginian, respectively. Cores 5 and 6 belong to the *Acaeniotyle umbilicata* Zone and Cores 7-9 to the *Eucyrtis tenuis* Zone.

A well-preserved fauna is present in Samples 8-1, 130-132 cm (pelagic clay) and 9-1, 101-103 cm (mudstone) with only a few elements in common with the radiolarian fauna recovered from the chert. It resembles very much the fauna described by Tan Sin Hok (1927) from the island of Roti and is considered contemporaneous with the Radiolaria in the cherts, the only difference being the result of diversity in preservation.

Radiolaria from Site 305 with Table 3

Neogene

Well-preserved Radiolaria are present in all of the five Neogene cores recovered. They are common in Cores 1-4 and rare in Core 5.

The diagnostic fossils used by Hays (1970) in his zonation of the North Pacific are either missing or only rarely present, and thus his zonation can be only tentatively applied here. The *Artostrobium tumidulum* Zone is present in Core 1 through Section 3 and the remainder of the core may possibly be attributed to the *Axoprunum angelinum* Zone, both of Pleistocene age. Core 2, Section 2 is Pleistocene (*Eucyrtidium matuyamai* Zone) and Sample 2, CC is from the late *Lamprocyrtis heteroporos* Zone. Cores 3, 4, and 5, Section 1 are early Pliocene to late Miocene (*Sphaeropyle langii* Zone) and Core 5, Section 3 is late Miocene (*Stichocorys peregrina* Zone).

Cretaceous

Preservation of the Radiolaria is consistently better in the calcareous sediment samples than in the cherts. This is in contrast to Sites 303 and 304 where the Radiolaria are consistently better preserved in the cherts. In the calcareous samples of Cores 44-47 Radiolaria are few to

TABLE 1 – *Continued*

46 *Trochodiscus exaspina*	61 *Alievium gallowayi*	58 *Alievium praegallowayi*	25 *Alievium* spp.	65 *Pseudoaulophacus pargueraensis*	*Spyrid* (?) gen. and sp. indet.	56 *Artostrobium tina*	60 *Artostrobium urna*	63 *Theocampe salillum*	45 *Diacanthocapsa communis*	29 *Dictyomitra alievi*	13 *Dictyomitra apiarium*	14 *Dictyomitra boesii*	20 *Dictyomitra carpatica* (?)	6 *Dictyomitra cosmoconica*	55 *Dictyomitra duodecimcostata*	66 *Dictyomitra koslovae*	30 *Dictyomitra* (?) *lacrimula*	50 *Dictyomitra pseudomacrocephala*	48 *Dictyomitra somphedia*	24 *Eucyrtis micropora*	35 *Eucyrtis tenuis*	10 *Lithocampe mediodilatata*	49 *Lithomelissa* (?) *petila*	44 *Platycryphalus* spp. aff. *P. hirsuta*	8 *Stichocapsa* (?) *rotunda*	34 *Dibolachras tytthopora*	*Podobursa* (?) *polylophia*	7 *Podbursa tetracola*	15 *Podobursa triacantha*	37 *Podobursa tricola*	2 *Podocapsa amphitreptera*	5 *Sethocapsa cetia*	9 *Sethocapsa leiostraca*	32 *Sethocapsa* (?) *orca*	23 *Sethocapsa trachyostraca*	11 *Syringocapsa limatum*	22 *Hemicryptocapsa* spp. cf. *H. capita*	47 *Holocryptocanium barbui*	33 *Zhamoidellum ornatum* (?)
	–	–		–		–	–	–					–					–	–				·	–														–	
–									–				·					R	R				R	F														R	
·									+				·					–	–				–	+														+	
–			–						–				+				–			–	–		+	–					–	–				–				?	–
			+										R				R			R	+					–			R	·				R					+
					–								R				R			C	R					·			R	+				R			–		R
			+		·								–				+			R	?					–			+	+				F	–		·		R
			+										+				·			R	+			·		+				·				R					R

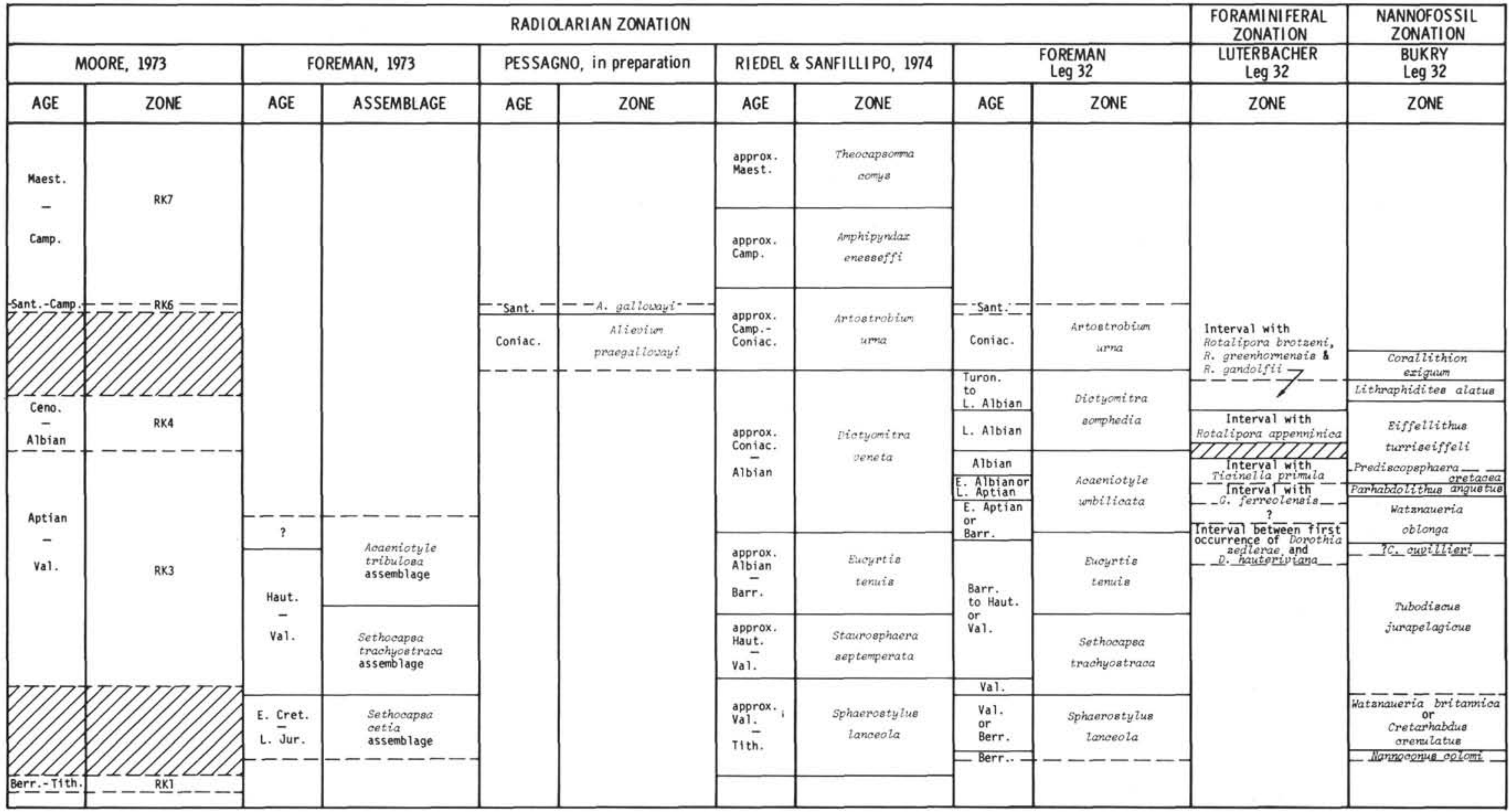


Figure 1. *Relation of Leg 32 Cretaceous radiolarian zones to earlier proposed radiolarian zones and to the corresponding foraminiferal and nannofossil zones presented in this report.*

TABLE 2
Occurrence and Abundance of Cretaceous Radiolaria at Site 304

Radiolarian Zones	Sample (Interval (in cm)) / Species	Abundance	Preservation	*Acaeniotyle diaphorogona*	*Acaeniotyle helicta*	*Acaeniotyle umbilicata*	*Cenosphaera* sp.	*Dicroa periosa*	*Dicroa* sp. A	*Sphaerostylus lanceola* group	*Staurosphaera septemporata*	*Triactoma echiodes*	*Triactoma* sp. cf. *T. echiodes*	*Triactoma hybum*	*Triactoma tithonianum*	*Acanthocircus carinatus* s.s.	*Acanthocircus dicranacanthos*	*Acanthocircus trizonalis*	*Acanthocircus variabilis*	*Spongosaturnalis* (?)*eidalimus*	*Spongosaturnalis horridus*	*Spongosaturnalis hueyi*	*Spongosaturnalis hueyi* group	*Spongosaturnalis* (?) *ichikawai*	*Spongosaturnalis* (?) *moorei*	*Spongosaturnalis* (?) *preclarus*	*Spongosaturnalis squinaboli*	*Spongosaturnalis* (?) *yaoi*	*Spongosaturnalis* (?) spp.	*Crucella cachensis*	*Paronaella* (?) *diamphidia*	*Paronaella* (?) *hipposidericus*	*Emiluvia chica*
				21	41	19	1	43	31	16	28	26	39	38	3	36	12	18		53	42	57	51	59	64	52	62	54	27	67	17	40	4
D. somph.	3, CC	C	M	-																+	-		+	-	-				C	-			
A. umbil.	4, CC	C	M	-				-	-											+			-						C				
	5-1, 140-141	F	P	R	-	·		·	-	-	-		-							·									R				
	6, CC	R	P	R	-	-		+	-	-	-	-	·				-	R											R				
	7-1, 145-147	C	P	R	+	+		-	R	R	-	-	·	-			-	R		-									R		-	-	
E. tenuis	8-1, 130-132	C	M	R	+	R			-	C	·	R		+		-	-	F	-										R		-	·	
	9-1, 148-150	C	M	R	-	R			-	C	-	R	·	+		-	+	F	-										R		-	-	

TABLE 2 – *Continued*

Sample	*Trochodiscus exaspina*	*Alievium gallowayi*	*Alievium praegallowayi*	*Alievium* spp.	*Pseudoaulophacus pargueraensis*	*Spyrid* (?) gen. and sp. indet.	*Artostrobium tina*	*Artostrobium urna*	*Theocampe salillum*	*Diacanthocapsa communis*	*Dictyomitra alievi*	*Dictyomitra apiarium*	*Dictyomitra boesii*	*Dictyomitra carpatica* (?)	*Dictyomitra cosmoconica*	*Dictyomitra duodecimcostata*	*Dictyomitra koslovae*	*Dictyomitra* (?) *lacrimula*	*Dictyomitra pseudomacrocephala*	*Dictyomitra somphedia*	*Eucyrtis micropora*	*Eucyrtis tenuis*	*Lithocampe mediodilatata*	*Lithomelissa* (?) *petila*	*Platycryphalus* spp. aff. *P. hirsuta*	*Stichocapsa* (?) *rotunda*	*Dibolachras tytthopora*	*Podobursa* (?) *polylophia*	*Podobursa tetracola*	*Podobursa triacantha*	*Podobursa tricola*	*Podocapsa amphitreptera*	*Sethocapsa cetia*	*Sethocapsa leiostraca*	*Sethocapsa* (?) *orca*	*Sethocapsa trachyostraca*	*Syringocapsa limatum*	*Hemicryptocapsa* spp. cf. *H. capita*	*Holocryptocanium barbui*	*Zhamoidellum ornatum* (?)
	46	61	58	25	65		56	60	63	45	29	13	14	20	6	55	60	30	50	48	24	35	10	49	44	8	34		7	15	37	2	5	9	32	23	11	22	47	33
3, CC	+									-				-					-	-				-	+															
4, CC	R									F				·					-	-				-	R															
5-1, 140-141	-													+				-		-		+			·															
6, CC						-				-				+				-			·	R								-	-				-					-
7-1, 145-147				-		-	-			-	-			R				+			F						-			-	-				-					-
8-1, 130-132				R		·					+			C				R			F						·			+	·				R	-		-		R
9-1, 148-150				R		-					+		-	F				R			F	+	-				R			R	+				F	R		-		R

common and poorly preserved. They are few to abundant and moderately well preserved in Cores 49-52, 58-61, and 63-66. Chert samples from Core 17, 19, 21, 22, 33, 35, and 38 contained no Radiolaria. Cores 31, 32, 34, 41, 42, 44, 53-57 contained very rare to few, very poorly to poorly preserved Radiolaria, and Cores 39 and 49, common, very poorly preserved Radiolaria.

Radiolaria in Cores 31 and 32, at a depth of 280-298.5 meters, are considered to be Santonian-Campanian in age. Radiolaria in Core 46 (428.5-438 m) belong to the *Dictyomitra somphedia* Zone; Cores 50-52 (466-494 m) and Cores 58-59 (541-560 m), Cores 60-61 (560-579 m), and Cores 63-64 (588-607 m) belong to the *Acaeniotyle umbilicata* Zone. Radiolaria in Cores 65 and 66 (607-626 m) are assigned to the *Eucyrtis tenuis* Zone.

Radiolaria from Site 306 with Table 4

This site was drilled to continue the sequence of continuous coring at Site 305. All the cores recovered are of Mesozoic age, except the first which is a mixture of sediments of Neogene and Cretaceous age.

Radiolaria are few and poorly preserved in Cores 2-4, common and moderately to poorly preserved in Cores 5-14, and few and poorly preserved in Cores 16-19. Radiolarian abundance and preservation are very rare and very poorly preserved in Cores 20 through 39, with the exception of Core 21 where they are few and moderate. Core 40 has Radiolaria which are common and moderately preserved; in Core 41 they are abundant and moderately preserved, and in Core 42 they are few and moderately preserved.

TABLE 3
Occurrence and Abundance of Cretaceous Radiolaria at Site 305

Radiolarian Zones	Sample (Interval in cm)	Abundance	Preservation	21 *Acaeniotyle diaphorogona*	41 *Acaeniotyle helicta*	19 *Acaeniotyle umbilicata*	1 *Genosphaera* sp.	43 *Dicroa periosa*	31 *Dicroa* sp. A	16 *Sphaerostylus lanceola* group	28 *Staurosphaera septemporata*	26 *Triactoma echoides*	39 *Triactoma* sp. cf. *T. echoides*	38 *Triactoma hybum*	3 *Triactoma tithonianum*	36 *Acanthocircus carinatus* s.s.	12 *Acanthocircus dicranacanthos*	18 *Acanthocircus trizonalis*	*Acanthocircus variabilis*	53 *Spongosaturnalis* (?) *eidalimus*	42 *Spongosaturnalis horridus*	57 *Spongosaturnalis hueyi*	51 *Spongosaturnalis hueyi* group	59 *Spongosaturnalis* (?) *ichikawai*	64 *Spongosaturnalis* (?) *moorei*	52 *Spongosaturnalis* (?) *preclarus*	62 *Spongosaturnalis squinaboli*	54 *Spongosaturnalis* (?) *yaoi*	27 *Spongosaturnalis* (?) spp.	67 *Crucella cachensis*	17 *Paronaella* (?) *diamphidia*	40 *Paronaella* (?) *hipposidericus*	4 *Emiluvia chica*
?	32, CC	R	P																														
D. somph.	46, CC	C	P	–		–		–																					R				
Acaeniotyle umbilicata	50, CC	C	M	–		–		–																									
	51, CC	C	M	–		–		–																									
	52, CC	C	M	–	–	–		–																									
	58, CC	C	M	R	–	+		+																					R				
	59-1, 100-102	F	P	R				+																									
	60-1, 138-140	C	M	R	–	+		+										–											R				
	61-1, 145-147	C	P	R	–	+		R										–			–											–	
	63-1, 100-102	C	M	R	–	+		–		–		–	–	–				–			–								R		–	–	
E. tenuis	63, CC	C	M	R	–	+		–		–		+	+	R				R			R								–			·	
	64-1, 148-150	C	M	R	F	R		–	–	–	–	+	+	+				R			R								–		–	·	
	65-1, 108-110	C	M	R	R	+		–	–	F	–	–	+	+		–	–	–	–		–											–	
	66-1, 100-102	C	M	R	+	R		–	·	C	–	+	+	+		–	–	+	–		–								R		–	+	

Samples of the hard flint-like chert were prepared from the core catchers of Cores 28, 30, and 32 through 35. As at Site 305, they contained only very rare, very poorly preserved, unidentifiable Radiolaria. Generally only recrystallized fragments were recovered.

Cores 2-4 (9.5-47 m) belong to the *Dictyomitra somphedia* Zone. Cores 5 through 12 (47-160.5 m) belong to the *Acaeniotyle umbilicata* Zone and contain a fauna which with further study may prove to be related to some of the forms described by Aliev (1965) from the late Early Cretaceous of Azerbaidzhan. Cores 14-19 (217-271 m) belong to the *Eucyrtis tenuis* Zone, and Core 21 (281-290 m) to the *Sethocapsa trachyostraca* Zone. The Radiolaria in Cores 20, and 22 to 39 are too poor to give an age assignment. Cores 40-42 are below the oldest core (195B-2, CC) of DSDP Leg 20 which could be dated on the basis of nannofossils and which is considered to be Valanginian-early Hauterivian in age. The fauna in Cores 40 and 42 is very similar to the next-older core recovered from Leg 20 (196-5). It had no co-occurring calcareous fossils and, on the basis of the Radiolaria, was considered to be Neocomian-?Late Jurassic in age. This fauna is now considered to be Valanginian-Berriasian on the basis of the associated nannofossils in Cores 40-42 and is assigned to the *Sphaerostylus lanceola* Zone.

Radiolaria from Site 307 with Table 5

Radiolaria are present in all of the cores recovered. The only Neogene sample was from the top of Core 1 where about 50 cm of soupy, very liquid brown pelagic clay was washed to recover some very rare, well-preserved, mostly nondiagnostic Cenozoic Radiolaria. One specimen of *Spongaster tetras tetras* suggests a Quaternary age. Fish teeth are common in this sample and in the core catcher.

Radiolaria from the Mesozoic cores are few to common in abundance and moderate to poor in preservation in both chert and soft sediment samples from Cores 2 to 9. The core catcher of Core 6 consists only of small chips of chert and porcellanite. Three different lithologies were sampled: light gray chert, dark brown chert, and light reddish-brown porcellanite. The light reddish-brown sample contains the oldest fauna and is considered to be the most likely to be in situ. The other two samples both contain a fauna younger than that found in Core 5. Chert in Cores 10, 11, and 13, and a mudstone sample from Core 12 contain only rare to few, poorly preserved Radiolaria.

In Core 2 (37.5-47 m) saturnalin rings and Tripo-sphaeridae similar to those of 310A-18 suggest that these cores may be contemporaneous, so Core 2 is thus considered to be early Cenomanian or late Albian (*Dictyomitra somphedia* Zone). Cores 3-4 (56-85 m), of late Albian and Albian age, belong to the *Dictyomitra somphedia* and *Acaeniotyle umbilicata* Zones, respectively. A distinct change in the fauna between Cores 4 and 5, with the last occurrence of *Sphaerostylus lanceola* and *Dictyomitra* (?) *lacrimula* in Core 5, marks the transition from the *Acaeniotyle umbilicata* Zone to the *Eucyrtis tenuis* Zone. Core 5 (103-112 m) is considered to be Aptian to Barremian, and Core 6 and 7 (121-167 m) Barremian to Hauterivian or Valanginian. All three are assigned to the *Eucyrtis tenuis* Zone. Core 8 (195-204 m) is also Barremian to Hauterivian or Valanginian, and Core 9 (232-241 m) is Valanginian. Both are assigned to the *Sethocapsa trachyostraca* Zone. Cores 10-12 (270-307 m) are Valanginian to Berriasian (*Sphaerostylus lanceola* Zone).

TABLE 3 – *Continued*

46	61	58	25	65		56	60	63	45	29	13	14	20	6	55	66	30	50	48	24	35	10	49	44	8	34		7	15	37	2	5	9	32	23	11	22	47	33
Trochodiscus exaspina	*Alievium gallowayi*	*Alievium praegallowayi*	*Alievium* spp.	*Pseudoaulophacus parguераensis*	*Spyrid* (?) gen. and sp. indet.	*Artostrobium tina*	*Artostrobium urna*	*Theocampe salillum*	*Diacanthocapsa communis*	*Dictyomitra alievi*	*Dictyomitra apiarium*	*Dictyomitra boesii*	*Dictyomitra carpatica* (?)	*Dictyomitra cosmoconica*	*Dictyomitra duodecimcostata*	*Dictyomitra koslovae*	*Dictyomitra* (?) *lacrimula*	*Dictyomitra pseudomacrocephala*	*Dictyomitra somphedia*	*Eucyrtis micropora*	*Eucyrtis tenuis*	*Lithocampe mediodilatata*	*Lithomelissa* (?) *petila*	*Platycryphalus* spp. aff. *P. hirsuta*	*Stichocapsa* (?) *rotunda*	*Dibolachras tytthopora*	*Podobursa* (?) *polylophia*	*Podobursa tetracola*	*Podobursa triacantha*	*Podobursa tricola*	*Podocapsa amphitreptera*	*Sethocapsa cetia*	*Sethocapsa leiostraca*	*Sethocapsa* (?) *orca*	*Sethocapsa trachyostraca*	*Syringocapsa limatum*	*Hemicryptocapsa* spp. cf. *H. capita*	*Holocryptocanium barbui*	*Zhamoidellum ornatum* (?)
	?																	-	-				-	-															
									·									+	+				+	F														-	
									R									-	-				-	R														-	
									+									-	-				-	-														-	
									+									-	-				-	R														·	
									+				-					-	-		-		-	R														-	
									-				·											R														-	
									-												+			R															
			-																	-				-															
			-										R							C				-		-				-				-					-
			·							-			R				-			C						-	-		-	-				-	-	-			-
										R			F				F			C						-			-	R				-					-
			R							+		-	-				F			C	R					+			-	-				F	-				R
			+		-					R		-	F				F			F	+					+	-		R	R				F	-	-	-	-	+

Radiolaria from Site 310 with Tables 6 and 7

Neogene

Radiolaria from Hole 310 are common and their preservation is good in Cores 1 through 6, and few and good in Cores 7 to 9 through Section 4. Radiolaria are not present in Section 5 through the core catcher of Core 9.

In Core 1 through Section 2 the latest Quaternary (*Artostrobium tumidulum* Zone, 0 to 0.4 m.y.) was recognized. Core 1, Section 3 to Core 2, Section 4 is assigned to the Pleistocene *Axoprunum angelinum* Zone, and Core 3 is early Pleistocene (*Eucyrtidium matuyamai* Zone, 9 to 1.8 m.y.). Core 4 through Core 5, Section 1 is assigned to the late Pliocene *Lamprocyrtis heteroporos* Zone, (2 to 2.7 m.y.) and Core 5, Section 2 through Core 7, Section 3 to the *Sphaeropyle langii* Zone which ranges from the early Pliocene to the late Miocene. Core 7, Section 5, through Core 8, Section 4, is considered to be late Miocene (*Stichocorys peregrina* Zone). Core 8, Section 5 is in the *Ommatartus penultimus* Zone and Cores 8, Section 6 through 9, Section 1 are considered to belong to the *Ommatartus antepenultimus* Zone. The absence of *O. antepenultimus* and *Cannartus laticonus* from Core 9, Sections 2-4 makes a zonal assignment uncertain.

Details of this zonation are given in Figure 2.

Cretaceous

Radiolaria are absent in all of the Cretaceous cores of Hole 310. They were recovered from the cuttings in some of the core-catcher samples of Hole 310A. They are common to few and moderately well preserved in Cores 8A, 10A, 16A, and 17A, common and poorly preserved in Cores 11A through 13A, very rare and very poorly preserved in Core 14A, and few and poor in Core 18A.

Radiolaria in Cores 8A-13A (231-287 m) are assigned to the *Artostrobium urna* Zone and in Cores 16A-18A (306-353 m) to the *Dictyomitra somphedia* Zone.

Radiolaria from Site 313 with Table 8

Cenozoic

Radiolaria are present only in Cores 1, 2, 9, 12, and 13 of the Cenozoic section. They are well preserved and common to abundant in all of these cores except Core 1, where they are rare.

Core 1 (0-8 m) contains a mixed Quaternary-Pliocene assemblage. Radiolaria in Core 2 (35-45 m) are of late early Miocene age (*Calocycletta costata* Zone). However, this same core is considered to be of middle Miocene age on the basis of the associated foraminifera and nannofossils. In Core 9 the Radiolaria belong to the upper part of the *Buryella clinata* Zone, and are considered to be late early Eocene. Cores 12 and 13 (205-223 m) contain Radiolaria belonging to the *Bekoma bidarfensis* Zone, both early Eocene.

Cretaceous

Radiolaria are not present in Cores 15 to 19, except for some very poorly preserved and very rare specimens in Core 15. They are also missing in Cores 24, 33 through 36, and Sample 40-2, 99-101 cm. They are rare to few in Cores 20 through 23, 25 through 27, 30 through 32, and 37 through 42.

TABLE 4
Occurrence and Abundance of Cretaceous Radiolaria at Site 306

Radiolarian Zones	Species / Sample (Interval in cm)	Abundance	Preservation	21 *Acaeniotyle diaphorogona*	41 *Acaeniotyle helicta*	19 *Acaeniotyle umbilicata*	1 *Cenosphaera* sp.	43 *Dicroa periosa*	31 *Dicroa* sp. A	16 *Sphaerostylus lanceola* group	28 *Staurosphaera septemporata*	26 *Triactoma echiodes*	39 *Triactoma* sp. cf. *T. echiodes*	38 *Triactoma hybum*	3 *Triactoma tithonianum*	36 *Acanthocircus carinatus* s.s.	12 *Acanthocircus dicranacanthos*	18 *Acanthocircus trizonalis*	*Acanthocircus variabilis*	53 *Spongosaturnalis* (?) *eidalimus*	42 *Spongosaturnalis horridus*	57 *Spongosaturnalis hueyi*	51 *Spongosaturnalis hueyi* group	59 *Spongosaturnalis* (?) *ichikawai*	64 *Spongosaturnalis* (?) *moorei*	52 *Spongosaturnalis* (?) *preclarus*	62 *Spongosaturnalis squinaboli*	54 *Spongosaturnalis* (?) *yaoi*	27 *Spongosaturnalis* (?) spp.	67 *Crucella cachensis*	17 *Paronaella* (?) *diamphidia*	40 *Paronaella* (?) *hipposidericus*	4 *Emiluvia chica*
D. somphedia	2, CC[a]	F	P	–																									–				
	3, CC[a]	F	P	–																									–				
	4, CC[a]	F	P	–																									–				
Acaeniotyle umbilicata	5, CC[a]	C	P	R	–	–		–																					R				
	6, CC	C	M	+	–	R		–																					F				
	7, CC	C	P	+	–			–		–								–											–				
	8-1, 15-17	C	M	+	–	–		·		–			–																R				
	8-1, 138-140	C	M	–	–	+		R	–				–					–											R				
	9-1, 130-132	C	M	+	–	+		–	–	–	–		–					–			–								–				
	9, CC	C	M	–		+		–	–	–	–	–	–	–				–			–												
	10-1, 124-125	C	G	F	–	R		F	–	–	–	–	–	–		–	–	R	–		+								R		–	–	·
	11, CC	C	M	–	–	R		·	+		–	·	–	F		–	–	R			R								R		+	–	R
	12-1, 60-62	C	M	R	–	–		–	+	–	–	·	–	F		–	–	R			C								–		+	–	F
	12-1, 144-146	C	M	R	+	R		–	–	–	–	·	–	R		–	–	+			+								–		–		+
	14, CC	C	M	F	–	R		–	–	C	–	R	R	F		+	–	+	–		+								+		–		C
Eucyrtis tenuis	16, CC	F	P	+		+				F																			·				
	17, CC	F	P							F																							
	18, CC	F	P	+		+				R									·														
	19, CC	F	P	+						R																							
S. trach.	21[b]	F	M	R	–	R					–					–	–															?	
S. lanceola	40-1, 119-121	C	M				·			C	–	–	–	–	+	–	F	R			–										–	–	
	41-1, 126-128	C	M							C					–		R	R	·												+		
	42-1, 105-107	F	G				·			F					–		–	–															
	42-1, 116-118	C	M	+		+	F			C					F		+	+													F		

[a]Samples are winnowed so that light material, such as saturnalin rings which one would expect to be present, are missing.

[b]Small forms may be lacking due to sieving, therefore absences have not been recorded.

The poorly preserved Radiolaria of Cores 20 through 23 (336-409 m) and 30 through 32 (466-494 m) are attributed to the late Late Cretaceous and the moderately to well-preserved Radiolaria of Cores 25 through 27 (419-447 m) and 37 through 41 (532-578 m) to the Campanian. The poorly preserved Radiolaria of Core 42 (578-588 m) are considered to be Late Cretaceous. Cores 26, 38, 39, and 41 may be assigned to the *Amphipyndax enesseffi* Zone. No tabulations were made for Radiolaria from the Late Cretaceous of Hole 313.

RADIOLARIAN ZONES

Cretaceous Zonation with Figure 1

Three zonal schemes and one series of informal assemblages have been proposed in the past 2 years for Radiolaria in part of, or the whole Cretaceous. Figure 1 presents these schemes in historical perspective with the oldest at the left side of the page and the more recent ones progressing in order to the right. It was not possible to recognize all the proposed zones and the figure indicates by hachures or blank spaces the areas of uncertainty. Although in the sites considered for the zonation scheme of Leg 32 no material younger than Santonian was used, the subsequent zones of Moore (1973) and Riedel and Sanfilippo (1974) are included to indicate their relationship to each other. Among the levels determined by Moore, his RK3/RK4 boundary may approximate that of *Acaeniotyle umbilicata/Dictyomitra somphedia* boundary of Foreman (this chapter). Other apparent firm points are the base of the RK6 Zone and the RK6/RK7 boundary, both of which fall within the *Artostrobium urna* Zone. Indeed, the base of the RK6 Zone may be approximately synchronous with the base of the *Alievium gallowayi* Zone of Pessagno (in preparation).

Of the Late Cretaceous zones proposed by Pessagno, only the *Alievium gallowayi* and *A. praegallowayi* zones could be recognized. They apparently fall within the *Artostrobium urna* Zone. The zonal marker species below the *A. praegallowayi* Zone were not identified, which may be due to the fauna on which that zonation is based developing under different ecological conditions.

TABLE 4 – *Continued*

46 *Trochodiscus exaspina*	61 *Alievium gallowayi*	58 *Alievium praegallowayi*	25 *Alievium* spp.	65 *Pseudoaulophacus pargueraensis*	*Spyrid* (?) gen. and sp. indet.	56 *Artostrobium tina*	60 *Artostrobium urna*	63 *Theocampe salillum*	45 *Diacanthocapsa communis*	29 *Dictyomitra alievi*	13 *Dictyomitra apiarium*	14 *Dictyomitra boesii*	20 *Dictyomitra carpatica* (?)	6 *Dictyomitra cosmoconica*	55 *Dictyomitra duodecimcostata*	66 *Dictyomitra koslovae*	30 *Dictyomitra* (?) *lacrimula*	50 *Dictyomitra pseudomacrocephala*	48 *Dictyomitra somphedia*	24 *Eucyrtis micropora*	35 *Eucyrtis tenuis*	10 *Lithocampe mediodilatata*	49 *Lithomelissa* (?)	44 *Platycryphalus* spp. aff. *P. hursuta*	8 *Stichocapsa* (?) *rotunda*	34 *Dibolachras tytthopora*	*Podobursa* (?) *polylophia*	7 *Podobursa tetracola*	15 *Podobursa triacantha*	37 *Podobursa tricola*	2 *Podocapsa amphitreptera*	5 *Sethocapsa cetia*	9 *Sethocapsa leiostraca*	32 *Sethocapsa* (?) *orca*	23 *Sethocapsa trachyostraca*	11 *Syringocapsa limatum*	22 *Hemicryptocapsa* spp. cf. *H. Capita*	47 *Holocryptocanium barbui*	33 *Zhamoidellum ornatum* (?)
									–									+	F				–	R														–	
									–									–	F				–	+														–	
									+									–	+				·	R														·	
			–						R				–					–	–	–			–	R														–	
R									F				R				–	–	–	?	?		–	R														·	
					–				–				–				–	–	–					R														–	
			–		R				–				+				–		–	?				R														+	
			–		+				–										–					R															
					–				–				–						–					+														–	
									–								–							+						–									
									–			–	F				–			R	R			–		–				–								·	
			–		–				–	–		–	F				–			C				–		–			–	+				–					–
			+							–		–	R				–			C						–			–					–	–			–	–
			–							+			R				C			C	+					–			–	+				+	–				F
			·		–					–	·	–	C				C			C	+	–			–	R	–		R	R		–		F	·	–	–		C
			·									?	R				+			R	·	?				·	–		+					+	+	·			
													+				–												·					+					
										·										+														+					
													+				+			R	–												?	+					·
			·											–			–			+	–	–			–	–	F		R	–	–	·	?	R	F	R	F		
					–						R	?	F	F			–			–		R			·		–	·	R		·	R	F	–	–	–	–		–
					–						–	R		R						?		+			R			·	+		·	R	·		–		–		
					R						·	R	C	·								+									·	·	–				–		
			R		R						R	F	F	F								F			F			+	F		R	·	R			R			

The three informal assemblages proposed by Foreman (1973) approximate the first three zones proposed by Riedel and Sanfilippo (1974). However, with the longer, more complete sequence from DSDP Leg 17, Site 167 with which they worked, they could select some more suitable zonal marker species and thus their names are used here. An exception is the new *Sethocapsa trachyostraca* Zone which replaces the *Staurosphaera septemporata* Zone. Its base is defined by the first appearance of *Sethocapsa trachyostraca.* This is at a lower level than the first appearance of *Staurosphaera septemporata* and thus lowers the top of the *Sphaerostylus lanceola* Zone.

Two other new zones, *Acaeniotyle umbilicata* and *Dictyomitra somphedia,* are introduced to divide the long interval between the *Eucyrtis tenuis* and *Artostrobium urna* zones. The base of the *Dictyomitra somphedia* Zone, which is defined by that form's first appearance, may be approximately synchronous with the base of Moore's RK4 Zone, which is defined by the first appearance of *Dictyomitra pseudomacrocephala.* It may also approximate the first appearances of *Dictyomitra veneta* and *Lithomelissa* (?) *petila.* However, their occurrences are so spotty and rare that it is not possible to determine in just what order they do actually first appear. *Lithomelissa* (?) *petila* may even have a slightly earlier first appearance. *D. somphedia* was selected as the marker fossil for this zone because of its large distinctive form and because it appeared to be the most widespread and common of these four species, appearing most frequently both in the Leg 20 and the Leg 32 material studied.

The relation of foraminiferal and nannofossil zones to the radiolarian zones are given in the last two columns of Figure 3. The correlation is made on the basis of material presented by Bukry and Luterbacher in other chapters of this volume.

The Cretaceous zones used are defined as follows:

Artostrobium urna Zone Riedel and Sanfilippo (1974)

The base is defined by the earliest morphotypic appearance of *Artostrobium urna.*

Dictyomitra somphedia Zone Foreman, new zone

The base is defined by the first morphological appearance of *Dictyomitra somphedia.* This may, in more southern latitudes, be approximately synchronous with the first appearance of *Dictyomitra veneta.*

The upper limit is defined by the first morphotypic appearance of *Artostrobium urna.* Included are the last occurrences of *Platycryphalus* spp. aff. *P. hirsuta, Dic-*

TABLE 5
Occurrence and Abundance of Cretaceous Radiolaria at Site 307

Radiolarian Zones	Sample (Interval in cm)	Abundance	Preservation	21 *Acaeniotyle diaphorogona*	41 *Acaeniotyle helicta*	19 *Acaeniotyle umbilicata*	1 *Cenosphaera* sp.	43 *Dicroa periosa*	31 *Dicroa* sp. A	16 *Sphaerostylus lanceola* group	28 *Staurosphaera septemporata*	26 *Triactoma echiodes*	39 *Triactoma* sp. cf. *T. echiodes*	38 *Triactoma hybum*	3 *Triactoma tithonianum*	36 *Acanthocircus carinatus* s.s.	12 *Acanthocircus dicranacanthos*	18 *Acanthocircus trizonalis*	*Acanthocircus variabilis*	53 *Spongosaturnalis* (?) *eidalimus*	42 *Spongosaturnalis horridus*	57 *Spongosaturnalis hueyi*	51 *Spongosaturnalis hueyi* group	59 *Spongosaturnalis* (?) *ichikawai*	64 *Spongosaturnalis* (?) *moorei*	52 *Spongosaturnalis* (?) *preclarus*	62 *Spongosaturnalis squinaboli*	54 *Spongosaturnalis* (?) *yaoi*	27 *Spongosaturnalis* (?) spp.	67 *Crucella cachensis*	17 *Paronaella* (?) *diamphidia*	40 *Paronaella* (?) *hipposidericus*	4 *Emiluvia chica*
?	2, CC	R	M															–		–	–		–	–	–	–	–	–	R	–			
D. somph.	3-1, 126-128	C	P															–		–	–		+	–	–	–	–	–	F				
A. umbil. ?	4, CC	C	P	–	–	–		–		–	–	–		–		–	–	–	–	⊙	–		Ⓡ	–	–	–	–	–	F				
E. tenuis	5, CC	F	P[a]							R	–																		–				
	6, CC	C	M	R	+	R		–	–	C	+	R	–	·		+	·	R	–	–	–		–						R		–	–	
	7-1, 75-77	C	M	F	+	R		–	R	C	+	R	+	R		R	+	F	+										R		+	·	–
	8, CC	C	M	R	–	F		–	R	C	–	R	–	–		–	F	F	+										R				–
S. trachyostraca	9-1, 80-82	C	M	R	–	R			–	C	F	R	–	–	–	–	F	F	+										R				–
	10-1, 119-120	F	P	+		R			–	C	–	–			R			+											–				F
S. lanceola	10-1, 142-144	F	P							C	–				R		+	R											–				F
	11-1, 102-104[b]	R	P																														R
	12-1, 120-122[b]	R	P							R					R		+	+															R

[a]Except one small sample of ash sediment with rare good Radiolaria.

[b]Absences are not recorded because of the poor preservation and poverty of forms.

◯ Suspected downward contamination.

tyomitra pseudomacrocephala, D. somphedia, and *Lithomelissa* (?) *petila,* and the first appearances of *Spongosaturnalis* (?) *preclarus, S.* (?) *eidalimus,* and *S.* (?) *yaoi.*

Acaeniotyle umbilicata Zone Foreman, new zone

The base is defined by the extinction of the *Sphaerostylus lanceola* group, which may be approximately synchronous with the extinction of *Dibolachras tytthopora, Sethocapsa* (?) *orca, Zhamoidellum ornatum* (?), *Acaeniotyle helicta,* and *Dictyomitra* (?) *lacrimula.*

The upper limit is defined by the first morphological appearance of *Dictyomitra somphedia.* Included are the last occurrence of *Dictyomitra periosa,* the first ap-

TABLE 6
Occurrence and Abundance of Cretaceous Radiolaria at Site 310

Radiolarian Zones		Sample (Interval in cm)	Abundance	Preservation	21 *Acaeniotyle diaphorogona*	41 *Acaeniotyle helicta*	19 *Acaeniotyle umbilicata*	1 *Cenosphaera* sp.	43 *Dicroa periosa*	31 *Dicroa* sp. A	16 *Sphaerostylus lanceola* group	28 *Staurosphaera septemporata*	26 *Triactoma echiodes*	39 *Triactoma* sp. cf. *T. echiodes*	38 *Triactoma hybum*	3 *Triactoma tithonianum*	36 *Acanthocircus carinatus* s.s.	12 *Acanthocircus dicranacanthos*	18 *Acanthocircus trizonalis*	*Acanthocircus variabilis*	53 *Spongosaturnalis* (?) *eidalimus*	42 *Spongosaturnalis horridus*	57 *Spongosaturnalis hueyi*	51 *Spongosaturnalis hueyi* group	59 *Spongosaturnalis* (?) *ichikawai*	64 *Spongosaturnalis* (?) *moorei*	52 *Spongosaturnalis* (?) *preclarus*	62 *Spongosaturnalis squinaboli*	54 *Spongosaturnalis* (?) *yaoi*	27 *Spongosaturnalis* (?) spp.	67 *Crucella cachensis*	17 *Paronaella* (?) *diamphidia*	40 *Paronaella* (?) *hipposidericus*	4 *Emiluvia chica*
A. gal	*A. urna*	8A, CC	C	M																	–		–	·	?	R	–		R	·	R			
A. praegallowayi		10A, CC	C	P																	–		–	R	R	F	–	F	C	+	–			
		11A, CC	C	P																	R			C	C	F	–	·	C	C	–			
		12A, CC	C	P																	–		–	F	–	–		+	C	F	–			
		13A, CC	C	P																	R		R	C	·	–	–	–	+	C	–			
D. somphedia		16A, CC	F	M																	–		–	·		–	F	–	–	C	–			
		17A, CC	C	M																	C		–	F	–	–	R	+	R	C				
		18A, CC	F	P																	–				–	–		–		F				

TABLE 5 – *Continued*

Trochodiscus exaspina	*Alievium gallowayi*	*Alievium praegallowayi*	*Alievium* spp.	*Pseudoaulophacus pargueraensis*	*Spyrid* (?) gen. and sp. indet.	*Artostrobium tina*	*Artostrobium urna*	*Theocampe salillum*	*Diacanthocapsa communis*	*Dictyomitra alievi*	*Dictyomitra apiarium*	*Dictyomitra boesii*	*Dictyomitra carpatica* (?)	*Dictyomitra cosmoconica*	*Dictyomitra duodecimcostata*	*Dictyomitra koslovae*	*Dictyomitra* (?) *lacrimula*	*Dictyomitra pseudomacrocephala*	*Dictyomitra somphedia*	*Eucyrtis micropora*	*Eucyrtis tenuis*	*Lithocampe mediodilatata*	*Lithomelissa* (?) *petila*	*Platycryphalus* spp. aff. *P. hirsuta*	*Stichocapsa* (?) *rotunda*	*Dibolachras tytthopora*	*Podobursa* (?) *polylophia*	*Podobursa tetracola*	*Podobursa triacantha*	*Podobursa tricola*	*Podocapsa amphitreptera*	*Sethocapsa cetia*	*Sethocapsa leiostraca*	*Sethocapsa* (?) *orca*	*Sethocapsa trachyostraca*	*Syringocapsa limatum*	*Hemicryptocapsa* spp. cf. *H. capita*	*Holocryptocanium barbui*	*Zhamoidellum ornatum* (?)
46	61	58	25	65		56	60	63	45	29	13	14	20	6	55	66	30	50	48	24	35	10	49	44	8	34		7	15	37	2	5	9	32	23	11	22	47	33
-	-	-							-										-				-	-														-	
-									?									-	-				F	-														R	
R			-						R	-		-	-				-	-	-	-	-		(+)	R		-			-	-				-				+	-
													F				R			R																		R	F
-			R		-				-	+	-	·	F				F			R	+		-	-		R			R	+			-	F	-			-	R
			R		+					+	+	+	F	-			F			C	R	-		-	-	F	-	-	F	R		-	-	+	+	-	+	-	R
			F		R					+	F	R	F	R			+			R	-	R			·	-	F	+	+	-	-	?	R	-	R	F	F	-	-
			F		·					-	R	R	R	R			-			R		R			·	-	F		+	-		-	F	-	F	+	R	-	-
											-	-	R	+						-					-		-		+			+	+	-	-	-	-		
											-	-		+						-									+			+	+		-				
														+																									
											+		+	+								R							R			+							

pearances of *Platycryphalus* spp. aff. *P. hirsuta* and *Diacanthocapsa communis*, and the last occurrence of *Acaeniotyle umbilicata* and *A. diaphorogona*.

Eucyrtis tenuis Zone Riedel and Sanfilippo (1974) emend. Foreman

This zonal name continues to be used to cover approximately the same interval as indicated by Riedel and Sanfilippo (1974). Only the definition of the base is altered because of the rarity of and the difficulty in confidently distinguishing the original basal marker species *Eucyrtis tenuis* from *Eucyrtis micropora*. In more southerly latitudes it may well be that this distinction can be more easily made.

The base is here defined by the first appearance of *Dibolachras tytthopora*. This is believed to be approximately synchronous with or slightly earlier than the first appearance of *Eucyrtis tenuis*, and with the first appearance of large well-developed specimens of *Dictyomitra* (?) *lacrimula*. The upper limit is defined by the last occurrence of members of the *Sphaerostylus lanceola*

TABLE 6 – *Continued*

Trochodiscus exaspina	*Alievium gallowayi*	*Alievium praegallowayi*	*Alievium* spp.	*Pseudoaulophacus pargueraensis*	*Spyrid* gen. and sp. indet.	*Artostrobium tina*	*Artostrobium urna*	*Theocampe salillum*	*Diacanthocapsa communis*	*Dictyomitra alievi*	*Dictyomitra apiarium*	*Dictyomitra boesii*	*Dictyomitra carpatica* (?)	*Dictyomitra cosmoconica*	*Dictyomitra duodecimcostata*	*Dictyomitra koslovae*	*Dictyomitra* (?) *lacrimula*	*Dictyomitra pseudomacrocephala*	*Dictyomitra somphedia*	*Eucyrtis micropora*	*Eucyrtis tenuis*	*Lithocampe mediodilatata*	*Lithomelissa* (?) *petila*	*Platycryphalus* spp. aff. *P. hirsuta*	*Stichocapsa* (?) *rotunda*	*Dibolachras tytthopora*	*Podobursa* (?) *polylophia*	*Podobursa tetracola*	*Podobursa triacantha*	*Podobursa tricola*	*Podocapsa amphitreptera*	*Sethocapsa cetia*	*Sethocapsa leiostraca*	*Sethocapsa* (?) *orca*	*Sethocapsa trachyostraca*	*Syringocapsa limatum*	*Hemicryptocapsa* spp. cf. *H. capita*	*Holocryptocanium barbui*	*Zhamoidellum ornatum*
46	61	58	25	65		56	60	63	45	29	13	14	20	6	55	66	30	50	48	24	35	10	49	44	8	34		7	15	37	2	5	9	32	23	11	22	47	33
	R	-		+		R	C	C							F	C																							
	+	+		-		R	F	C							C	-																							
	-	R		-		-	·	·							F	-																							
	-	·		-		-	F	C							R	-																							
	+	R		?		R	R	?							-	-							-																
		-				+	-	-							R	-							-																
-		-				-	-	-							-				-				+																
-		-				-	-	-							-				-				-																

TABLE 7
Occurrence and Abundance of Neogene Radiolaria at Site 310

Radiolarian Zones	Sample (Interval in cm)	Abundance	Preservation	11 *Axoprunum angelinum*	21 *Sphaeropyle langii*	10 *Sphaeropyle robusta*	18 *Cannartus* sp.	2 *Ommatartus* sp. A	3 *Ommatartus* sp. B	4 *Ommatartus* sp. cf. *Cannartus bassanii*	14 *Ommatartus antepenultimus*	22 *Ommatartus avitus*	15 *Ommatartus hughesi*	16 *Ommatartus penultimus*	20 *Ommatartus tetrathalamus*	1 *Oroscena* sp. (digitate spines)	*Spongaster pentas*	29 *Spongaster tetras irregularia*	*Spongaster tetras tetras*	5 *Dendrospyris bursa*	13 *Artostrobium tumidulum*	19 *Lamprocyrtis hannai*	28 *Lamprocyrtis haysi*	23 *Lamprocyrtis heteroporos*	26 *Lamprocyrtis neoheteroporos*	25 *Theocorythium trachelium dianae*	24 *Theocorythium trachelium trachelium*	17 *Theocorythium vetulum*	*Cyrtocapsella cornuta*	*Cyclampterium* (?) *brachythorax*	6 *Cyclampterium* (?) sp.	*Eucyrtidium calvertense*	27 *Eucyrtidium matuyamai*	12 *Lithopera bacca*	*Pterocanium prismatium*	8 *Stichocorys delmontensis*	9 *Stichocorys peregrina*	7 *Theocorys* sp.
a	1-1, 126-128	C	G	-	+	-									+			+	-		F	R	R	-	-	R	-	-						+				
	1-2, 40-42	C	G	-	+										-			+	-		C		R	-	-	R	-							+				
	1-3, 110-112	C	G	+	+	-									+			R	-		C	F	R	-	-	R	-					+		+				
	1-4, 84-86	C	G	R	R	-									+			R	+		F	+	-	-	-	R	R							R				
b	1, CC	C	G	+	R	-									R			-	-		F	R	R	-	-	+	R					+		+				
	2-1, 120-123	C	G	-	+	-									+			+	-		C	R	-	-	-	+	-	-				-		-				
	2-2, 120-123	C	G	+	R	-									-			R	-		F		+	-	-	+	+	-				+		R				
	2-3, 119-122	C	G	R	R	-									+			R	-		C	F	R	-	R	+	R	-				R		+				
	2-4, 103-106	C	G	-	R	-									R			R	-		F	R	-	-	+	-	+	F				R	-	R				
	2, CC	C	G	F	R	-									F			R	-		F	F	R	-	+	R	R	C				R	R	R				
	3-1, 130-132	F	G	F	R	-									F		·	+	R		C	R	+	-	R	+	+	+				+	+	-				
	3-2, 128-130	C	G	R	R	-									F		-	+	-		F	+	+	-	-	-	-	F				R	F	+				
c	3-3, 130-132	C	G	F	R	-									-		-	-	·		R	F	+	R	R	-	-	F				+	R	R				
	3-4, 130-132	C	G	C	R	-									-		-	-	-		C	+	-	R	R	R	+	C				+	F	-				
	3-5, 120-122	C	G	F	R	-									+		-	-	-		C	+	-	R	R	R	R	F				R	R	R				
	3-6, 130-132	C	G	R	R	-									+		-	-	-		R	+	-	F	R	+	-	F				R	R	+				
	3, CC	C	G	R	F	R									-		-	-	-		R	R	-	F	R	+	R	C				R	R	+				
	4-1, 50-53	F	G	F	R	R									R		-	-	-		F	+	-	C	+	R	+	R				F	-	+				
	4-2, 120-123	C	G	R	R	R									R		-	-	-		R	R	-	C	-	R	-	C				R	-	+				
	4-3, 120-123	C	G	R	R	R									+		-	-	-		R	R	-	C	-		R	+				R	-	-				
d	4-4, 120-123	C	G	F	R	R									-						F	+		F	-		+	F				+	-	+				
	4-5, 110-113	F	G	R	R	R									+							R		F	-	R	R	F			-	R	-	R	·			
	4-6, 119-121	C	G	·	R	R									+						+	+		R	-	R	+	C					-	+				
	4, CC	C	G	R	F	F									R						-	+		F	-	+	+	C				R	-	+	·		-	
	5-1, 124-126	F	G	R	R	R									-						+	+		F	-	?	?	C				R	-	-			-	
	5-2, 122-124	C	G	F	R	+									+						-	+		R	-			C					-	+			R	
	5-3, 124-126	F	G	R	R	R									-		-	-	-		R	R		F	-			F					-	-			F	
	5-5, 124-126	F	G	+	R	R									+						+	F		R	-			C					-	-		·	R	
	5, CC	F	G	R	R	F									+							+		F	-			F					-	-		·	R	
e	6-1, 120-123	F	G	F	R	R								-		R					+	R		C	-		-	C				R	-	-		-	R	
	6-3, 128-130	C	G	R	R	F								-		-					-	R		F	-			C				R	-	F	·	-	C	
	6-5, 138-141	C	G	+	R	F								+		+						C		R				F				+		F	·	+	F	
	6, CC	C	G	R	R	F								+		R						C		R			+	C				+		-	-	R	R	
	7-1, 133-136	C	G	F	R	R	-					-		+								C		R			-	C				R		R		-	F	
	7-3, 125-127	F	G	F	R	R	R					+		+							R	+		-			-	+				+		F	-	-	R	
	7-5, 124-126	F	G	F	-	R	F							+		·					R	+		-			-	R						F		-	+	
	7, CC	F	G	F	-	F	F							-							R	-		-				R						-	-	-	R	
f	8-1, 125-127	F	G	F	-	F	C							-							R	-						R			-			F		R	F	
	8-3, 126-128	F	G	-	-	F	F	-	-	-	-		-	-	-	-				-	+	-		-				R			-			F		-	-	
	8-4, 124-126	F	G		-		R	-	-	-	-		-	-		-				-											-			C		R	F	+
g	8-5, 125-127	F	G	R	-	F		F	R	+	-	-	R	R	-	-				R	+	-		-				R			R			C		C	F	
	8-6, 100-102	F	G	+		F		A	C	R	R		R	-		R				C	-							-	-	-	C			C				R
h	8, CC	F	G		-	+		C	R	-	-		+	-		C				C	+								-	-	F			C		F	R	R
	9-1, 120-123	F	G	+		R		C	F	C	+		R	-		C				C								-	-	-	R			C		F		R
	9-2, 120-123	F	G			+		C	F	F	-		-			C				C	+							-	-	-	+			C		R	+	R
	9-4, 124-126	F	G	+	-	+		F	R	R	-		-	-		C				C	+							-	-	-	+			C		R	+	R
	9-5, 124-126	-																																				

[a]*Artostrobium tumidulum*
[b]*Axoprunum angelinum*
[c]*Eucyrtidium matuyamai*
[d]*Lamprocyrtis heteroporos*
[e]*Sphaeropyle langii*
[f]*Stichocorys peregrina*
[g]*Ommatartus penultimus*
[h]*Ommatartus antepenultimus*

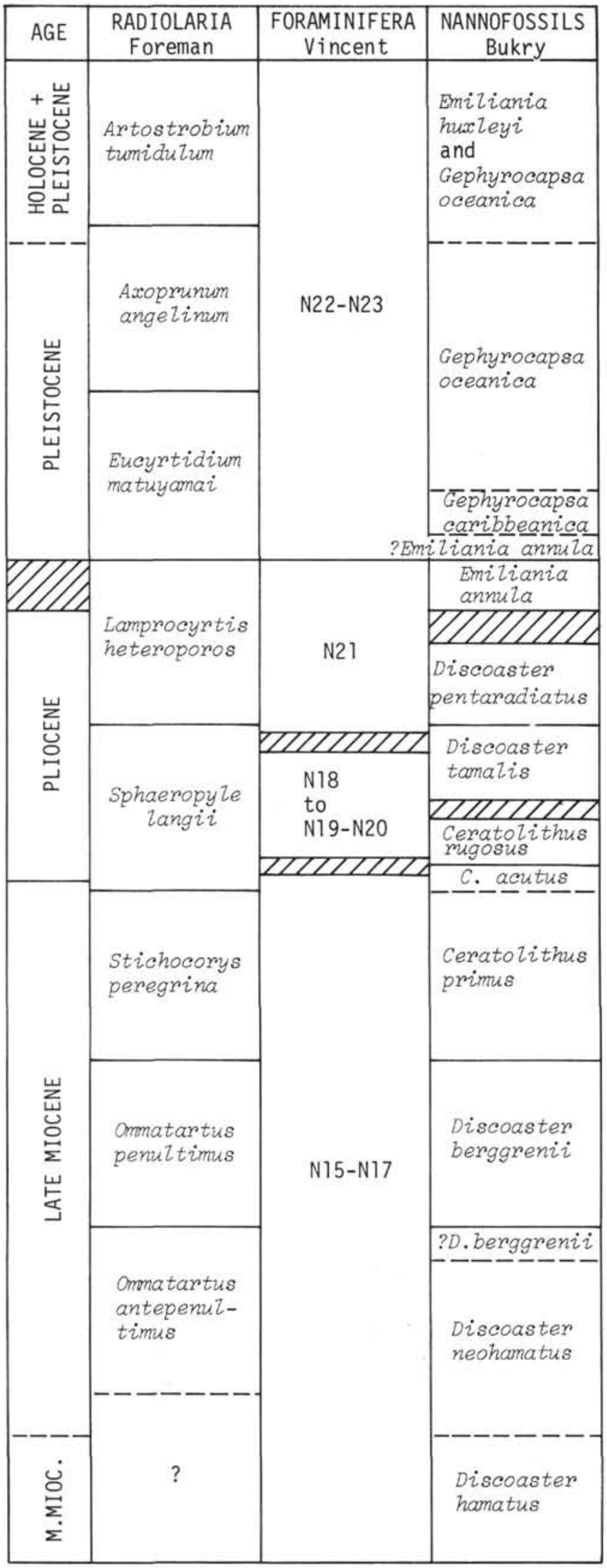


Figure 2. *Relation of Neogene radiolarian zones to the foraminiferal and nannofossil zones presented in this report.*

group, which may be approximately synchronous with the last occurrences of *Dibolachras tytthopora, Sethocapsa* (?) *orca,* and *Zhamoidellum ornatum* (?). Thus it appears that the total range of *D. tytthopora* may span the range of this zone.

Included are the last occurrences of *Acanthocircus dicranacanthos, Sethocapsa trachyostraca,* and *Staurosphaera septemporata,* and the first appearance of *Acaeniotyle helicta.*

Sethocapsa trachyostraca Zone Foreman, new zone

The base is defined by the first appearance of *Sethocapsa trachyostraca* and the upper limit by the first occurrence of *Dibolachras tytthopora.* Included are the first appearances of *Stauro-sphaera septemporata, Dicroa* sp. A, and *Sethocapsa* (?) *orca,* and the last occurrence of *Dictyomitra cosmoconica.*

It may be that this zone can be divided into two zones, the first based on the earliest appearance of *Sethocapsa trachyostraca* and the second on the earliest appearance of *Staurosphaera septemporata.* This step is not now taken because of the uncertainty concerning the time interval between the earliest appearance of these two forms.

Sphaerostylus lanceola Zone Riedel and Sanfilippo (1974) emend. Foreman

The base continues to be defined by the first evolutionary appearance of *Sphaerostylus lanceola* (Riedel and Sanfilippo, 1974). The top, however, is lowered and is defined by the first appearance of *Sethocapsa trachyostraca.*

Early Eocene Zonation

Only three radiolarian-bearing cores were recovered from the early Eocene: Core 313-9 (*Buryella clinata* Zone) and Cores 313-12 and 13 (*Bekoma bidarfensis* Zone).

Buryella clinata Zone Foreman, 1973a, emend.

The base continues to be defined as the earliest evolutionary appearance of *Buryella clinata.* Only its ancestor is changed. The evolutionary progression extends from *Pterocodon* (?) *anteclinata* to *Buryella clinata* rather than as stated earlier from *Buryella tetradica* to *B. clinata.* The top continues to be defined by the earliest evolutionary appearance of *Phormocyrtis striata striata.*

Bekoma bidarfensis Zone Foreman, 1973a

The definition of this zone can be amplified to include near its top the first morphological appearance of *Theocampe urceolus.* The base continues to be defined by the earliest morphotypic appearance of *Bekoma bidarfensis* and the top by the earliest evolutionary appearance of *Buryella clinata.*

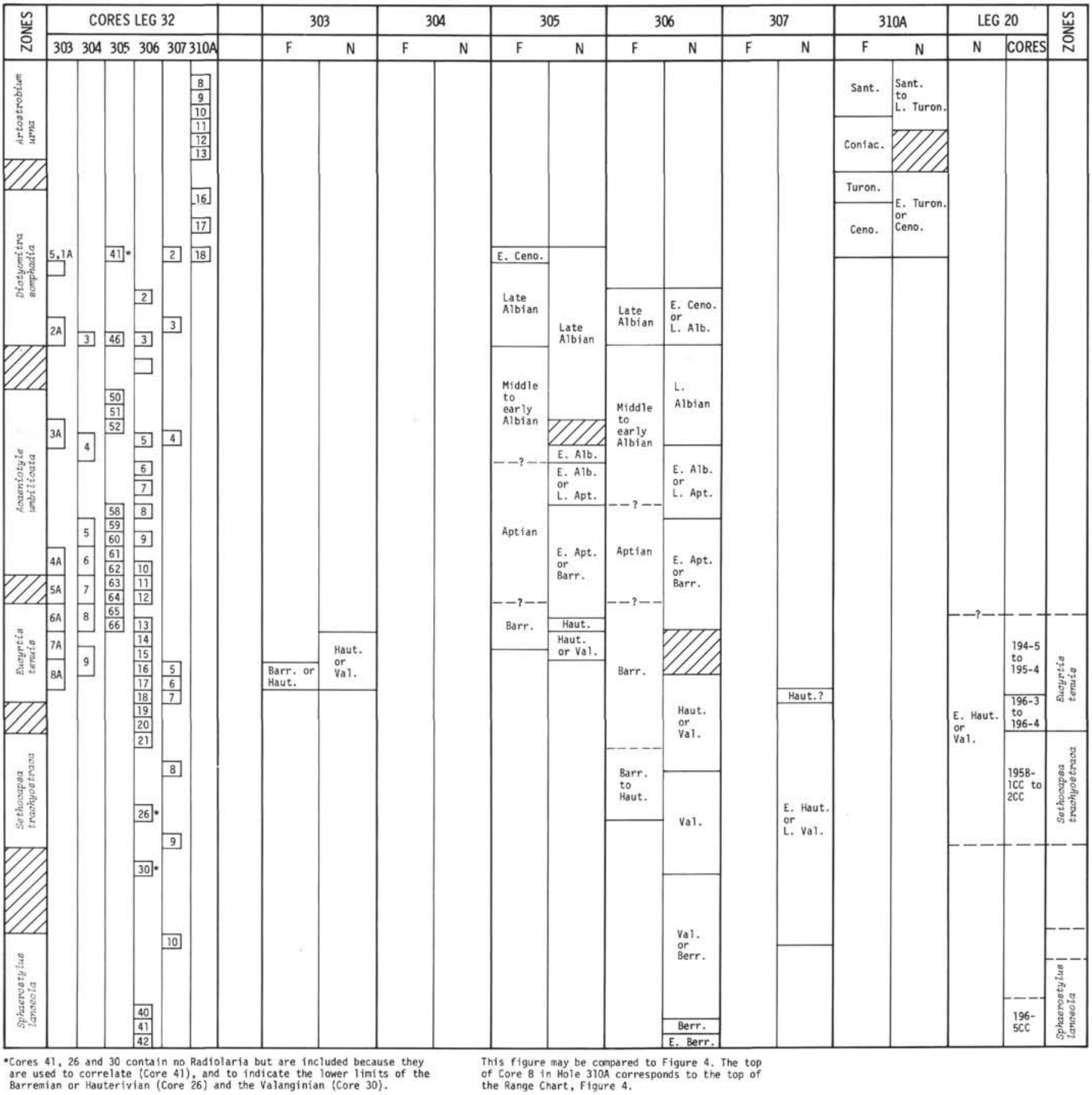
Neogene Zonation with Figure 2

Previous zones for the Neogene proposed by Hays (1970) for the Pliocene-Pleistocene of the North Pacific, and Riedel and Sanfilippo (1970, 1971) for the late Miocene of the equatorial Pacific, have been used. The post-Miocene zones of Riedel and Sanfilippo for the equatorial Pacific could not be recognized. The species used by Nigrini (1971) in her zonation of the Quaternary of the equatorial Pacific were looked for, but with the

TABLE 8
Occurrence and Abundance of Early Eocene Radiolaria at Site 313

Radiolarian Zones	Sample (Interval in cm)	Abundance	Preservation	*Giraffospyris lata*	*Lithomitra docilis*	*Theocampe amphora* group	*Theocampe urceolus*	*Amphipternis clava*	*Bekoma bidarfensis*	*Buryella clinata*	*Buryella pentadica*	*Buryella tetradica*	*Lamptonium fabaeforme* (?) *chaunothorax*	*Lamptonium fabaeforme* (?) *constrictum*	*Lamptonium fabaeforme fabaeforme* (?)	*Lamptonium pennatum*	*Lamptonium sanfilippoae*	*Lithochytris archaea*
	313-9-1, 123-125	A	G	-	-	C	C	-	-	C		-	R	-	R	-	-	F
	313-9, CC	A	G	-	+	C	C	-	-	C		-	F	-	F	-	-	F
	313-12-1, 128-131	A	G	F	+	-	R	-	+	R		R	-	-	R	R	-	F
Bekoma bidarfensis	313-12-3, 124-126	A	G	C	+	-	-		+	-		C	R		R	R		R
	313-12-5, 124-126	A	G	C	R	-			R	-		C	R		R	R		R
	313-12, CC	A	G	C	-		·		+			F	R		F	R		R
	313-13-1, 124-126	A	G	C			·		R			F	R		R	-		F
	313-13-3, 125-127	A	G	C			-		F			C	R		R	-		F
	313-13-5, 124-126	A	G	C			-		F		-	F			F	R		C
	313-13, CC	A	G	C					+		-	C	R		F	R		C

Sample (Interval in cm)	*Lynchnocanomma bellum*	*Phormocyrtis cubensis*	*Phormocyrtis striata exquisita*	*Phormocyrtis striata striata*	*Phormocyrtis turgida*	*Pterocodon* (?) *anteclinata*	*Pterocodon* (?) *tenellus*	*Rhopalocanium ornatum*	*Theocorys acroria*	*Theocorys anaclasta*	*Theocorys anapographa*	*Theocorys* (?) *phyzella*	*Theocotyle* (T.) *cryptocephala* (?) *nigriniae*	*Theocotyle (Theocotylissa) alpha*	*Theocotyle (Theocotylissa) auctor*	*Theocotyle (Theocotylissa) ficus*	*Theocotyle (Theocotylissa)* (?) *fimbria* (early form)	*Thyrsocyrtis hirsuta hirsuta*	*Thyrsocyrtis hirsuta tensa*	*Thyrsocyrtis tarsipes*	*Tricolocampe vitrea*	*Lophocyrtis biaurita*
313-9-1, 123-125	R	·	C	R	-	-	-	+	F	·	-	-	C	-	-	C	-	C	C	·	-	R
313-9, CC	-	-	C	R	-	-	-	·	F	-	-	-	C	-	-	C	-	C	F	-	-	-
313-12-1, 128-131	-	R	C	-	R	R	R	-	-	-	-	F	F	F	C	-	R	-	-	R	R	-
313-12-3, 124-126		R	C	-	R	F	F		-			F	F	F	F		R	·		R		
313-12-5, 124-126		F	C		F	R	F				-	F	R	-	C		F	+			R	
313-12, CC		F	C		C	F	F					R	F	-	C		C			R	R	
313-13-1, 124-126		R	C		R	C	F					R	F	-	R		R			R	R	
313-13-3, 125-127		R	C		C	F	F		R			R	R		C		F			R		
313-13-5, 124-126		F	C		F	F	F					R	R		R		R			R	R	
313-13, CC		F	C		F	R	F		R		-	R	R		C		F			R	+	



*Cores 41, 26 and 30 contain no Radiolaria but are included because they are used to correlate (Core 41), and to indicate the lower limits of the Barremian or Hauterivian (Core 26) and the Valanginian (Core 30).

This figure may be compared to Figure 4. The top of Core 8 in Hole 310A corresponds to the top of the Range Chart, Figure 4.

Figure 3. *Correlation of Cretaceous cores based on radiolarian and foraminiferal events with age assignments according to foraminifera and nannofossils.*

exception of *Theocorythium trachelium trachelium* and *Theocorythium vetulum*, were either not found or occurred too sporadically to attempt a correlation with Hays (1970) zones for the North Pacific.

To accommodate the interval between the late Miocene-early Pliocene, the *Stichocorys peregrina* Zone and the earliest zone of Hays (*Lamprocyrtis heteroporos* Zone), a new zone for the North Pacific, the *Sphaeropyle langii* Zone, has been introduced. This zone approximates the range of the *Spongaster pentas* Zone in more southern latitudes.

The Neogene Zones are defined as follows:

Artostrobium tumidulum Zone Hays, 1970

The base is defined by the presence of *Artostrobium tumidulum* subsequent to the extinction of *Axoprunum angelinum*. This zone extends to the top of Recent sediments.

Axoprunum angelinum Zone Hays, 1970

This zone is defined by the range of *Axoprunum angelinum* subsequent to the extinction of *Eucyrtidium matuyamai*. Its base may also be coincident with the last occurrence of *Theocorythium vetulum*.

Eucyrtidium matuyamai Zone Hays, 1970, emend. Foreman

In the material examined the last occurrence of *Lamprocyrtis heteroporos* was about midway in the range of *Eucyrtidium matuyamai*, well above the Pliocene-Pleistocene boundary, and thus the definition of the Zone is amended to include the complete evolutionary range of *E. matuyamai* only, regardless of the last occurrence of *Lamprocyrtis heteroporos*. Included are the last occurrence of *Sphaeropyle robusta* and the first appearances of *Spongaster tetras irregularis* and *Lamprocyrtis haysi*.

Lamprocyrtis heteroporos Zone Hays, 1970, emend. Foreman

The base is defined by the occurrence of *Lamprocyrtis heteroporos* subsequent to the extinction of *Stichocorys peregrina* and the top by the first evolutionary appearance of *Eucyrtidium matuyamai*.

Sphaeropyle langii Zone Foreman, new zone

The base is defined by the first morphological appearance of *Sphaeropyle langii* and the top by the base of the *Lamprocyrtis heteroporos* Zone. The first morphological appearance of *Lamprocyrtis heteroporos* is included in this zone. The range of this zone approximates that of the *Spongaster pentas* Zone of the equatorial Pacific.

Stichocorys peregrina Zone Riedel and Sanfilippo, 1970, emend. Foreman

The base is defined by the earliest evolutionary appearance of *Stichocorys peregrina* and the top by the base of the *Sphaeropyle langii* Zone. The top of this zone is redefined for the North Pacific where the *Spongaster pentas* Zone cannot be recognized.

Ommatartus penultimus Zone Riedel and Sanfilippo, 1970

The base is defined by the earliest evolutionary appearance of *Ommatartus penultimus* and the top by the base of the *Stichocorys peregrina* Zone.

Ommatartus antepenultimus Zone Riedel and Sanfilippo, 1970

The base is defined by the earliest evolutionary appearance of *Ommatartus antepenultimus* and the top by the base of the *O. penultimus* Zone.

RANGES OF RADIOLARIA

List of Events with Tables 9 and 10

The list of events (Table 9) for the Cretaceous has been constructed from the information in Tables 1-6. This list gives, in order from youngest to oldest, the last occurrence and the first appearance for most of the species considered here at Sites 303-307 and 310. Thus, the list serves to correlate in detail between sites, and indeed the information compiled here has been used to make the Cretaceous correlation chart (Figure 1). A few species have been omitted from the list of events because their occurrence was so rare or considered so unreliable that listing them would have been misleading. If all were perfect, lines drawn between sites for each event would progress evenly across in parallel rows. However, variable conditions at each site, and probably unrecognized reworking and caving result in the crossing of many lines. The resulting areas of uncertainty between zone boundaries are represented by hachured lines on the range chart.

The events are indicated as occurring between the pair of cores where the species is present and the first subsequent core where the species was not observed. Numbers in parentheses below the core numbers indicate the depth below the sea floor in meters for each core. In the left-hand column the species name is accompanied by a "T" for top, last occurrence, or a "B" for base, first appearance. The number in this column is the consecutive running number for the species as it appears on the range chart.

Events at the top above the last sample and at the base below the last sample are arbitrarily arranged as there is no information in this report that would indicate their order. Similarly, events in the body of the chart which correlate across between the same sets of core pairs are also arbitrarily arranged.

In Hole 306 Samples 16, CC through 20, CC contain only a few poorly preserved or no Radiolaria, and 21, CC was oversieved, so absences of small forms from that sample are not reliable. Therefore, because it might be misleading, absences have not been recorded from these levels.

For species which have their first observed occurrence in one of these samples, the base is considered to fall between that sample and the next lower sample with common moderately well-preserved Radiolaria (i.e., 40-1, 119-121). Conversely, for species which have their last occurrence in Sample 40-1, 119-121, the top is considered to fall between that sample and the next higher one with common moderately well-preserved Radiolaria (i.e., either 21, CC if it is a large form or 14, CC if it is small or frequently recognized only from a fragment).

In the same manner a list of events (Table 10) has been made for the early Eocene section sampled at Site 313. Because of the time limits in preparing this report, only selected early Eocene Radiolaria from Cores 9, 12, and 13 were tabulated and arranged in this events list. It compares the events of DSDP Leg 32 with the events in the same time span in Leg 10. Unfortunately, in Leg 32 many of these events fall in the unsampled interval between Cores 9 and 12. All the events which fall within or above Core 9 except the base of *Theocorys anaclasta* occur at an earlier level in the material from Leg 10, indicating some large discrepancies which cannot be resolved until more comparative material is available.

The events occurring in Cores 12, 13, and below Core 13 indicate that Cores 12 and 13 are high in the interval between Samples 94-31, CC and 94-32, CC of Leg 10, thus representing an interval late in the *Bekoma bidarfensis* Zone.

In the Leg 10 material the rather large time interval between Cores 94-31 and 94-32 made it appear that the ancestor of *Buryella clinata* would be *Buryella tetradica*. Now that material from this interval is available in Cores 313-12 and 313-13 it is apparent that the ancestor of *Buryella clinata* is not *Buryella tetradica* but rather a new species related to *Pterocodon* (?) *ampla* (?), described and named *Pterocodon* (?) *anteclinata* in this chapter. The evolutionary change from *P.* (?) *anteclinata*

TABLE 9
List of Events for the Cretaceous of the North Pacific from DSDP Leg 32

Zones	Events	Site 303	Site 304	Site 305	Site 306	Site 307	Site 310
	T 64 *Spongosaturnalis* (?) *moorei*	–	–	–	–	–	Above 8A, CC
	T 54 *Spongosaturnalis* (?) *yaoi*	–	–	–	–	–	Above 8A, CC
	T 55 *Dictyomitra duodecimcostata*	–	–	Above 32, CC	–	–	Above 8A, CC
	T 66 *Dictyomitra koslovae*	–	–	–	–	–	Above 8A, CC
	T 59 *Artostrobium urna*	–	–	–	–	–	Above 8A, CC
	T 60 *Artostrobium tina*	–	–	–	–	–	Above 8A, CC
	T 63 *Theocampe salillum*	–	–	–	–	–	Above 8A, CC
	T 65 *Pseudoaulophacus pargueraensis*	–	–	–	–	–	Above 8A, CC
	T 67 *Crucella cachensis*	–	–	–	–	–	Above 8A, CC
	T 61 *Alievium gallowayi*	–	–	Above 32, CC	–	–	Above 8A, CC
	T 51 *Spongosaturnalis hueyi* group	4, CC–5, CC (183–211) G	2, CC–3, CC (219–235) P	–	–	1, CC–3–1 (8–58) G	Above 8A, CC
	T 21 *Spongosaturnalis* (?) spp.	4, CC–5, CC (183–211) G	2, CC–3, CC (219–235) G	52, CC–58, CC (485–541) P	4, CC–5, CC (40–57) P	1, CC–2, CC (8–40) G	Above 8A, CC
Artostrobium urna	B 67 *Crucella cachensis*	–	–	–	–	–	8A, CC–10A, CC (71–90) G
	B 66 *Dictyomitra koslovae*	–	–	–	–	–	8A, CC–10A, CC (71–90) G

TABLE 9 – *Continued*

Artostrobium urna	B 65 *Pseudoaulophacus pargueraensis*	–	–	–	–	–	8A, CC-10A, CC (71-90) G
	T 58 *Spongosaturnalis* (?) *ichikawai*	–	–	–	–	–	8A, CC-10A, CC (71-90) M
	T 57 *Alievium praegallowayi*	–	–	–	–	–	8A, CC-10A, CC (71-90) G
	T 61 *Spongosaturnalis squinaboli*	–	–	–	–	–	8A, CC-10A, CC (71-90) M
	T 56 *Spongosaturnalis hueyi*	–	–	–	–	–	10A, CC-11A, CC (90-99) G
	T 53 *Spongosaturnalis* (?) *eidalimus*	4, CC-5, CC (183-211) G	2, CC-3, CC (219-235) P	–	–	3-1-4, CC (58-85) P	10A, CC -11A, CC (90-99) G
	B 64 *Spongosaturnalis* (?) *moorei*	–	–	–	–	–	11A, CC-12A, CC (99-109) G
	B 63 *Theocampe salillum*	–	–	–	–	–	12A, CC-13A, CC (109-118) G
	B 61 *Spongosaturnalis squinaboli*	–	–	–	–	–	12A, CC-13A, CC (109-118) G
	B 61 *Alievium gallowayi*	–	–	32, CC-46, CC (290-429) P	–	–	13A, CC-16A, CC (118-147) G
	B 58 *Alievium praegallowayi*	–	–	–	–	–	13A, CC-16A, CC (118-147) G
	B 57 *Spongosaturnalis hueyi*	–	–	–	–	–	13A, CC-16A, CC (118-147) G
	B 59 *Spongosaturnalis* (?) *ichikawai*	–	–	–	–	–	13A, CC-16A, CC (118-147) M
	B 60 *Artostrobium urna*	–	–	–	–	–	13A, CC-16A, CC (118-147) G
	T 52 *Spongosaturnalis* (?) *preclarus*	4, CC-5, CC (183-211) G	–	–	–	–	13A, CC-16A, CC (118-147) G

Dictyomitra somphedia	B 55 *Dictyomitra* *duodecimcostata*	–	–	32, CC–46, CC (290–429) P	–	–	16A, CC–17A, CC (147–156) G
	B 56 *Artostrobium* *tina*	–	–	–	–	–	16A, CC–17A, CC (147–156) G
	T 49 *Lithomelissa* (?) *petila*	4, CC–5, CC (183–211) M	–	32, CC–46, CC (290–429) G	3, CC–4, CC (19–40) P	1, CC–3–1 (8–58) G	16A, CC–17A, CC (147–156) M
	B 52 *Spongosaturnalis* (?) *preclarus*	5, CC–2A, CC (211–220) G	–	–	–	–	Below 17A, CC
	B 53 *Spongosaturnalis* (?) *eidalimus*	5, CC–2A, CC (211–220) G	5–1 – 7–1 (253–272) P	–	–	–	Below 17A, CC
	T 48 *Dictyomitra* *somphedia*	1A, CC–2A, CC (211–220) G	–	32, CC–46, CC (290–429) G	1, CC–2, CC (9–10) G	–	–
	T 50 *Dictyomitra* *pseudomacrocephala*	1A, CC–2A, CC (211–220) G	–	32, CC–46, CC (290–429) G	1, CC–2, CC (9–10) G	–	–
	T 44 *Platycryphalus* spp. aff. *P. hirsuta*	1A, CC–2A, CC (211–220) G	2, CC–3, CC (219–235) G	32, CC–46, CC (290–429) G	1, CC–2, CC (9–10) G	3–1 – 4, CC (58–85) M	–
	T 47 *Holocryptocanium* *barbui*	1A, CC–2A, CC (211–220) G	2, CC–3, CC (219–235) G	51, CC–52, CC (476–485) P	3, CC–4, CC (19–40) P	1, CC–3–1 (8–58) G	–
	T 46 *Trochodiscus* *exaspina*	2A, CC–3A, CC (220–229) P	2, CC–3, CC (219–235) G	–	5, CC–6, CC (57–78) P	3–1 – 4, CC (58–85) G	–
	B 51 *Spongosaturnalis* *hueyi* group	2A, CC–3A, CC (220–229) G	3, CC–4, CC (235–244) G	–	–	3–1 – 4, CC (58–85) P	Below 17A, CC
	B 50 *Dictyomitra* *pseudomacrocephala*	2A, CC–3A, CC (220–229) G	–	46, CC–50, CC (429–466) G	2, CC–3, CC (10–19) G	–	–
	B 49 *Lithomelissa* (?) *petila*	2A, CC–3A, CC (220–229) M	–	46, CC–50, CC (429–466) G	4, CC–5, CC (40–57) M	3–1 – 4, CC (58–85) P	Below 17A, CC
	B 48 *Dictyomitra* *somphedia*	2A, CC–3A, CC (220–229) G	–	46, CC–50, CC (429–466) M	4, CC–5, CC (40–57) G	–	–
	T 45 *Diacanthocapsa* *communis*	2A, CC–3A, CC (220–229) G	3, CC–4, CC (235–244) G	46, CC–50, CC (429–466) G	3, CC–4, CC (19–40) G	3–1 – 4, CC (58–85) M	–

TABLE 9 – *Continued*

Acaeniotyle umbilicata	B 47 *Holocryptocanium barbui*	3A, CC–4A, CC (229–239) P	4, CC–6, CC (244–268) P	52, CC–58, CC (485–541) P	10–1 - 12–1 (78–94) P	5, CC–6, CC (103–122) P	–
	B 46 *Trochodiscus exaspina*	3A, CC–4A, CC (229–239) P	4, CC–5–1 (244–253) M	–	6, CC–7, CC (78–94) P	4, CC–6, CC (85–122) M	–
	T 21 *Acaeniotyle diaphorogona*	3A, CC–4A, CC (229–239) G	4, CC–5–1 (244–253) M	52, CC–58, CC (485–541) G	4, CC–5, CC (40–57) G	–	–
	T 20 *Dictyomitra carpatica* (?)	1A, CC–2A, CC (211–220) P	3, CC–4, CC (235–244) P	52, CC–58, CC (485–541) M	5, CC–6, CC (57–78) G	4, CC–6, CC (85–103) G	–
	T 19 *Acaeniotyle umbilicata*	3A, CC–4A, CC (229–239) G	4, CC–5–1 (244–253) M	52, CC–58, CC (485–541) G	5, CC–6, CC (57–78) G	4, CC–5, CC (85–122) G	–
	T 43 *Dicroa periosa*	3A, CC–4A, CC (220–229) M	4, CC–5–1 (244–253) M	52, CC–58, CC (485–541) G	Within 8–1 (113) G	–	–
	T 45 *Diacanthocapsa communis*	3A, CC–4A, CC (229–239) G	4, CC–6, CC (244–263) M	58, CC–59–1 (541–552) G	6, CC–7, CC (78–94) M	4, CC–6, CC (85–122) G	–
	B 44 *Platycryphalus* spp. aff. *P. hirsuta*	3A, CC–4A, CC (229–239) G	5–1 - 6, CC (253–263) P	60–1 - 61–1 (561–571) G	9, CC–10–1 (135–152) G	4, CC–6, CC (85–122) G	–
	T 35 *Eucyrtis tenuis*	4A, CC–5A, CC (239–251) G	5–1 - 6, CC (253–263) P	58, CC–60–1 (541–561) M	5, CC–6, CC (57–78) P	4, CC–6, CC (85–122) G	–
	B 43 *Dicroa periosa*	4A, CC–5A, CC (239–251) G	6, CC–7–1 (263–272) P	61–1 - 63–1 (571–590) G	11, CC–12–1 (172–189) P	–	–
	T 24 *Eucyrtis micropora*	4A, CC–5A, CC (239–251) G	5–1 - 6, CC (253–263) P	61–1 - 63–1 (571–590) G	5, CC–6, CC (57–78) M	4, CC–5, CC (85–103) G	–
	T 18 *Acanthocircus trizonalis*	2A, CC–3A, CC (220–229) P	5–1 - 6, CC (253–263) M	63–1 - 63, CC (590–591) G	9, CC–10–1 (135–152) M	4, CC–6, CC (85–122) G	–
	T 42 *Spongosaturnalis horridus*	?	–	63–1 - 63, CC (590–591) G	9, CC–10–1 (135–152) G	–	–
	T 26 *Triactoma echiodes*	4A, CC–5A, CC (239–251) G	5–1 - 6, CC (253–263) P	63–1 - 63, CC (590–591) G	10–1 - 11, CC (152–172) G	4, CC–6, CC (85–122) G	–
	T 39 *Triactoma* sp. cf. *T. echiodes*	4A, CC–5A, CC (239–251) M	5–1 - 6, CC (253–263) P	63–1 - 63, CC (590–591) G	10–1 - 11, CC (152–172) P	6, CC–7–1 (122–158) M	–
	T 25 *Alievium* spp.	4A, CC–5A, CC (239–251) G	7–1 - 8–1 (272–282) M	63–1 - 63, CC (590–591) M	10–1 - 11, CC (152–172) M	4, CC–6, CC (85–122) G	–

	T 38 *Triactoma* *hybum*	5A, CC–6A–1 (251–257) M	7–1 - 8–1 (272–282) G	63–1 - 63, CC (590–591) G	10–1 - 11, CC (152–172) G	4, CC–6, CC (85–122) M	–
	T 37 *Podobursa* *tricola*	4A, CC–5A, CC (239–251) G	7–1 - 8–1 (272–282) M	63, CC–64–1 (591–599) G	10–1 - 11, CC (152–172) G	4, CC–6, CC (85–122) M	–
	T 40 *Paronaella* (?) *hipposidericus*	–	7–1 - 8–1 (272–282) P	63–1 - 63, CC (590–591) G	–	6, CC–7–1 (122–158) M	–
	T 17 *Paronaella* (?) *diamphidia*	–	–	–	10–1 - 11, CC (152–172) G	6, CC–7–1 (122–158) M	–
	T 31 *Dicroa* sp. A	4A, CC–5A, CC (239–251) M	6, CC–7–1 (253–272) M	65–1 - 66–1 (608–618) P	10–1 - 11, CC (152–172) G	6, CC–7–1 (122–158) M	–
	T 30 *Dictyomitra* (?) *lacrimula*	4A, CC–5A, CC (239–251) G	6, CC–7–1 (263–272) G	63, CC–64–1 (591–599) G	Within 12–1 (189) G	4, CC - 5, CC (85–103) G	–
	T 41 *Acaeniotyle* *helicta*	4A, CC–5A, CC (239–251) M	6, CC–7–1 (263–272) M	63, CC–64–1 (591–599) G	Within 12–1 (189) G	4, CC–6, CC (85–122) M	–
	T 29 *Dictyomitra* *alievi*	–	7–1 - 8–1 (272–282) M	63, CC–64–1 (591–599) G	Within 12–1 (189) P	4, CC–6, CC (85-122) M	–
	B 42 *Spongosaturnalis* *horridus*	?	–	64–1 - 65–1 (599–608) G	14, CC–40–1 (217–450) M	–	–
	T 33 *Zhamoidellum* *ornatum* (?)	4A, CC–5A, CC (239–251) M	7–1 - 8–1 (272–282) G	64–1 - 65–1 (599–608) M	Within 12–1 (189) G	4, CC - 6, CC (85–103) G	–
	T 32 *Sethocapsa* (?) *orca*	4A, CC–5A, CC (239–251) G	7–1 - 8–1 (272–282) G	64–1 - 65–1 (599–608) G	Within 12–1 (189) G	4, CC–5, CC (85–122) G	–
	T 16 *Sphaerostylus* *lanceola* group	4A, CC–5A, CC (239–251) G	6, CC–7–1 (263–272) G	64–1–65–1 (599–608) G	12–1 -14, CC (189–217) G	4, CC–5, CC (85–122) G	–
Eucrytis tenuis	T 34 *Dibolachras* *tytthopora*	5A, CC–6A–1 (251–257) M	7–1 - 8–1 (272–282) G	64–1- 65–1 (599–608) G	12–1 - 14, CC (189–217) G	4, CC–6, CC (85–103) G	–
	T 36 *Acanthocircus* *carinatus*	–	–	–	–	4, CC–6, CC (85–122) G	–
	T 15 *Podobursa* *triacantha*	4A, CC–5A, CC (239–251) G	7–1 - 8–1 (272–282) G	65–1 - 66–1 (608–618) G	12–1 - 14, CC (189–217) G	4, CC–6, CC (85–122) G	–
	T 28 *Staurosphaera* *septemporata*	–	7–1 - 8–1 (272–282) P	–	–	4, CC–6, CC (85–122) G	–

TABLE 9 – *Continued*

Eucyrtis tenuis	T 14 *Dictyomitra boesii*	–	–	–	?	4, CC-6, CC (85–122) P	–
	T 23 *Sethocapsa trachyostraca*	–	8-1 - 9-1 (282–290) G	–	12-1 - 14, CC (189–217) G	6, CC-7-1 (122–158) G	–
	T 13 *Dictyomitra apiarium*	–	–	–	12, CC - 14, CC (191–217) P	6, CC-7-1 (122–158) G	–
	T 22 *Hemicryptocapsa* sp. aff. *H. capita*	6A-1 - 7A, CC (267–268) M	8-1 - 9-1 (282–290) P	–	14, CC - 21, CC (217–283) P	6, CC-7-1 (122–158) G	–
	T 12 *Acanthocircus dicranacanthos*	–	8-1 - 9-1 (282–290) M	–	14, CC - 40-1 (217–450) G	4, CC-6, CC (85–122) P	–
	B 41 *Acaeniotyle hilicta*	Below 7A, CC	8-1 - 9-1 (282–290) G	Below 66-1	12-1 - 14, CC (189–217) G	7-1 - 8, CC (158–197) G	–
	B 40 *Paronaella* (?) *hipposidericus*	–	8-1 - 9-1 (282–290) P	Below 66-1	–	–	–
	B 38 *Triactoma hybum*	6A-1 -7A, CC (237–268) P	Below 9-1	Below 66-1	14, CC-40-1 (217–450) G	7-1 - 8, CC (158–197) G	–
	B 39 *Triactoma* sp. cf. *T. echiodes*	Below 7A, CC	Below 9-1	Below 66-1	14, CC-40-1 (217–450) G	7-1 - 8, CC (158–197) M	–
	B 37 *Podobursa tricola*	Below 7A, CC	Below 9-1	Below 66-1	14, CC-40-1 (217–450) G	7-1 - 8, CC (158–197) G	–
	B 36 *Acanthocircus carinatus*	–	–	–	14, CC-40-1 (217–450) G	7-1 -8, CC (158–197) G	–
	T 11 *Syringocapsa limatum*	–	–	–	14, CC-16, CC (217–235) M	7-1 - 8, CC (158–197) G	–
	T 10 *Lithocampe mediodilatata*	–	–	–	14, CC-16, CC (217–235) G	7-1 - 8, CC (158–197) G	–
	B 34 *Dibolachras tythopora*	Below 8A, CC	Below 9-1	Below 66-1	16, CC-21, CC (235–283) M	7-1 - 8, CC (158–197) G	–
	B 35 *Eucyrtis tenuis*	Below 8A, CC	Below 9-1	Below 66-1	16, CC-40-1 (235–450) G	7-1 - 8, CC (158–197) G	–
	B 33 *Zhamoidellum ornatum* (?)	Below 8A, CC	Below 9-1	Below 66-1	19, CC-40-1 (263–450) P	7-1 - 8, CC (158–197) G	–

	B 32 *Sethocapsa* (?) *orca*	Below 8A, CC	Below 9-1	Below 66-1	21, CC-40-1 (283-450) G	7-1 - 8, CC (158-197) G	–
	T 9 *Sethocapsa leiostraca*	–	–	–	?	7-1 - 8, CC (158-197) G	–
	T 8 *Stichocapsa* (?) *rotunda*	–	–	–	21, CC-40-1 (283-450) G	7-1 - 8, CC (158-197) M	–
	T 7 *Podobursa tetracola*	–	–	–	21, CC-40-1 (283-450) M	7-1 - 8, CC (158-197) G	–
	T 6 *Dictyomitra cosmoconica*	–	–	–	21, CC-40-1 (283-450) G	7-1 - 8, CC (158-197) G	–
	B 31 *Dicroa* sp. A	Below 8A, CC	7-1-8-1 (272-282) P	Below 66-1	Within 12-1 (189) M	8, CC-9-1 (197-233) G	
	B 29 *Dictyomitra alievi*	–	Below 9-1	Below 66-1	12-1 -14, CC (189-217) P	8, CC-9-1 (197-233) G	–
	B 30 *Dictyomitra* (?) *lacrimula*	Below 7A, CC	Below 9-1	Below 66-1	19, CC-40-1 (263-450) G	8, CC-9-1 (197-233) M	–
	B 21 *Spongosaturnalis* (?) spp.	Below 7A, CC	Below 9-1	Below 66-1	14, CC-16, CC (217-235) P	9-1 - 10-1 (233-271) M	Below 17A, CC
	B 28 *Staurosphaera septemporata*	–	8-1 - 9-1 (282-290) P	–	–	9-1 - 10-1 (233-271) M	–
	B 26 *Triactoma echiodes*	Below 7A, CC	Below 9-1	Below 66-1	14, CC-40-1 (217-450) G	9-1 - 10-1 (233-271) M	–
	B 25 *Alievium* spp.	Below 8A, CC	Below 9-1	Below 66-1	16, CC-40-1 (235-450) G	9-1 - 10-1 (233-271) M	–
	B 23 *Sethocapsa trachyostraca*	–	Below 9-1	–	21, CC-40-1 (283-450) G	9-1 - 10-1 (233-271) M	–
	B 24 *Eucyrtis micropora*	Below 8A, CC	Below 9-1	Below 66-1	?	9-1 - 10-1 (233-271) M	–
	B 22 *Hemicryptocapsa* spp. cf. *H. capita*	Below 7A, CC	Below 9-1	–	21, CC-40-1 (283-450) M	9-1 - 10-1 (233-271) M	–
	T 5 *Sethocapsa cetia*	–	–	–	14, CC-21, CC (217-283) M	9-1 - 10-1 (233-271) G	–

TABLE 9 – *Continued*

	T 4 *Emiluvia chica*	–	–	–	21, CC–40–1 (283–450) M	9–1 - 10–1 (233–271) G	–
	T 3 *Triactoma tithonianum*	–	–	–	21, CC–40–1 (283–450) M	9–1 - 10–1 (233–271) G	–
Spaerostylus lanceola	T 1 *Cenosphaera* sp.	–	–	–	21, CC–40–1 (283–450) M	–	–
	T 2 *Podocapsa amphitreptera*	–	–	–	21, CC–40–1 (283–450) M	–	–
	B 17 *Paronaella* (?) *diamphidia*	–	–	–	Below 42–1	7–1 - 8, CC (158–197) P	–
	B 11 *Syringocapsa limatum*	–	–	–	Below 42–1	9–1 - 10–1 (233–271) P	–
	B 19 *Acaeniotyle umbilicata*	Below 8A, CC	Below 9–1	Below 66–1	Below 42–1	Below 10–1	–
	B 21 *Acaeniotyle diaphorogona*	Below 8A, CC	Below 9–1	Below 66–1	Below 42–1	Below 10–1	–
	B 9 *Sethocapsa leiostraca*	–	–	–	Below 42–1	Below 10–1	–
	B 8 *Stichocapsa* (?) *rotunda*	–	–	–	Below 42–1	Below 10–1	–
	B 7 *Podobursa tetracola*	–	–	–	Below 42–1	Below 11–1	–
	B 20 *Dictyomitra carpatica* (?)	Below 8A, CC	Below 9–1	Below 66–1	Below 42–1	Below 12–1	–
	B 15 *Podobursa triacantha*	Below 7A, CC	Below 9–1	Below 66–1	Below 42–1	Below 12–1	–
	B 18 *Acanthocircus trizonalis*	Below 8A, CC	Below 9–1	Below 66–1	Below 42–1	Below 12–1	–
	B 12 *Acanthocircus dicranacanthos*	–	Below 9–1	–	Below 42–1	Below 12–1	–

	B 5 *Sethocapsa cetia*	–	–	–	Below 42-1	Below 12-1	–
	B 4 *Emiluvia chica*	–	–	–	Below 42-1	Below 12-1	–
	B 3 *Triactoma tithonianum*	–	–	–	Below 42-1	Below 12-1	–
	B 10 *Lithocampe mediodilatata*	–	–	–	Below 42-1	Below 12-1	–
	B 13 *Dictyomitra apiarium*	–	–	–	Below 42-1	Below 12-1	–
	B 14 *Dictyomitra boesii*	–	–	–	Below 42-1	Below 12-1	–
	B 6 *Dictyomitra cosmoconica*	–	–	–	Below 42-1	Below 12-1	–
	B 2 *Podocapsa amphitreptera*	–	–	–	Below 42-1	–	–
	B 1 *Cenosphaera* sp.	–	–	–	Below 42-1	–	–
	B 16 *Sphaerostylus lanceola* group	Below 8A, CC	Below 9-1	Below 66-1	Below 42-1	Below 12-1	–

TABLE 10
Comparison of Early Eocene Events of Leg 32 in the North Pacific with those of Leg 10 in the Gulf of Mexico

Zones	DSDP Leg 10, Site 94				DSDP Leg 32, Site 313				Zones
Phormocyrtis striata striata					*Phormocyrtis striata exquisita* → *P. striata striata*		Above 9-1	G	
					T *Theocorys acroria*	m	Above 9-1		
					T *Phormocyrtis cubensis*	m	Above 9-1	P	
	B *Theocorys anaclasta*	m	28–5 – 28, CC (538.5-539.5)	M	B *Theocorys anaclasta*		9–1 – 9, CC (187-188)	M	*Buryella clinata*
					B *Lychnocanomma bellum*	m	9–1 – 9, CC (187-188)	G	
					B *Lophocyrtis biaurita*	m	9–1 – 9, CC (187-188)	G	
	Phormocyrtis striata exquisita → *P. Striata striata*		28, CC-29, CC (539.5-551)	G					
	T *Theocorys acroria*	m	28, CC-29, CC (539.5-551)	G					
	B *Rhopalocanium ornatum*	m	28, CC-29, CC (539.5-551)	G	B *Rhopalocanium ornatum*	m	9, CC-12-1 (188-206)	M	
	B *Thyrsocyrtis hirsuta tensa*	m-e	28, CC-29, CC (539.5-551)	M	B *Thyrsocyrtis hirsuta tensa*	m	9,CC-12-1 (188-206)	G	
	B *Theocampe amphora* group	m	28, CC-29, CC (539.5-551)	G	B *Theocampe amphora* group	m	9, CC-12-1 (188-206)	G	
Buryella clinata	T *Giraffospyris lata*	m	29, CC-30-1 (551-571.5)	M	T *Giraffospyris lata*	m	9, CC-12-1 (188-206)	G	
	T *Phormocyrtis cubensis*	m	29, CC-30-1 (551-571.5)	G					
	T *Buryella tetradica*	m	29, CC-30-1 (551-571.5)	G	T *Buryella tetradica*	m	9, CC-12-1 (188-206)	G	
	T *Theocotyle (Theocotylissa)* (?) *fimbria*	m	30–1 – 30–2 (571.5-573.5)	G	T *Theocotyle (Theocotylissa)* (?) *fimbria*	m	9, CC-12-1 (188-206)	G	
	B *Amphipternis clava*	m	30–2 – 30, CC (573.5-574)	P					
	B *Phormocyrtis striata striata*	m	30–2 – 30, CC (573.5-574)	G	B *Phormocyrtis striata striata*	m	9, CC-12-1 (188-206)	G	

Zone	Event		Sample		Event		Sample		Zone
Buryella clinata	B *Lychnocanoma bellum*	m	30, CC-31, CC (574-589)	P					
	T *Pterocodon* (?) *ampla* (?)	m	30, CC-31, CC (574-589)	G					
	Theocotyle (Theocotylissa) alpha → *T. (Theocotylissa) ficus*		30, CC-31, CC (574-589)	M	*Theocotyle (Theocotylissa) alpha* → *T. (Theocotylissa) ficus*		9, CC-12-1 (188-206)	G	
	Theocotyle (Theocotylissa) auctor → *T. (Theocotylissa) alpha*		30, CC-31, CC (574-589)	M	*Theocotyle (Theocotylissa) auctor* → *T. (Theocotylissa) alpha*		9, CC-12-1 (574-589)	G	
	T *Pterocodon* (?) *tenellus*	m	30, CC-31, CC (574-589)	G	T *Pterocodon* (?) *tenellus*	m	9, CC-12-1 (188-206)	G	
	T *Theocorys* (?) *phyzella*	m	30, CC-31, CC (574-589)	G	T *Theocorys* (?) *phyzella*	m	9, CC-12-1 (188-206)	G	
	T *Phormocyrtis turgida*	m	30, CC-31, CC (574-589)	G	T *Phormocyrtis turgida*	m	9, CC-12-1 (188-206)	G	
	T *Bekoma bidarfensis*	m	30, CC-31, CC (574-589)	G	T *Bekoma bidarfensis*	m	9, CC-12-1 (188-206)	G	
	B *Lophocyrtis biaurita*	m	31, CC-32, CC (589-609)	G					
	Thyrsocyrtis tarsipes → *T. hirsuta hirstua*		31, CC-32, CC (589-609)	G	*Thyrsocyrtis tarsipes* → *T. hirsuta hirstua*		9, CC-12-1 (188-206)	G	
	B *Buryella clinata*	m & e	31, CC-32, CC (589-609)	G	T *Pterocondon* (?) *anteclinata* → *Buryella clinata*		9, CC-12-1 (188-206)	G	
					B *Buryella clinata*	m	12-1 – 12-3 (206-209)	G	*Bekoma bidarfensis*
Bekoma bidarfensis	B *Theocampe urceolus*	m	31, CC-32, CC (589-609)	G	B *Theocampe urceolus*	m	13-1 – 13-3 (215-218)	M	
	B *Lithochytris archaea*	m	31, CC-32, CC (589-609)	G	B *Lithochyrtris archaea*	m	Below 13, CC	G	
	B *Theocotyle (Theocotyle) cryptocephala* (?) *nigriniae*	m	31, CC-32, CC (589-609)	G	B *Theocotyle (Theocotyle) cryptocephala* (?) *nigriniae*	m	Below 13, CC	G	
	B *Theocotyle (Theocotylissa)* (?) *fimbria*	m	31, CC-32, CC (589-609)	G	B *Theocotyle (Theocotylissa)* (?) *fimbria*	m	Below 13, CC	G	
	B *Lamptonium pennatum*	m	Below 32, CC	G	B *Lamptonium pennatum*	m	Below 13, CC	G	

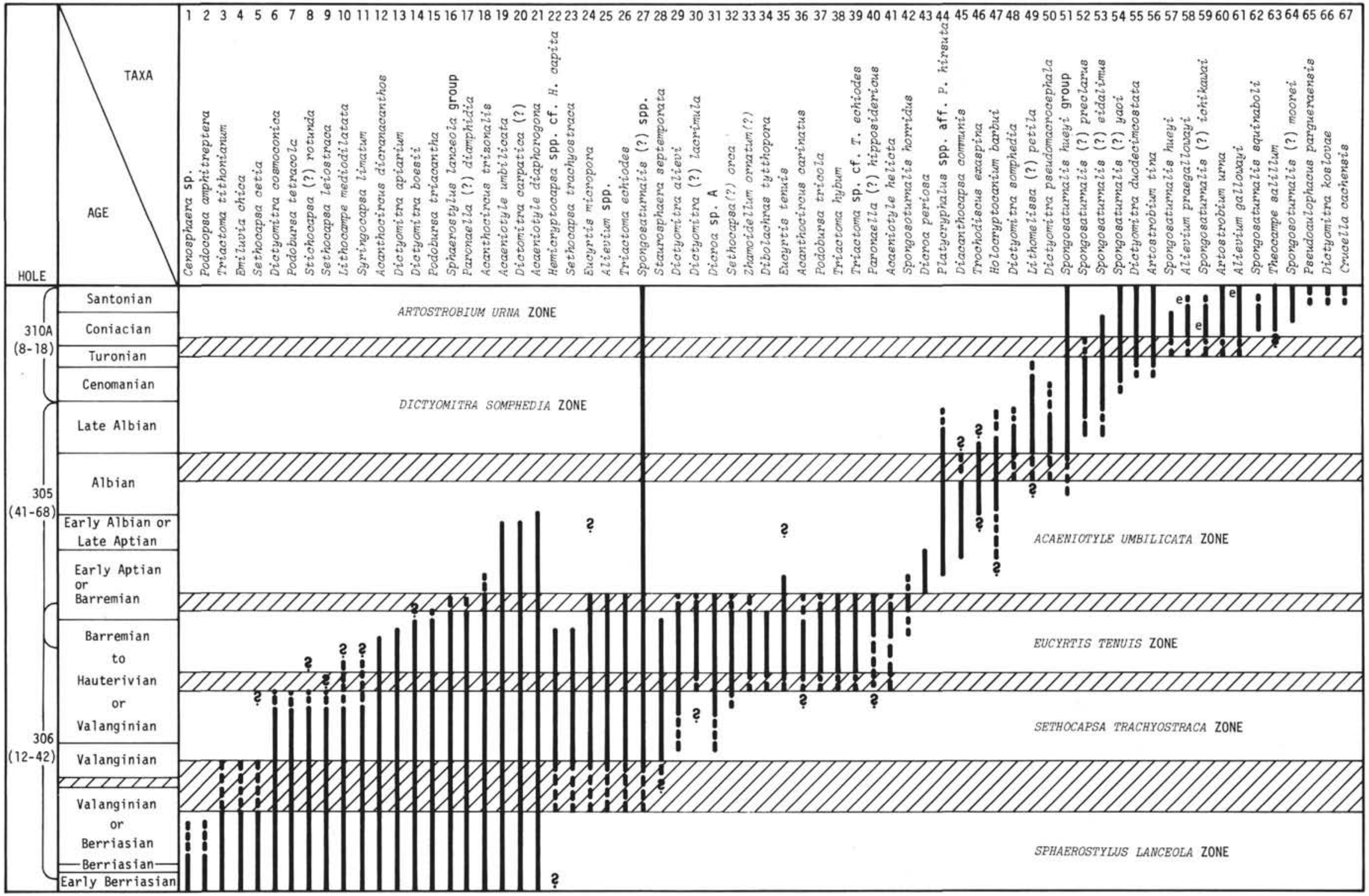


Figure 4. *Range chart for Cretaceous radiolaria.*

to *B. clinata* probably occurs immediately above Core 313-12 in the interval represented by Core 313-11, from which only chert fragments in the core catcher were recovered.

Explanation of Correlation and Range Charts with Figures 3, 4, and 5

The Cretaceous correlation chart (Figure 1) has been constructed from the information presented in the list of events (Table 9), and the range chart (Figure 4) constructed from information presented in the list of events and the correlation chart. For the Late Cretaceous, events in Hole 310A, Cores 8-17 are used, and for the Early Cretaceous a composite of events in Holes 303, 303A, 304, 305, 306, and 307 is used. Core 310A-18 has been correlated with Core 305-41 on the basis of a foraminiferal event, and the remainder of the cores in Hole 305 with those of Hole 306 on the basis of both foraminiferal and radiolarian events. The scale is based on the depths below the sediment surface of cores in Holes 310A (8-18), 305 (41-64), and 306 (12-42). Radiolarian events in Holes 303A and 304 are used to confirm the events indicated for Holes 305 and 306 and rarely, if the information they contain is judged to be more reliable than for the other holes, to establish range lines. In general the Early Cretaceous ranges are based on information from Holes 305, 306, and 307. Cores 8, 9, 10, 11, and 12 of Hole 307 contain moderate (8 and 9) to poorly preserved (10-12) Radiolaria and poorly preserved nannoplankton. The Radiolaria in these cores are older than those of Core 306-21 and younger than those of 306-40. The determination of their position on the chart between these two cores is somewhat arbitrary, as there are no or only very poorly preserved Radiolaria in the section between the two Site 306 cores mentioned, and therefore no exact correlation could be made for this level between the two holes.

The correlation chart (Figure 1) shows that in the late Cretaceous and late Early Cretaceous the age assignments based on foraminiferal and nannoplankton data agree rather closely. However in the Neocomian, as is the case in other reports, there is less agreement, with the nannoplankton data consistently presenting an age approximately one stage older than the foraminiferal data. Because no value judgments can be made, the complete ranges given for both the foraminifera and the nannoplankton are used in assigning ages to the corresponding cores with only Radiolaria. Therefore, as explained below, some rather long ranges result for the radiolarian-bearing cores of Neocomian age.

On the basis of the nannofossils in this report and the Leg 20 Report, Cores 8 and 9 of Hole 307 would be assigned to the Hauterivian-Valanginian interval. However, foraminiferal data give a Barremian-Hauterivian age for this same interval, resulting in the rather extended time ranges of Barremian to Hauterivian or Valanginian for these two cores in the *Sethocapsa trachyostraca* Zone and also for the cores in the next higher mid- to lower *Eucyrtis tenuis* Zone. Cores 10-12 have affinities with the fauna in Site 306, Cores 40-42, and are considered to fall in the Valanginian or Berriasian range established on the basis of nannofossils for the cores in Hole 306 immediately above Cores 41 and 42.

A dashed line indicates uncertainty in the limit of the range of a species between two nonadjacent cores in the same hole, or when there are two equally reliable but slightly conflicting limits for the range of a species from two different holes. Question marks indicate larger conflicts of evidence among the holes considered in this study or from outside reports.

The Neogene range chart (Figure 5) has been constructed from the information i-n the tabulations at Site 310 (Table 7). The scale is based on the depths below the sediment surface of Cores 1-9 at that site. A question mark at the lower end of the range for *Theocorythium vetulum* indicates uncertainty concerning its lower limit. At the point where the ? occurs, *T. vetulum* passes to a form with an abdomen which is short and more barrel-shaped than conical. (*T.* sp. aff. *T. vetulum,* Plate 9, Figure 10.)

SYSTEMATIC SECTION

Cretaceous

Family ACTINOMMIDAE Haeckel, 1862, emend. Riedel, 1967a

Genus ACAENIOTYLE Foreman

Acaeniotyle Foreman, 1973b, p. 258.

Acaeniotyle diaphorogona Foreman emend.
(Plate 2F, Figures 1-5; Plate 3, Figures 1, 2)
(Range chart number 21)

Acaeniotyle diaphorogona Foreman, 1973b, p. 258, pl. 2, fig. 2-5.
Acaeniotyle tribulosa Foreman, 1973b, p. 258, pl. 2, fig. 8.
Acaeniotyle sp. aff. *A. diaphorogona* Foreman, 1973b, pl. 2, fig. 6, 7; pl. 16, fig. 16.

Remarks: *Acaeniotyle diaphorogona* is here emended to include all forms with three spines, regardless of their length or their orientation. Some early forms (Plate 2F, Figure 5) have short thorns at the distal end of the spines. Rare forms in which the interior could be observed show a small inner shell.

A similar rare form in 310A-13, CC (Plate 1F, Figure 1) differs in having fewer, larger, more widely spaced pores. There are no connecting forms.

Acaeniotyle helicta Foreman, new species
(Plate 2E, Figures 12, 13; Plate 3, Figure 5)
(Range chart number 41)

Acaeniotyle umbilicata (Rüst) *in* Foreman, 1973b, p. 258.

Description: Shell as for *Acaeniotyle umbilicata,* differing only in the spines, one or both of which are twisted, and its size which is at the small end of the size range for *A. umbilicata.*

Measurements (based on 10 specimens from 303A-6-1, 98-100; 305-64-1, 118-120; and 307-7-1, 75-77). Length overall, 330-515μ, of long spine 125-215μ, of short spine 100-145μ; diameter of shell in plane of polar spines 105-155μ.

Etymology: From the Greek adjective *heliktos,* twisted.

Acaeniotyle umbilicata (Rüst)
(Plate 2E, Figures 14-17; Plate 3, Figure 3)
(Range chart number 19)

Xiphosphaera umbilicata Rüst, 1898, p. 7, pl. 1, fig. 9.
Xiphosphaera tuberosa Tan Sin Hok, 1927, p. 35, pl. 5, fig. 8.
Spumellariinid, Pessagno, 1969, p. 610, pl. 4, fig. N.
Acaeniotyle umbilicata (Rüst) *in* Foreman, 1973b, p. 258, pl. 1, fig. 13, 14, 16.

Remarks: One specimen was observed which showed a small spherical inner shell, attached by six radial beams to the outer shell.

Similar forms observed from the Late Cretaceous in other material differ in having fewer, larger, more widely spaced pores. There are no connecting forms.

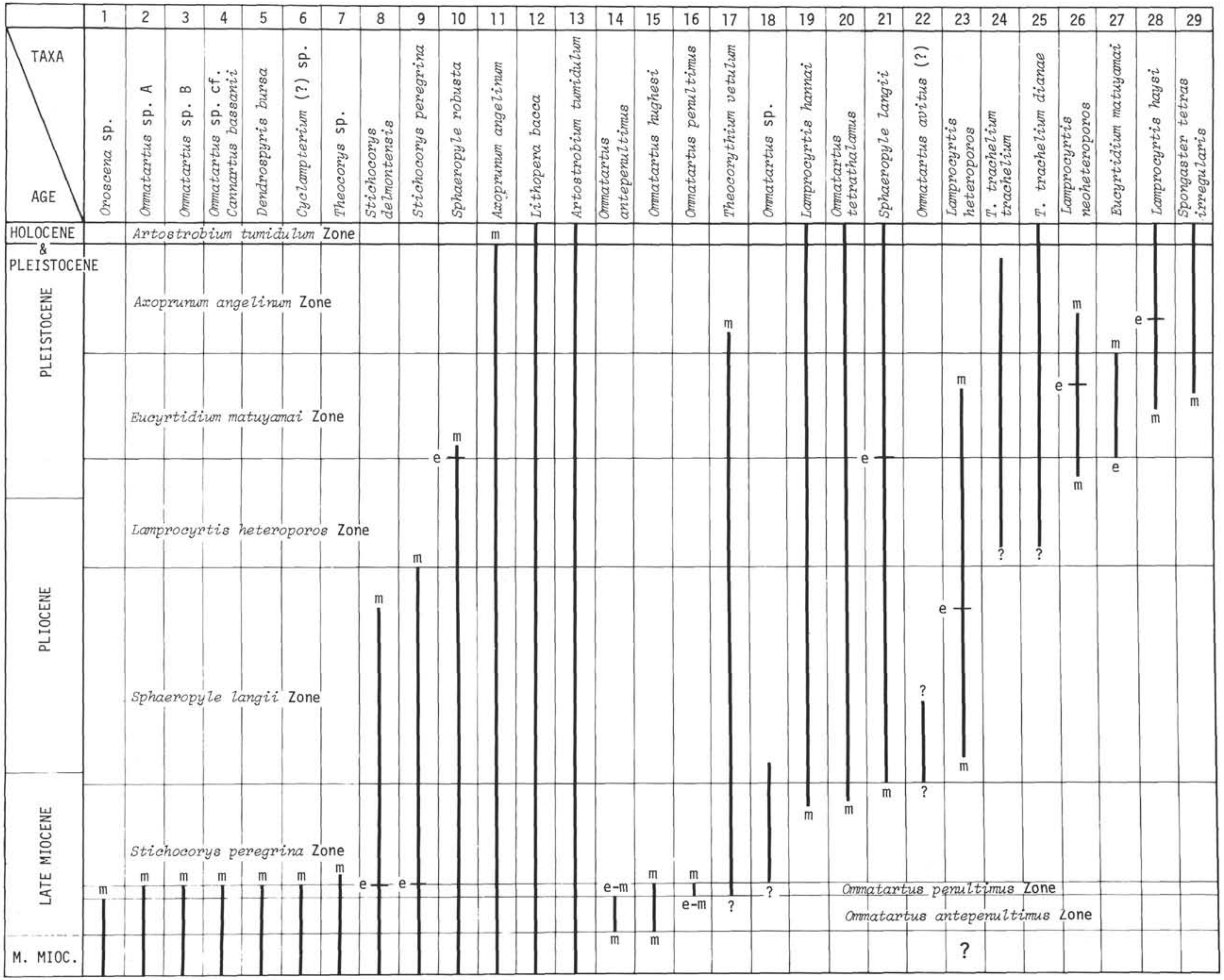


Figure 5. *Range chart for Neogene radiolaria from Site 310.*

Acaeniotyle sp. aff. A. umbilicata Rüst
(Plate 2E, Figure 18)

Acaeniotyle sp. aff. *A. umbilicata* Rüst *in* Foreman, 1973b, pl. 1, fig. 15.

Remarks: It seems useful to separate from *Acaeniotyle umbilicata* some exceptionally large forms with long, very sturdy spines (Foreman, 1973b, p. 258) and with an apparent restricted range. As these large forms have not been tabulated, their presence in samples from 303A-4, CC; 305-65-1, 108-110; and 306-10-1, 124-125 and 11, CC, is indicated here.

Genus CENOSPHAERA Ehrenberg

Cenosphaera Ehrenberg, 1854a, p. 237.

Type species (by monotypy) *Cenosphaera plutonis* Ehrenberg, 1854.

Cenosphaera sp.
(Plate 3, Figure 4)
(Range chart number 1)

[?] *Conocaryomma* (?) *magnimamma* (Rüst) *in* Pessagno, 1973, p. 154, 155, fig. 5, 6.

Remarks: The few specimens that have been observed show that the nodose surface is formed by a series of ridges on the surface of the spherical shell which are raised at the point where they join to form uniform, evenly distributed nodes. Short cylindrical spines extend from the apex of at least some of the nodes. Pores are rounded, very irregular in size and shape.

DICROA Foreman, new genus

Type species: Dicroa periosa Foreman, new species.

Definition: A spherical or elliptical shell bearing two or three bifurcated polar spines.

Remarks: Species belonging to this genus are known from the late Early Cretaceous of DSDP Leg 32, North Pacific, and from the early Santonian of Trinidad.

Etymology: The generic name is from the Greek feminine noun *dikroa*, fork.

Dicroa periosa Foreman, new species
(Plate 2E, Figure 8; Plate 3, Figure 8)
(Range chart number 43)

Description: The shell is elliptical to circular and bears two approximately equal, sturdy, three-bladed spines which bifurcate. The shell appears to be spongy internally, overlain by a meshwork of large, regular, angular pores. Some specimens are preserved with only the spongy part of the shell remaining and others with only the meshwork of large pores. Generally the spongy shell and some fragments of the outer meshwork are present. When the shell is elliptical, the largest dimension is along the polar plane. The forked ends of the exceptionally large, sturdy polar spines tend to recurve inwards.

Measurements (based on 14 specimens from 303A-4, CC; 306-10-1, 124-125; and 307-6, CC). Length overall 1000-1230μ, of polar spines 320-540μ (majority 400-500μ); width between tips of bifurcated spine 250-575μ (majority 385-460μ), of spine near base 20-45μ (majority 30-45μ), of shell in polar plane 100-175μ, in equatorial plane 100-170μ.

Remarks: *Trisphaera bicornispinosa* Zhamoida, 1968, is apparently a related form. It differs in having smaller pores and three spines; poor preservation makes the character of the forked spines uncertain.

A single fragment of a form with a branched spine, not included in this species, was observed in 303A-3, CC (Plate 3, Figure 12). It differs in its smaller size and having a shell that has smaller pores and is slightly nodose.

Etymology: From the Greek adjective *periosus*, immense.

Dicroa sp. A
(Plate 2E, Figures 9-11; Plate 3, Figure 11)
(Range chart number 31)

Description: The shell is circular and bears two three-bladed spines which bifurcate. The shell is apparently spongy internally, overlain by a meshwork of large pores, similar to that of *D. periosa*. The forked ends of the spines tend to recurve inwards.

Measurements (based on 8 specimens from 306-12-1, 60-62; 307-7-1, 72-75; and 303A-7, CC). Length overall (based on two specimens) 515-525μ, of polar spines 175-225μ; width between tips of bifurcated spine 110-170μ, of spine near base 20-25μ.

Remarks: This species differs from *D. periosa* only in the marked difference in size. It is not named, pending a more detailed description based on more complete specimens. Generally only the distinctive forked spines were observed. It occurs consistently in strata older than that in which *D. periosa* is found and may be considered the ancestor of that form.

Genus SPHAEROSTYLUS Haeckel

Sphaerostylus Haeckel, 1881, p. 451. Foreman, 1973b.

Sphaerostylus lanceola (Parona) group
(Plate 2E, Figures 3-6)
(Range chart number 16)

Sphaerostylus lanceola (Parona) group *in* Foreman, 1973b, p. 258, pl. 1, fig. 7-11.

Sphaerostylus lanceola (Parona) Riedel and Sanfilippo, 1974, pl. 1, fig. 1-3.

Stylatractus ovatus Hinde *in* Moore, 1973, p. 823, pl. 2, fig. 1.

Remarks: Forms with one spine twisted (Plate 2E, Figure 3) have a rather restricted range. It may be useful to separate them from this group.

Genus STAUROSPHAERA Haeckel

Staurosphaera Haeckel, 1881, p. 450. Foreman, 1973b, p. 259.

Staurosphaera septemporata Parona
(Plate 2E, Figure 7; Plate 3, Figure 6)
(Range chart number 28)

Staurosphaera septemporata Parona *in* Foreman, 1973b, p. 259, pl. 3, fig. 4. Moore, 1973, p. 824, pl. 2, fig. 2. Riedel and Sanfilippo, 1974, pl. 1, fig. 6-8.

Genus STAUROSPHAERETTA Squinabol

Staurosphaeretta Squinabol, 1904, p. 192.

Type species (by monotypy) *Staurosphaera hindei* Squinabol, 1904.

Staurosphaeretta hindei (Squinabol)
(Plate 1F, Figure 2; Plate 2F, Figure 8)

Staurosphaera hindei Squinabol, 1904, p. 191, pl. 3, fig. 3.

Genus TRIACTOMA Rüst

Triactoma Rüst, 1885. Foreman, 1973b, p. 259.

Triactoma echiodes Foreman
(Plate 2F, Figures 9, 10; Plate 3, Figure 10)
(Range chart number 26)

Triactoma echiodes Foreman, 1973b, p. 260, pl. 3, fig. 1; pl. 16, fig. 21.

Triactoma sp. cf. T. echiodes Foreman
(Range chart number 39)

Triactoma sp. cf. *T. echiodes* Foreman *in* Foreman, 1973b, p. 260, pl. 3, fig. 3 (not fig. 2).

Remarks: Included here are all small pored forms lacking a central raised area, with spines more regularly disposed than for *T. echiodes*. These forms are generally smaller than *T. echiodes*. They are tabulated but not included in the events list or more completely described at this time because of their rarity. See also Remarks under *T. hybum*.

Triactoma hybum Foreman, new species
(Plate 2F, Figures 6, 7; Plate 3, Figures 7, 9)
(Range chart number 38)

Triactoma sp. cf. *T. echiodes* Foreman *in* Foreman, 1973b, pl. 3, fig. 2 (not fig. 3).

Description: Shell as for *T. echiodes* with the exception that it is generally smaller, with smaller pores, has a distinct hump-like raised area at the center of the upper and lower surfaces, and the spines are somewhat more regularly disposed.

Measurements (based on 10 specimens from 307-6, CC; 307-7-1, 75-77; 306-11, CC; 306-12-1, 60-62; and 306-14, CC). Diameter of shell 85-115μ, length of spines 115-195μ (majority 125-155μ).

Remarks: This species is apparently closely related and probably descended from a form *Triactoma* sp. cf. *T. echiodes* Foreman with which it co-occurs in the early part of its range and from which it differs in having a distinct raised area as described above. Both differ from *T. echiodes* in their size and more regularly disposed spines.

Etymology: The specific name is derived from the Greek adjective *hybos*, humped.

Triactoma tithonianum Rüst
(Plate 3, Figure 13)
(Range chart number 3)

Triactoma tithonianum Rüst *in* Foreman, 1973b, p. 260, pl. 2, fig. 1.

Actinommid, gen. and sp. indet.
(Plate 1D, Figure 1)

Remarks: This large ellipsoidal spongy form is distinguished by its size and a shell which is thickened at one end, becoming thinner at the opposite end where short spines protrude. These spines extend at least halfway around the margin on some forms. It is illustrated here because of its apparent short range.

Actinommids, gen. and sp. indet.
(Plate 2F, Figures 12-14)

Remarks: Under this heading are illustrated spongy discoidal (Figure 13) and lenticular (Figures 12 and 14) forms with, respectively, four and six smooth, slender spines.

Subfamily SATURNALINAE Deflandre, 1953

Genus ACANTHOCIRCUS Squinabol

Acanthocircus Squinabol, 1903a, p. 124. Foreman, 1973b, p. 260.

Acanthocircus carinatus Foreman s.s.
(Plate 2C, Figure 8; Plate 4, Figure 12)
(Range chart number 36)

Acanthocircus carinatus Foreman, 1973b, p. 260, pl. 5, fig. 1, 2 (not Riedel and Sanfilippo, 1974, pl. 2, fig. 1, 2).
Spongosaturnalis variabilis Squinabol *in* Moore, 1973, p. 824, pl. 6, fig. 1, 3 (not fig. 2).

Remarks: Included here are elliptical saturnalin rings with two blades on their inner margin and with a ridge between the two spines at the narrow end of the ring. Forms with two end spines, but lacking a ridge, are excluded and are assigned to *Acanthocircus variabilis* (Squinabol).

It was noted in Foreman (1973b) that early forms had a greater width between the end spines; in addition, early forms also tend to have a less robust ridge between the end spines.

Acanthocircus dicranacanthos (Squinabol) emend.
(Plate 20, Figures 5, 6)
(Range chart number 12)

Saturnalis dicranacanthos Squinabol, 1914, p. 289, fig. 1; pl. 22, fig. 4-7; pl. 23, fig. 8.
Saturnalis novalensis Squinabol, 1914, p. 297, pl. 23, fig. 7; pl. 20, fig. 1.
Saturnulus sp. Fischli, 1916, p. 46, 47, fig. 55.
Acanthocircus dizonius (Rüst) (?) *in* Foreman, 1973b, p. 260, pl. 4, fig. 4, 5. Riedel and Sanfilippo, 1974, pl. 2, fig. 4, 5 (not fig. 3).
Spongosaturnalis dicranacanthos (Squinabol) *in* Pessagno, 1969, p. 610, pl. 4, fig. A, B, Moore, 1973, p. 824, pl. 3, fig. 1, 3.

Remarks: Included here are elliptical saturnalin rings with two blades on the outer margin and with a single bifurcated spine at each narrow end, regardless of the nature of the shell. Rare specimens (Squinabol, 1914, pl. 22, fig. 7) with a bifurcated spine at one end only are also included.

Acanthocircus trizonalis (Rüst) (?) emend.
(Plate 20, Figures 1-4)
(Range chart number 18)

[?] *Saturnulus trizonalis* Rüst, 1898, p. 9, pl. 2, fig. 4.
Saturnalis amissus Squinabol, 1914, p. 296, pl. 23, fig. 2-5.
Saturnulus trizonalis Rüst *in* Fischli, 1916, p. 46, 47, fig. 52.
Saturnatis ? aff. *amissus* Squinabol *in* Zhamoida, 1969, p. 19, fig. 9, p. 24.
Spongosaturnalis amissus (Squinabol) *in* Moore, 1973, p. 824, pl. 3, fig. 2.
Acanthocircus trizonalis (Rüst) (?) *in* Foreman, 1973b, p. 261, pl. 4, fig. 6-8.
Acanthocircus dizonius (Rüst) *in* Riedel and Sanfilippo, 1974, pl. 2, fig. 3 (not fig. 4, 5).

Remarks: *A. trizonalis* is emended from Foreman, 1973b, to include forms such as *Saturnatis* (?) aff. *amissus* Squinabol *in* Zhamoida, 1969, which have very small end spines and the saddle not, or only very slightly, developed. Forms with bifurcated end spines are treated as the separate species *A. dicranacanthos*.

Acanthocircus variabilis (Squinabol)
(Plate 2C, Figures 9, 10)

Saturnalis variabilis Squinabol, 1914, pl. 22, fig. 8, 9.
Acanthocircus sp. aff. *Saturnalis variabilis in* Foreman, 1973b, p. 261, pl. 5, fig. 4, 5; pl. 16, fig. 18.
Spongosaturnalis variabilis in Moore, 1973, p. 824, pl. 6, fig. 2 (not fig. 1, 3).
Acanthocircus carinatus in Riedel and Sanfilippo, 1974, pl. 2, fig. 1, 2.

Remarks: Included here are elliptical saturnalin rings with two blades on their inner margin and with two or three approximately equal spines at each end of the ellipse. The two-spined forms do not have a ridge between the spines. They are tabulated, but are not included in the events list.

Acanthocircus sp.
(Plate 2C, Figure 7)

Remarks: Although this rare form has not been treated in detail, it is illustrated here because of its apparent limited range. It differs from a similar form in the early Santonian of Trinidad in having blades on the inner margin of the ring which do not continue across the ends of the polar spines.

Genus SPONGOSATURNALIS Campbell and Clark

Spongosaturnalis Campbell and Clark, 1944b, p. 7. Foreman, 1973b, p. 261.

Spongosaturnalis (?) eidalimus Foreman, new species
(Plate 1B, Figures 6, 7; Plate 4, Figure 5)
(Range chart number 53)

Description: This species is similar to *S.* (?) *yaoi* from which it differs in having a ring more circular in shape and always elliptical in cross-section. Also the spines adjacent to the polar spines are generally less divergent and may be parallel to each other. Early specimens may bear eight spines.

Measurements (based on 10 specimens from 310A-11, CC; 13, CC; and 17, CC). Vertical diameter of ring 190-225μ, lateral diameter 255-285μ; width of ring 15μ.

Remarks: When the ring becomes smaller and more angular, this species passes into *S.* (?) *yaoi* which may be considered a descendant. See also Remarks under *S* (?) *yaoi*. *S.* (?) *eidalimus* may itself be a descendant of *S.* (?) sp. b described by Yao (1972) from which it differs in having fewer spines.

Etymology: The specific name *eidalimus* is from the Greek adjective *eidalimos*, comely.

Spongosaturnalis horridus (Squinabol)
(Plate 2C, Figure 1; Plate 4, Figure 3)
(Range chart number 42)

Acanthocircus horridus Squinabol, 1903b, p. 125, pl. 9, fig. 3.
Saturnalis polymorphus Squinabol, 1914 (invalid name), p. 293.
[?] *Spongosaturnalis polymorphus* (Squinabol) *in* Moore, 1973, p. 824, pl. 6, fig. 6.

Description: The ring is circular (rarely elliptical), very broad, and bladed on the inner margin. It bears 14 to 18 (rarely 12) pointed spines, and rarely a spine may be branched. Fragments of a spongy shell adhere to some specimens, and there is some evidence to suggest a small inner shell may be present (Plate 4, Figure 3).

Measurements (based on 10 specimens from 305-63, CC; 305-64-1, 148-150; and 306-12-1, 60-62). Vertical diameter of ring 140-235μ, lateral diameter 235-265μ; width of ring 25-30μ.

Remarks: This form may be distinguished from those included under *S.* (?) *preclarus* and *S.* (?) spp. in this chapter as described under the Remarks accompanying their descriptions.

Spongosaturnalis hueyi (Pessagno)
(Plate 1A, Figure 6; Plate 4, Figure 10)
(Range chart number 57)

Spongosaturninus hueyi Pessagno, in preparation, pl. 12, fig. 1.

Spongosaturnalis hueyi (Pessagno) group
(Plate 1A, Figures 7, 8; Plate 1B, Figures 1-3)
(Range chart number 51)

Spongosaturninus hueyi Pessagno, in preparation, pl. 12, fig. 1.

Description: Included in this group are forms with the general configuration of *S. hueyi*. The ring may be angular or circular to elliptical. It is smooth and may be lamellar or elliptical in cross-section, or very slightly thickened on both margins. It varies considerably in width and bears 8 to 10 (rarely 12 on older forms) flat, generally spatulate, sometimes branched, evenly distributed spines. The spines adjacent to the polar spines extend parallel to them or diverge only slightly.

Measurements (based on 12 specimens from 310A-11, CC; 12, CC; 13, CC; and 17, CC). Vertical diameter of ring 160-270μ, lateral diameter 160-340μ; width of ring 15-30μ.

Remarks: Members of this group are distinguished from *S.* (?) *moorei* and *S.* (?) *yaoi* by their greater number of spines, and from *S.* (?) spp. (this chapter) by lacking a bladed ring. They differ from *S.* (?) *preclarus* in having a narrower ring and fewer spines. Specimens with eight spines differ from *S.* (?) *ichikawai* as described under that species.

The young forms tend to have shorter spines with those adjacent to the polar spines less divergent. Older forms tend to have spines longer, more divergent, and the very oldest specimens had spines that branched.

Spongosaturnalis (?) ichikawai Foreman, new species
(Plate 1B, Figures 4, 5; Plate 4, Figure 7)
(Range chart number 59)

Description: The ring is a subangular to angular octagon, slender, smooth, elliptical in cross-section, with eight smooth (rarely seven), evenly distributed spines, extending one from each corner. The spines adjacent to the polar spines extend parallel to them or diverge only slightly.

Measurements (based on 11 specimens from 310A-10, CC; 11, CC). Vertical diameter of ring 185-250μ (majority 185-225μ), lateral diameter 235-290μ (majority 235-270μ), width of ring 10-15μ.

Remarks: This species is distinguished from members of the *S. hueyi* group with eight spines by its more slender, distinctly octagonal-shaped ring. It is apparently descended from similar older forms with more than eight spines of the *S. hueyi* group (Plate 1A, Figure 8).

This species is named for Koichiro Ichikawa in recognition of his work with Mesozoic Radiolaria of Japan.

Spongosaturnalis (?) moorei Foreman, new species
(Plate 1B, Figure 11; Plate 4, Figure 9)
(Range chart number 64)

Spongosaturnalis sp. A Moore, 1973, p. 824, pl. 13, fig. 8.

Description: The ring is rectangular with the sides adjoining the polar spines almost straight and the lateral sides only slightly convex outwardly. It is smooth, lamellar to elliptical in cross-section, and bears four spatulate spines, one at each corner, obliquely outward directed. Rarely these may branch.

Measurements (based on 10 specimens from 310A-8, CC; 10, CC; and 11, CC). Vertical diameter of ring 140-175μ, lateral diameter 155-195μ, width of ring 12-20μ.

Remarks: The origin of this species is not certain, but it is probably the end member of a lineage that begins with a member of the *S. hueyi* group, with the ring becoming progressively less circular and more angular, and with an accompanying decrease in the number of spines. (See also Remarks under *S.* [?] *yaoi*.) Less likely is the alternative that it may be descended from a very rare, larger, more curved, four-spined form *S.* (?) sp. cf. *S.* (?) *moorei* (Plate 4, Figure 4).

Moore reports this form from the Upper Cretaceous (Cenomanian/Turonian-Coniacian/Santonian) of the central Pacific basin, DSDP Leg 17, Hole 167.

This species is named for Ted C. Moore who first recognized it as a stratigraphically significant form in his work on DSDP Leg 17.

Spongosaturnalis (?) multidentatus (Squinabol)
(Plate 1A, Figures 1-3)

Saturnalis multidentatus Squinabol, 1914, p. 298-299, pl. 23, fig. 11, 12.
Spongosaturnalis (?) *multidentatus* (Squinabol) *in* Foreman, 1973b, p. 261, pl. 15, fig. 4.

Spongosaturnalis (?) preclarus Foreman, new species
(Plate 1A, Figures 4, 5; Plate 4, Figure 8)
(Range chart number 52)

Description: The ring is circular, broad, smooth, flat, or with a slight thickening of the outer margin. It bears numerous (generally 12 to 16) short to moderately long, smooth spines.

Measurements (based on 10 specimens from 310A-16, CC; 17, CC; and 303-5, CC). Vertical diameter of ring 195-270μ, lateral diameter 195-340μ, width of ring 25-45μ.

Remarks: This species is distinguished from specimens identified as *S.* (?) sp. (this chapter) by its broader smooth ring and from *S. horridus* by its ring which is not bladed. It differs from *S. hueyi* in having more numerous pointed spines.

Etymology: The specific name *preclarus* is Latin and means very beautiful.

Spongosaturnalis squinaboli Foreman, new species
(Plate 1C, Figures 1, 2; Plate 4, Figure 6)
(Range chart number 62)

Spongosaturnalis (?) sp. Foreman, 1971, p. 1674, pl. 1, fig. 4. Foreman, 1973b, pl. 15, fig. 6, 7.

Description: The ring and spines are similar to those of *S.* (?) *yaoi* except that the ring is bladed on its outer margin. Short spiny protrusions on the polar spines of the specimens from DSDP Leg 7 (Foreman, 1971) indicate the presence of a fragile outer spongy shell and a slightly sturdier, irregular, small inner shell.

Measurements (based on 10 specimens from 310A-10, CC and 12, CC; and DSDP Leg 7, 61-1, CC). Vertical diameter of ring 165-230μ (majority 185-215μ), lateral diameter 215-260μ, width of ring 15-25μ.

Remarks: This species differs from *S.* (?) *hexagonus* Yao in having smooth spines.

It is apparently widespread and is known from the Santonian-Campanian of DSDP Leg 7, 61-1, CC and Leg 20, 198A-4, CC in the western Pacific, and from the early Santonian of Trinidad, Marac well 1 (Foreman, 1968).

This species is named for Senofonte Squinabol who first recognized the stratigraphic usefulness of saturnalins.

Spongosaturnalis (?) yaoi Foreman, new species
(Plate 1B, Figures 8-10; Plate 4, Figures 1, 2)
(Range chart number 54)

Description: The ring is angular, six-sided, generally slightly broader than it is high, smooth and flattened or elliptical in cross-section. Six (rarely seven on older forms) uniform spines extend outward from the corners. The four spines adjacent to the polar spines diverge.

Measurements (based on 12 specimens from 310A-10, CC; 11, CC; and 12, CC). Vertical diameter of ring 155-225μ, lateral diameter 185-270μ width of ring 15-25μ.

Remarks: Young specimens tend to have the side of the ring adjacent to a polar spine straight with little or no indentation at the point where the side joins the polar spine. Older forms, however, tend to have that side indented so that sometimes it forms a broad V. Specimens in the median part of the range have some forms with the spines appearing pinched or thickened, and sometimes branching.

S. (?) *yaoi* has been described very broadly, and it may be that the forms with a ring narrow and elliptical in cross-section (Plate 4, Figure 2) are not related to the forms with a more flattened ring (Plate 4, Figure 1). The former are apparently descended from *S.* (?) *eidalimus* by the ring becoming more angular, while the latter are more likely to be descended from forms with flattened rings in the *S. hueyi* group by the loss of some spines.

This species is named for Akira Yao in recognition of his work with the spongosaturnalids of central Japan.

Spongosaturnalis (?) spp.
(Plate 1C, Figures 3-10; Plate 2C, Figures 2-6)
(Range chart number 27)

Zygostephanus aculeatus Rüst, 1898, p. 37, pl. 7, fig. 13; Fischli, 1916, p. 46, 47, fig. 50, 51.
Zygostephanus aculeatus (?) Rüst *in* Holmes, 1900, p. 703, pl. 38, fig. 13.
Acanthocircus dendroacanthos Squinabol, 1903b, pl. 9, fig. 9.
Saturnalis polymorphus Squinabol, 1914 (invalid name), p. 293, pl. 22, fig. 11, 12; pl. 24, fig. 2, 5-7 (not fig. 3).
Spongosaturnalis (?) *aculeatus* (?) (Rüst) *in* Foreman, 1973b, pl. 4, fig. 2.
Spongosaturnalis (?) sp. aff. *S.* (?) *aculeatus* (Rüst) *in* Foreman, 1973b, pl. 4, fig. 1, 3.
Spongosaturnalis (?) sp. cf. *S.* (?) *aculeatus* (?) (Rüst) *in* Foreman, 1973b, pl. 14, fig. 1-3.
Spongosaturnalis (?) sp. cf. *Zygostephanus aculeatus* Rüst (?) *in* Holmes, 1900, *in* Foreman, 1973b, pl. 14, fig. 10.
Spongosaturnalis (?) sp. *in* Foreman, 1973b, pl. 14, fig. 4, 5, 9; pl. 15, fig. 2, 3.

Description: Placed here are a great variety of multispined saturnalins which it does not now seem practical to divide further. Forms included have a ring circular to elliptical, and bladed or thickened on one or both margins. They bear eight or more spines. These tend to be blunt and short on the younger forms, and longer, more pointed, on the older forms. Some spines may branch, and the spines adjacent to the polar spines may be parallel or diverge.

Measurements range as follows: vertical diameter 135-270μ, lateral diameter 170-340μ, width of ring 15-25μ.

Remarks: Excluded is a form *S. horridus* which would fit the above broad definition, but which it seems useful to separate because of its limited stratigraphic range. It may be distinguished from the other forms included above by its exceptionally broad ring with a blade on the inner margin only, and numerous sharp pointed spines.

Family HAGIASTRIDAE Riedel, emend. Pessagno, 1971

Genus CRUCELLA Pessagno

Crucella Pessagno, 1971, p. 52.

Crucella cachensis Pessagno
(Plate 5, Figure 6)
(Range chart number 67)

Crucella cachensis Pessagno, 1971, p. 53, pl. 9, fig. 1-3. Pessagno, in preparation, pl. 3, fig. 14, 15.

Remarks: The rare specimens observed here agree well with the illustrations and species description of Pessagno, who indicated that this species ranges from early to middle Turonian in California.

Crucella irwini Pessagno
(Plate 1D, Figure 6; Plate 5, Figure 1)

Crucella irwini Pessagno, 1971, p. 55, pl. 9, fig. 4-6.

Crucella messinae Pessagno
(Plate 1D, Figures 8, 9; Plate 5, Figure 2)

Crucella messinae Pessagno, 1971, p. 56, pl. 6, fig. 1-3.

Remarks: Forms identified as *Crucella messinae* agree well with Pessagno's description and illustration. In addition, some forms with a somewhat more distinct linear structure have been illustrated as *Crucella* sp. (Plate 1D, Figure 7; Plate 2D, Figures 9-11).

Genus PARONAELLA Pessagno

Paronaella Pessagno, 1971, p. 46. Foreman, 1973b, p. 262.

Paronaella (?) diamphidia Foreman
(Plate 5, Figures 4, 5)
(Range chart number 17)

Paronaella (?) *diamphidia* Foreman, 1973b, p. 262, pl. 8, fig. 3, 4.

Paronaella (?) hipposidericus Foreman, new species
(Plate 2E, Figures 1, 2; Plate 5, Figures 3, 7, 10)
(Range chart number 40)

Paronaella (?) sp. aff. *P.* (?) *diamphidia* Foreman, 1973b, p. 262, pl. 8, fig. 5.

Description: The shape of the shell is similar to that of *P.* (?) *diamphidia* except that the odd arm, extending from the apex of the horseshoe, generally extends vertically, and that the basic structure of all three arms shows them to be approximately equal in size, except for the addition of a spongy patagium on the margin of two of the arms. All three arms show a distinct linear structure.

Measurements (based on five specimens from 305-63,CC; 64-1, 148-50; and 66-1, 100-102). Greatest distance, exclusive of spines, between outer margin of two most prominent arms, 295-325μ; between inner margin, near end, of two most prominent arms, 115-130μ.

Remarks: This species appears to be descended from *Paronaella* (?) *diamphidia* with which it co-occurs in the later part of the latter's range. However, the rarity of both forms in the material studied precludes the setting of any evolutionary limits at this time. It is distinguished from *P.* (?) *diamphidia* by its generally larger size and arms with distinct linear structure.

Etymology: From the Greek adjectival form of *hipposideros, hipposiderikus*, pertaining to a horseshoe.

Family PHACODISCIDAE Haeckel, 1881 (?)

Genus EMILUVIA Foreman, emend.

Emiluvia Foreman, 1973b, p. 262.

Remarks: In the material from DSDP Leg 20 from which this genus was originally defined, only the external characteristics of its constituent species could be examined, and it thus seemed appropriate to place this genus in the Family Pseudoaulophacidae. Since then internal casts have been observed. These show an internal structure which suggests that a more appropriate assignment might be the Family Phacodiscidae. However, the presence of an actual phacoid shell is still doubtful, and thus the assignment is only questionably made. This genus differs from others in the Family Phacodiscidae in that its constituent species have at least a partially nodular surface connected by bars, as for the Pseudoaulophacidae.

Emiluvia chica Foreman, emend.
(Plate 5, Figures 12, 13)
(Range chart number 4)

Emiluvia chica Foreman, 1973b, p. 262, pl. 8, fig. 7.

Remarks: The specimens observed in the DSDP Leg 32 material agree well with the earlier description based on material from DSDP Leg 20. In addition, internal casts show the presence of a probable small internal phacoid shell (Plate 5, Figure 12).

Emiluvia pessagnoi Foreman

Emiluvia pessagnoi Foreman, 1973b, p. 262, pl. 8, fig. 6.

Remarks: Only one specimen of this large distinctive form was observed in the material studied from DSDP Leg 32.

Family CENODISCIDAE Haeckel, 1887

Genus TROCHODISCUS Haeckel

Trochodiscus Haeckel, 1887, p. 417. Type species (subsequent designation by Campbell, 1954, p. D77) *Trochodiscus cenophacus* Haeckel, 1887.

Remarks: The species described below is probably not closely related to the type species of *Trochodiscus*. The generic assignment remains the same as that given by the original author until a more suitable one is found.

Trochodiscus exaspina Squinabol
(Plate 2F, Figure 11; Plate 4, Figure 11)
(Range chart number 46)

Trochodiscus exaspina Squinabol, 1914, p. 272, pl. 20, fig. 6.

Remarks: Included under this heading are all the discoidal or spherical porous forms with four or more short, broad, three-bladed spines. The spines are frequently shaped as the petals of a flower, i.e., with the broadest part medianly.

Family PSEUDOAULOPHACIDAE Riedel, 1967a

Genus ALIEVIUM Pessagno

Alievium Pessagno, 1972, p. 297. Foreman, 1973b, p. 262.

Alievium gallowayi (White)
(Plate 1D, Figures 2, 3; Plate 5, Figure 11)
(Range chart number 61)

Baculogypsina (?) *gallowayi* White, 1928, p. 305, pl. 41, fig. 9, 10.
Pseudoaulophacus superbus (Squinabol) *in* Foreman, 1971, p. 1675, pl. 2, fig. 5.
Alievium gallowayi (White) *in* Pessagno, 1972, p. 299, pl. 25, fig. 4-6; pl. 26, fig. 5; pl. 31, fig. 2, 3. Pessagno, in preparation, pl. 9, fig. 1.

Remarks: The rare specimens observed here agree well with the descriptions of Pessagno (1972). Besides the additional localities and range (early Santonian to late Campanian) given by Pessagno (1972), this species is also known from the Santonian-Campanian of Cuba and the Santonian-early Campanian of DSDP Leg 7, Site 61, in the western Pacific.

Alievium praegallowayi Pessagno
(Plate 1D, Figures 4, 5; Plate 5, Figure 9)
(Range chart number 58)

Alievium praegallowayi Pessagno, 1972, p. 301, pl. 25, fig. 2, 3.

Alievium spp.
(Plate 2D, Figures 7, 8; Plate 5, Figure 14)
(Range chart number 25)

Alievium sp. Foreman, 1973b, p. 262, pl. 9, fig. 1, 2.

Genus PSEUDOAULOPHACUS Pessagno

Pseudoaulophacus Pessagno, 1963, p. 200.

Pseudoaulophacus pargueraensis Pessagno
(Plate 5, Figure 8)
(Range chart number 65)

Pseudoaulophacus pargueraensis Pessagno, 1963, p. 204, pl. 2, fig. 4, 7; pl. 6, fig. 4, 5. 1972, p. 309, pl. 30, fig. 4.

Remarks: Besides the localities and range (early Santonian-early Campanian) given by Pessagno (1972, p. 309), this species is also known from the Santonian-Campanian of Cuba, and the Santonian-early Campanian of DSDP Leg 7, Site 61, in the western Pacific.

Suborder NASSELLARIA Ehrenberg, 1875

Family ACANTHODESMIIDAE Hertwig, 1879

Spyrid (?) gen. and sp. indet. Riedel and Sanfilippo
(Plate 2I, Figure 13)

Spyrid (?) gen. and sp. indet. Riedel and Sanfilippo, 1974, pl. 3, fig. 4-8; pl. 12, fig. 5.

Remarks: This form has been tabulated, but because of its rare spotty occurrence is not included in the events list.

Family ARTOSTROBIIDAE Riedel, 1967a

Genus ARTOSTROBIUM Haeckel

Artostrobium Haeckel, 1887, p. 1482. Foreman, 1966, p. 355 emend.

Artostrobium tina Foreman
(Plate 1F, Figures 3-5; Plate 6, Figure 5)
(Range chart number 56)

Artostrobium tina Foreman, 1971, p. 1678, pl. 4, fig. 3.

Artostrobium urna Foreman
(Plate 1F, Figures 6, 7; Plate 6, Figure 6)
(Range chart number 60)

Artostrobium urna Foreman, 1971, p. 1677, pl. 4, fig. 1, 2.

Genus THEOCAMPE Haeckel

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

Theocampe salillum Foreman
(Plate 1F, Figure 8; Plate 6, Figure 4)
(Range chart number 63)

Theocampe salillum Foreman, 1971, p. 1678, pl. 4, fig. 5.

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

Genus CLATHROPYRGUS Haeckel

Clathropyrgus Haeckel, 1881, p. 439. No legal type species has been assigned for this genus.

Clathropyrgus titthium Riedel and Sanfilippo
(Plate 6, Figure 10)

Clathropyrgus titthium Riedel and Sanfilippo, 1974, pl. 3, fig. 12; pl. 12, fig. 10-12.

Remarks: The first appearance of this form in 310A-8, CC serves as the basis for correlating the base of Moore's RK6 Zone with the base of Pessagno's *Alievium gallowayi* Zone.

Genus DIACANTHOCAPSA Squinabol

Diacanthocapsa Squinabol, 1903a. Type species (by subsequent monotypy) *Diacanthocapsa euganea* Squinabol, 1903b.

Remarks: Although Squinabol defined this genus as a two-segmented form with two opposite spines, *D. euganea,* the type species, probably is a three-segmented form. However, in the absence of a more suitable generic assignment, the two-segmented form described below is assigned here.

Diacanthocapsa communis (Squinabol)
(Plate 2I, Figure 17; Plate 6, Figure 11)
(Range chart number 45)

Xyphostylus communis Squinabol, 1903b, p. 111, pl. 10, fig. 20.

Description: Shell as described and illustrated by Squinabol with the exception that no slightly tuberculate forms have been observed and the "cushion" supporting the "superior spine" is here interpreted as the cephalis. In addition, the cephalis is poreless, and the large thoracic segment, while generally spherical, may sometimes be flattened apically. Pores of this segment are relatively large, subcircular to angular, regular in size and distribution. It bears three (perhaps four) slender, smooth, horizontal spines, evenly distributed medianly. These are frequently broken or entirely missing. The two unequal spines of Squinabol are also smooth and are considered as the cephalic apical spine and the thoracic terminal spine.

Measurements (based on 20 specimens from 304-4, CC; 305-50, CC and 58, CC; 306-4, CC; and 307-4, CC). Overall length 225-280μ, length of two segments 115-170μ; greatest width, exclusive of spines, 125-155μ; diameter of pores 9-15μ.

Genus DICTYOMITRA Zittel

Dictyomitra Zittel, 1876, p. 77. Foreman, 1973b, p. 263.

Remarks: Although it has not been possible to define, describe, and tabulate more than a few of the many species of *Dictyomitra* encountered, it was possible to distinguish and describe briefly some ribbed forms and some forms with a nodose shell. Other forms of *Dictyomitra* are illustrated in order to distinguish them from *Dictyomitra cosmoconica.*

Dictyomitra alievi Foreman
(Plate 2H, Figures 8, 9; Plate 7, Figure 2)
(Range chart number 29)

Dictyomitra alievi Foreman, 1973b, p. 263, pl. 9, fig. 10; pl. 16, fig. 4.

Dictyomitra apiarium (Rüst)
(Plate 2G, Figures 7, 8)
(Range chart number 13)

Lithocampe apiarium Rüst, 1885, p. 315, pl. 29, fig. 8.
Dictyomitra apiarium (Rüst) *in* Rüst, 1898, p. 58.
Dictyomitra sp. ind. c Hinde, 1900, p. 39, pl. 3, fig. 13.
Lithomitra excellens Tan *in* Moore, 1973, p. 827, pl. 4, fig. 3, 4.

Dictyomitra boesii Parona
(Plate 2H, Figures 10, 11; Plate 7, Figure 9)
(Range chart number 14)

Dictyomitra boesii Parona, 1890, p. 170, pl. 6, fig. 9. Riedel and Sanfilippo, 1974, pl. 4, fig. 5, 6.

Lithocampe ananassa Rüst *in* Moore, 1973, p. 828, pl. 4, fig. 4-7.
Amphipyndax (?) sp. Foreman, 1973b, p. 263, pl. 9, fig. 3, 4.

Remarks: In the material studied from DSDP Leg 20, the interior of this species could not be examined and from the external evidence it appeared that it might belong to the Family Amphipyndacidae. However, better material from DSDP Leg 32 confirms the generic assignment of Parona.

Dictyomitra carpatica Lozyniak (?)
(Plate 2G, Figures 11-14; Plate 7, Figures 6, 7)
(Range chart number 20)

[?] *Dictyomitra carpatica* Lozyniak, 1969, p. 38, pl. 2, fig. 11, 13.
Dictyomitra carpatica Lozyniak (?) *in* Foreman, 1973b, p. 263, pl. 10, fig. 1-3; pl. 16, fig. 5.

Remarks: Young forms (Plate 7, Figure 6) tend to have a well-developed rectangular ridge on the distal half of each segment, while older forms (Plate 7, Figure 7) have this ridge less distinct, more curved.

Dictyomitra cosmoconica Foreman
(Plate 2H, Figure 3; Plate 7, Figure 1)
(Range chart number 6)

Dictyomitra cosmoconica Foreman, 1973b, p. 263, pl. 9, fig. 11; pl. 16, fig. 3.

Dictyomitra duodecimcostata (Squinabol)
(Plate 1G, Figures 5, 6; Plate 7, Figure 8)
(Range chart number 55)

Lithostrobus duodecimcostata Squinabol, 1903b, p. 138, pl. 10, fig. 21.
[?] *Dictyomitra formosa* Squinabol, 1904, p. 232, pl. 10, fig. 4.
Dictyomitra (Dictyomitra) multicostata Zittel *in* Pessagno, 1963, p. 206, pl. 4, fig. 3; pl. 5, fig. 7.
Dictyomitra sp. *in* Kling, 1971, pl. 8, fig. 4.
Dictyomitra torquata Foreman, 1971, p. 1676, pl. 3, fig. 4. Foreman, 1973b, pl. 15, fig. 9-11. Riedel and Sanfilippo, 1974, pl. 5, fig. 1, 4 (not pl. 5, fig. 2, 3; pl. 14, fig. 2).
Dictyomitra duodecimcostata (Squinabol) group *in* Petrushevskaya and Koslova, 1972, p. 550, pl. 2, fig. 10, 11.

Remarks: This species continues to be broadly described to include forms both with a differentiated first expanded segment and forms in which the expanded segments increase uniformly in size. It is distinguished from *D. koslovae* by its generally more robust form and larger size, and by the presence of segments all of which are distally expanded after the initial proximal, smooth, conical segments. See also remarks under *D. koslovae.*

When a more complete sequence of well-preserved material is available, it may prove useful to separate this broad species into two species, based on the character of the first expanded segment.

Dictyomitra koslovae Foreman, new species
(Plate 7, Figure 4)
(Range chart number 66)

Dictyomitra sp. Kling, 1971, pl. 8, fig. 2.
Dictyomitra sp. Foreman, 1971, p. 1677, pl. 3, fig. 5. Foreman, 1973b, pl. 15, fig. 13-15.
Dictyomitra cf. *D. torquata* Moore, 1973, p. 829, pl. 9, fig. 1-3 (not fig. 4).
Dictyomitra sp. A Moore, 1973, p. 830, pl. 17, fig. 2, 3.
Dictyomitra torquata Foreman *in* Riedel and Sanfilippo, 1974, pl. 5, fig. 2, 3 (not fig. 1, 4); pl. 14, fig. 2.

Description: Shell conical proximally, subconical to almost cylindrical distally. The fourth or fifth segment (usually the fourth) is generally markedly wider than the next one or two segments. These one or two narrower segments have straight sides or are only gently inflated. Subsequent segments may be inflated medianly or not at all. Rarely they are slightly inflated distally. The arrangement of pores and costae is as for *D. duodecimcostata.* The total number of segments varies from 7 to 10.

Measurements (based on 12 specimens from DSDP Leg 7, 61-1, CC; Leg 26, 256-6-3, 55-58; Cuba B191; and 310A-8, CC). Length of seven segments 140-185μ (majority 150-170μ); width of seventh segment 80-100μ, of broadest segment 80-105μ.

Remarks: This species differs from *D. duodecimcostata* in its generally less robust, narrower form and in the one or two segments subsequent to the fourth or fifth expanded segment, which are narrower with straight sides or only gently inflated. It is distinguished from *D. sagitafera* Aliev (1965) by having fewer pores and no ribs on the proximal conical part.

Because this species is better preserved in samples other than those from DSDP Leg 32, the description and measurements were made considering specimens in the synonymy and as indicated in the measurements paragraph as well as from Leg 32. The specimen illustrated in Foreman, 1971, pl. 3, fig. 5, USNM 1679242; V13/4, is designated as the holotype.

This species is named for Genrietta Koslova in recognition of her work with Cretaceous Radiolaria.

Dictyomitra (?) lacrimula Foreman
(Plate 2G, Figures 5, 6; Plate 6, Figure 1)
(Range chart number 30)

Dictyomitra (?) *lacrimula* Foreman, 1973b, p. 263, pl. 10, fig. 11.
Cornutanna conica Aliev *in* Moore, 1973, p. 830, pl. 14, fig. 2 (not fig. 1).

Remarks: In the Cretaceous there are a number of smooth-ribbed conical forms with wide open or only slightly constricted apertures (Plate 6, Figure 2), and with a variety of internal segmental divisions. *D. lacrimula* is strictly limited to those forms with an inverted conical terminal segment with a small aperture. When the internal segmental division can be seen there are six to seven segments gradually increasing in length and width, except for the last conical segment which narrows.

Numerous specimens in the DSDP Leg 32 material allow the dimensions to be expanded as follows: length of shell 155-280μ; greatest width of shell 70-140μ.

This species should probably be assigned to the new genus *Protunuma* Ichikawa and Yao, in preparation. However, the manuscript arrived too late for the change to be made.

Dictyomitra pseudomacrocephala Squinabol
(Plate 7, Figure 10)
(Range chart number 50)

Dictyomitra pseudomacrocephala Squinabol, 1903b, p. 139, pl. 10, fig. 2. Cita, 1964, p. 143, pl. 12, fig. 8, 9. Petrushevskaya and Koslova, 1972, p. 550, pl. 2, fig. 5. Pessagno, in preparation, pl. 3, fig. 2, 3.
[?] *Dictyomitra sagitafera* Aliev, 1961, p. 25, pl. 1, fig. 1-3. Aliev, 1965, p. 55, pl. 10, fig. 2-4.
Dictyomitra malleola Aliev *in* Pessagno, 1969, p. 610, pl. 5, fig. A.
Dictyomitra macrocephala Squinabol *in* Moore, 1973, p. 829, pl. 9, fig. 8, 9. Riedel and Sanfilippo, 1974, pl. 4, fig. 10, 11; pl. 14, fig. 11.
Dictyomitra sp. Foreman, 1973b, pl. 14, fig. 16.

Remarks: *Dictyomitra pseudomacrocephala* is extremely rare in the material studied. It is distinguished from *D. macrocephala* Squinabol and *D. malleola* Aliev by the presence of vertical ridges and depressions.

Dictyomitra somphedia Foreman
(Plate 7, Figures 11-13)
(Range chart number 48)

Dictyomitra somphedia Foreman, 1973b, p. 264, pl. 14, fig. 18.

Remarks: This large distinctive species may be recognized even in poorly preserved material by its size and shape. The median change in contour from a subconical proximal part to an inflated distal part is very characteristic. The illustrated specimens show variations in the form of the expanded part. There are no co-occurring forms with which this species can be confused.

Dictyomitra veneta (Squinabol)
(Plate 1G, Figure 4)

Phormocyrtis veneta Squinabol, 1903b, p. 134, pl. 9, fig. 30.
Dictyomitra veneta (Squinabol) *in* Petrushevskaya and Koslova, 1972, p. 550, pl. 2, fig. 2. Foreman, 1973b, p. 264, pl. 14, fig. 11. Riedel and Sanfilippo, 1974, pl. 5, fig. 5, 6.
[?] *Dictyomitra veneta* (Squinabol) *in* Moore, 1973, p. 829, pl. 9, fig. 7.
Phormocyrtis (?) *veneta* Squinabol *in* Pessagno, in preparation, pl. 3, fig. 10.

Remarks: In the DSDP Leg 32 material as in Leg 20, this species is extremely rare. Only two specimens of *D. veneta* were observed in Sample 307-3-1, 126-128. It has therefore not been included in any of the tabulations or events lists.

The specimen of *D. veneta* illustrated by Moore is only doubtfully included in the synonymy because no previous evidence has suggested that this form has distal segments defined externally by strictures.

Dictyomitra spp. cf. D. tekschaensis Aliev
(Plate 1H, Figure 1; Plate 2H, Figure 1)

Dictyomitra tekschaensis Aliev, 1967, p. 29, fig. K.

Remarks: Under this name are illustrated forms with closely spaced uniform round pores, a smooth surface, and uniform inflated segments. They are apparently restricted to the early Late Cretaceous and the late Early Cretaceous.

Dictyomitra sp. A
(Plate 1G, Figure 7; Plate 2G, Figures 18-20)

Remarks: This ribbed form is characterized by its slender shape and relatively long, uniform segments. They are generally only very slightly inflated, with little or almost no external segmental constriction.

Dictyomitra sp. B
(Plate 2G, Figures 9, 10)

Remarks: This ribbed form is characterized by its closely spaced ribs and relatively short segments which are inflated medianly and increase only gradually in length.

Dictyomitra sp. C
(Plate 2G, Figures 15-17)

Remarks: This ribbed species is characterized by segments, each of which is only moderately inflated distally, with only a slight external segmental constriction. This forms a distinctive undulating profile.

Dictyomitra spp.
(Plate 1H, Figures 4, 5; Plate 2H, Figures 5-7)

Remarks: The forms illustrated here are characterized by their nodes and rather long segments. Late forms (Plate 1H, Figures 4, 5 and Plate 2H, Figure 5) have small, sharp, compact nodes and the early ones (Plate 2H, Figures 6, 7) larger, blunt, porous nodes.

Dictyomitra spp.
(Plate 1H, Figures 2, 3; Plate 2H, Figure 2)

Remarks: The illustrated forms are all very rare. They are included in the synchronopticon in order to distinguish them from *Dictyomitra cosmoconica.* They all have in common their large size and segmental divisions outlined by closely spaced nodes which together form distinct ridges at the segmental strictures. *D. cosmoconica* differs from the specimens illustrated on Plate 1H, Figure 2 and Plate 2H, Figure 2 by its pores which are larger, more regularly quincuncially arranged, and from the specimen illustrated on Plate 1H, Figure 3 in the character of its ridges. *D. cosmoconica* has ridges which are small, indistinct proximally, gradually becoming sturdier, rather than sturdy proximally, gradually becoming thinner.

Dictyomitra (?) sp.
(Plate 2H, Figure 4)

Remarks: A distinctive conical form terminating in three tubular feet is present in only one sample, 307-7-1, 75-77. It is also known from DSDP Leg 20, 196-4-1 (#3). Although rare at both localities, its apparent short range in the lower part of the *Eucyrtis tenuis* Zone may make this a useful marker for that level.

Genus EUCYRTIS Haeckel

Eucyrtis Haeckel, 1881, p. 438. Foreman, 1973b, p. 264.

Remarks: In three recent papers produced in the Reports of the Deep Sea Drilling Project—Foreman, 1973b; Riedel and Sanfilippo, 1974; and Renz, 1974—there appears to be some confusion in regard to two species variously assigned to *Stichocapsa tenuis* Rüst, *Eucyrtis hanni* (Tan), and *Eucyrtis zhamoidai* Foreman.

The two species *Eucyrtis tenuis* and *Eucyrtis micropora* which is the senior synonym of *E. hanni* and *E. zhamoidai* are described below, and distinguishing features are discussed.

Eucyrtis bulbosa Renz (?)
(Plate 2K, Figures 3-5)

[?] *Eucyrtis bulbosus* Renz, 1974, pl. 7, fig. 26-29; pl. 12, fig. 15a, b.

Remarks: These rare forms are only doubtfully assigned to *E. bulbosa* because the small proximal part appears to have fewer segments than described for this species.

The forms illustrated here vary considerably, with the specimen in Figure 3 having a slightly nodose surface and that in Figure 5 having a relatively shorter proximal part.

Eucyrtis columbaria Renz
(Plate 2I, Figure 19)

Eucyrtis columbarius Renz, 1974, pl. 7, fig. 14-20; pl. 12, fig. 13a-c.

Remarks: Rare, poorly preserved specimens of this form were observed in two samples assigned to the *Eucyrtis tenuis* Zone: 304-9-1, 148-150 and 307-7-1, 75-77.

Eucyrtis micropora (Squinabol)
(Plate 2I, Figures 2-5)
(Range chart number 24)

Archicapsa micropora Squinabol, 1903b, p. 129, pl. 9, fig. 14.
Eusyringium sp. A *in* Zhamoida et al., 1968, pl. 1, fig. 8. Zhamoida, 1969, p. 19, fig. 8. Zhamoida, 1972, p. 121, pl. 17, fig. 3.
Eucyrtis zhamoidai Foreman, 1973b, pl. 10, fig. 9, 10; pl. 16, fig. 1.
[?] *Eucyrtis zhamoidai* Foreman, 1973b, pl. 16, fig. 2.
Eucyrtis hanni Riedel and Sanfilippo, 1974, pl. 5, fig. 9-13; pl. 12, fig. 18 (not fig. 16, 17). Renz, 1974, pl. 7, fig. 21-25; pl. 12, fig. 16a, b.
Stichocapsa tenuis Rüst *in* Riedel and Sanfilippo, 1974, pl. 9, fig. 13 (not fig. 14).

Description: Shell subspindle-shaped. The cephalis has a branched vertical spine as in Foreman, 1966, fig. 4-6. The conical proximal segments increase gradually in width and length until medianly they are less regular. The one or two segments following the widest one begin to constrict, and the last one of these tends to be but is not always bowl-shaped. The narrow terminal tube-like segment is without division or rarely has one segmental division proximally. It is developed as a separate one or two segments, not as a continuation of the inverted conical bowl-shaped segment. Externally there is little or no segmental division except for a constriction, sometimes very slight, between the bowl-shaped segment and the terminal tube. Pores are small, rounded, arranged randomly or in vague transverse rows. The surface is spiny, sometimes with long downward-directed spines distally.

Measurements (based on 15 specimens from 305-65-1, 108-110; 307-7-1, 75-77; and 307-9-1, 80-82). Length of one complete specimen 230μ, of longest incomplete specimen 400μ; greatest width 65-100μ. Three specimens with internal segmentation visible had 7, 8, and 9 segments, respectively.

Remarks: See Remarks under *Eucyrtis tenuis* for distinguishing features.

Eucyrtis tenuis (Rüst)
(Plate 2I, Figures 7-9)
(Range chart number 35)

Stichocapsa tenuis Rüst, 1885, p. 318, pl. 47, fig. 13, 14. Riedel and Sanfilippo, 1974, pl. 9, fig. 14 (not fig. 13).
[?] *Stichocapsa tenuis* Rüst, 1885 *in* Riedel and Sanfilippo, 1974, pl. 9, fig. 12.

Description: The shell is multisegmented, spindle-shaped, with no or very little external segmental division. The cephalis bears a horn and has a branched vertical spine as in Foreman, 1966, fig. 4-6. The segments increase gradually in width and very gradually in length to their greatest dimension medianly and then gradually decrease in size. The distal narrowed part is segmented for much of its length. Rare complete specimens show that the distal end closes with a spine. Pores are small, rounded, arranged randomly or in vague transverse rows. The surface may be smooth or thorny.

Measurements (based on 12 specimens from 305-65-1, 108-110; 307-6, CC; and 307-7-1, 75-77). Length of longest incomplete specimen 410μ; greatest width 55-80μ. Five specimens with internal segmentation visible had 10, 12, and 14 segments.

Remarks: *E. tenuis* is distinguished from *E. micropora* by the internal segmentation which in *E. tenuis* is more uniform with only a slight increase in length of the segments medianly. *E. tenuis* also has the post-median constricting part segmented for much of its length and thus in specimens of comparable size has more segments than *E. micropora.* This post-median constricting part also tends to be broader than in *E. micropora. E. tenuis* shows even less external segmental division than *E. micropora,* and there is no bowl-shaped segment or constriction distally as for many specimens of *E. micropora.* It also lacks the downward-directed spines of *E. micropora.* When there is no or little external change of contour and because of poor preservation no downward directed spines or internal segmentation visible, it is virtually impossible to distinguish *E. tenuis* from *E. micropora.* Take, for example, the figure of *Eucyrtis micropora* = *E. hanni* illustrated by Renz, 1974, pl. 7, fig. 24. Without the internal segmental division visible, it would not be possible to distinguish this form from *E. tenuis.* The difficulty of distinguishing *E. tenuis* from *E. micropora* is illustrated by the confusion that exists between these species among the references listed in the synonymy of both these species. Foreman (1973b) assigned all of her forms to *E. zhamoidai.* However, reexamination of the holotype of *E. zhamoidai* (Foreman 1973b, pl. 16, fig. 1) shows that it has eight segments before the distal-most tube-like segment, and a slight change of contour between this last segment and that immediately preceding. It should be assigned to *E. micropora* and is thus a junior synonym of that species as suggested by Renz, 1974. Superficially it looks very much like the cast of the next figure (Foreman, 1973b, pl. 16, fig. 2), which differs in having 11 more uniform segments plus a narrow distal tube-like segment. Thus, that form possesses some of the characteristics of both *E. micropora* and *E. tenuis.* It is now only questionably assigned to *E. micropora.* Conversely, Riedel and Sanfilippo, 1974, assigned these same forms to *E. tenuis.*

Riedel and Sanfilippo, 1974, indicate that *E. micropora* occurs at either end of the range of *E. tenuis,* and thus presumably it co-occurs with *E. tenuis* throughout , yet they indicate that it co-occurs in only one sample, Beets R60-161, again illustrating the difficulty in distinguishing these two forms in poor material.

The same difficulty was encountered in the material from DSDP Leg 32, and therefore in the tabulations only certain specimens of *E. tenuis* are noted, and absences, because they may be due to uncertainties in identifying this form, are not recorded.

Genus LITHOCAMPE Ehrenberg

Lithocampe Ehrenberg, 1838, p. 128. Type species (subsequent designation by Campbell, 1954, p. D140) *Lithocampe radicula* Ehrenberg, 1838.

Remarks: The species described below are certainly not closely related to the type species *L. radicula.* However, the generic assignment remains unchanged as a convenience until further studies are completed.

Lithocampe chenodes Renz
(Plate 2K, Figure 6)

Lithocampe chenodes Renz, 1974, pl. 7, fig. 30; pl. 12, fig. 14a-d.

Remarks: Very rare specimens of this form were observed in only one sample, 307-7-1, 75-77.

Lithocampe elegantissima Cita
(Plate 2G, Figures 3, 4)

Lithocampe elegantissima Cita, 1964, p. 148, pl. 12, fig. 2, 3.

Remarks: This species was originally described from sediments of Albian-Aptian age from Monte Baldo in northern Italy. The illustrations all show a cylindrical fourth segment. In the material from DSDP Leg 32 this species was observed only in cores assigned to the *Eucyrtis tenuis* Zone (Aptian or Barremian to Hauterivian or Valanginian). These older forms differ slightly from the younger ones by the large fourth segment which is distinctly inflated rather than cylindrical.

Lithocampe mediodilatata Rüst
(Plate 2K, Figure 2; Plate 6, Figure 17)
(Range chart number 10)

Lithocampe mediodilatata Rüst, 1885, p. 316, pl. 40, fig. 9. Moore, 1973, p. 828, pl. 2, fig. 5, 6. Riedel and Sanfilippo, 1974, pl. 7, fig. 1-4.

"Lithocampe" mediodilatata Rüst ? *in* Pessagno, 1969, p. 610, pl. 4, fig. G, H.

Theoperid, gen. and sp. indet. Foreman, 1973b, pl. 12, fig. 2.

Genus LITHOMELISSA Ehrenberg

Lithomelissa Ehrenberg, 1847. Type species (by subsequent monotypy) *Lithomelissa microptera* Ehrenberg, 1854b.

Remarks: It is not likely that the species described below is related to the type species of *Lithomelissa.* However, this genus continues to be used as previously (Foreman, 1968) for two-segmented Mesozoic forms with three wings as a matter of convenience until a more suitable genus is defined.

Lithomelissa (?) petila Foreman, new species
(Plate 1G, Figures 2, 3; Plate 6, Figure 3)
(Range chart number 44)

Lithomelissa (?) sp. Foreman, 1973b, pl. 14, fig. 17.

Description: The shell is of two segments and bears a slender bladed horn and three-bladed wings. The hemispherical cephalis has a few irregularly disposed rounded pores. The thorax is cylindrical except proximally where it is slightly expanded at the point where the wings emerge. Pores are moderate, rounded, and irregularly arranged on the expanded part; large, angular, and tending to be elliptical on the cylindrical part. They are arranged quincuncially in longitudinal rows with the long axis transverse. One specimen was observed to have a smooth aperture; all others are ragged. The long downward-directed wings curve with convexity outward.

Measurements (based on 12 specimens from 303A-4, CC; 305-46, CC; 306-4, CC; and 307-3-1, 126-128). Length overall, exclusive of horn of longest broken specimen 410μ, of wings 110-320μ; width of thorax medianly 60-100μ; greatest width f pores 15-204m.

Remarks: Although this species is rare in the material studied, the sturdy, distinctive character of the shell should make this a useful form in the mid-Cretaceous (late Albian-early Cenomanian section) where there are few distinctive forms.

This species is also present in the possible Cenomanian of DSDP Leg 20, 195-3, CC.

Etymology: Latin adjective *petilus* meaning slender.

Genus PLATYCRYPHALUS Haeckel

Platycryphalus Haeckel, 1881, p. 430. Type species (by subsequent monotypy) *Platycryphalus pumilus* Rüst, 1885.

Remarks: Although Rüst in his description considered *P. pumilus* to be a two-segmented form, his mention of a large first segment is considered as the possible basis for interpreting the illustrated specimen as having two proximal segments, and the unnamed species described below are thus assigned here.

Platycryphalus spp. aff. P. hirsuta (Squinabol)
(Plate 2G, Figure 2; Plate 6, Figures 7-9)
(Range chart number 44)

Sethocyrtis (?) *hirsuta* Squinabol, 1904, p. 215, pl. 7, fig. 11.

Remarks: Included here are a variety of forms with two pyramidal proximal segments and a cylindrical third segment with a wide open, smooth aperture. The first two segments vary considerably. There may or may not be an external constriction between them, so that frequently they appear as one segment. Overall the surface is generally smooth with pores of the third segment rounded, closely spaced, and evenly distributed. A larger form, not included, is illustrated (Plate 1G, Figure 1; Plate 2G, Figure 1) as *Platycryphalus* sp.

Genus STICHOCAPSA Haeckel

Stichocapsa Haeckel, 1881, p. 439. Foreman, 1973b, p. 265.

Stichocapsa (?) rotunda Hinde
(Plate 2J, Figure 6; Plate 7, Figure 5)
(Range chart number 8)

Stichocapsa rotunda Hinde, 1900, p. 41, pl. 3, fig. 24. Moore, 1973, p. 827, pl. 5, fig. 1, 3, 4.

Stichocapsa (?) *rotunda* Hinde *in* Foreman, 1973b, p. 265, pl. 11, fig. 1, 2; pl. 16, fig. 20.

Subfamily SYRINGOCAPSINAE Foreman, 1973b

Genus DIBOLACHRAS Foreman

Dibolachras Foreman, 1973b, p. 265.

Dibolachras tytthopora Foreman
(Plate 2L, Figures 2, 3; Plate 6, Figure 16)
(Range chart number 34)

Dibolachras tytthopora Foreman, 1973b, p. 265, pl. 11, fig. 4; pl. 16, fig. 15.

Genus PODOBURSA Wiśniowski, emend. Foreman

Podobursa Wiśniowski, 1889, p. 686. Foreman, 1973b, p. 266.

Podobursa (?) polylophia Foreman emend.
(Plate 2L, Figure 1)

Eusyringium typicum Rüst *in* Moore, 1973, p. 829, pl. 1, fig. 5-7.
Podobursa (?) *polylophia* Foreman, 1973b, p. 266, pl. 11, fig. 8, 9.

Remarks: This species is more common in the DSDP Leg 32 material than in the Leg 20 material from which it was originally described. The original description is emended here to include a greater variety of forms. Included now are early forms with a long horn, bladed or ridged at the base. Younger forms tend to have a shorter smooth horn. The nodes are larger medianly or in some forms only present medianly. They form the bases for the spines which may be short cylindrical or longer tapering. It is distinguished from the closely related *Syringocapsa limatum* as described under that species. This species is not included in the events list.

Podobursa tetracola Foreman
(Plate 7, Figure 3)
(Range chart number 7)

Podobursa tetracola Foreman, 1973b, p. 266, pl. 13, fig. 10; pl. 16, fig. 14.

Podobursa triacantha (Fischli)
(Plate 2L, Figures 4-6)
(Range chart number 15)

Podobursa triacantha (Fischli) *in* Foreman, 1973b, p. 266, pl. 13, fig. 1-7.
Podobursa sp. *in* Riedel and Sanfilippo, 1974, pl. 13, fig. 7.

Podobursa tricola Foreman
(Plate 2L, Figures 7, 8)
(Range chart number 37)

Podobursa tricola Foreman, 1973b, p. 267, pl. 13, fig. 9; pl. 16, fig. 12.

Genus PODOCAPSA Rüst, emend. Foreman

Podocapsa Rüst, 1885, p. 304. Foreman, 1973b, p. 267.

Podocapsa amphitreptera Foreman
(Plate 6, Figure 15)
(Range chart number 2)

Podocapsa amphitreptera Foreman, 1973b, p. 267, pl. 13, fig. 11.

Genus SETHOCAPSA Haeckel

Sethocapsa Haeckel, 1881, p. 433. Foreman, 1973b, p. 267.

Sethocapsa cetia Foreman
(Plate 6, Figure 14)
(Range chart number 5)

Sethocapsa cetia Foreman, 1973b, p. 267, pl. 12, fig. 1; pl. 16, fig. 19.

Sethocapsa leiostraca Foreman
(Plate 2J, Figure 5)
(Range chart number 9)

Sethocapsa leiostraca Foreman, 1973b, p. 268, pl. 12, fig. 5, 6.

Sethocapsa (?) orca Foreman, new species
(Plate 2J, Figures 1, 2; Plate 6, Figure 12)
(Range chart number 32)

Description: The shell is large, of probably four segments; a cephalis and two post-cephalic segments comprising a small conical proximal part, and a large spherical terminal segment. The proximal segments have small irregular pores and the large spherical segment moderate, subcircular to angular, uniform pores, closely spaced and regularly quincuncially arranged in diagonal rows like a honeycomb. The intervening pore bars are generally narrow and smooth except for a slight raised area where they join. On their lower margin the pores are scalloped or subdivided. One specimen was observed with a small smooth rounded aperture, 25μ in diameter.

Measurements (based on 15 specimens from 304-9, CC; 305-66-1, 100-102; 306-14, CC; and 307-7-1, 75-77). Length overall 310-435μ, of small proximal part 45-75μ; width of globose terminal segment 230-370μ, of shell wall 20-30μ.

Remarks: This species is distinguished from *Sethocapsa leiostraca* Foreman by its larger size, proportionately smaller pores, and lack of spines, and from *Tetracapsa ixodes* Rüst by its terminal segment which is spherical and has much more closely spaced pores.

This species is only doubtfully assigned to *Sethocapsa* because one specimen was observed with a small aperture in its terminal segment.

Etymology: The specific name *orca* is the Latin feminine noun, whale or large rounded vessel.

Sethocapsa trachyostraca Foreman
(Plate 2J, Figures 3, 4)
(Range chart number 23)

Stichocapsa conosphaeroides Rüst *in* Moore, 1973, p. 827, pl. 4, fig. 5, 6.
Sethocapsa trachyostraca Foreman, 1973b, p. 268, pl. 12, fig. 4. Riedel and Sanfilippo, 1974, pl. 9, fig. 5-7.

Sethocapsa spp. cf. Theocapsa uterculus
(Plate 2I, Figures 21, 22)

cf. *Theocapsa uterculus* Parona, 1890, p. 168, pl. 5, fig. 17.

Remarks: These forms are characterized by their last two segments which have distinctly flattened proximal margins. The illustrated forms have the last segment with uniform rounded pores, set in angular pore frames. Other forms in which the last segment has a nodose surface are also known.

Sethocapsa spp.
(Plate 2I, Figures 10-12, 14)

Remarks: The forms illustrated here are very characteristic of the late Early Cretaceous. The species illustrated (Figures 10-12) is distinguished by the small conical proximal part with its three segments clearly marked by external strictures. The large globose segment has no spines. The species illustrated (Figure 14) is distinguished from the preceding species by the character of its small proximal part which is almost cylindrical, rather than conical. Well-preserved specimens have a few short cylindrical spines on the last globose segment.

This form may be a descendant of *Sethocapsa leiostraca;* however, no connecting forms are known.

Genus SYRINGOCAPSA Neviani

Syringocapsa Neviani, 1900, p. 662. Foreman, 1973b, p. 268.

Remarks: Included here are forms with three or more segments in which the last segment is globose, does not bear any spines, and terminates in a porous tube. The distinction between *Podobursa* and *Syringocapsa* on the basis of the presence or absence of spines is rather artificial and thus separates two closely related forms, *Podobursa* (?) *polylophia* and *Syringocapsa limatum.* However, until the relationships of these and other forms assigned to these two genera are better understood, no change in generic assignments is made.

Syringocapsa limatum Foreman
(Plate 2K, Figure 7)
(Range chart number 11)

Syringocapsa limatum Foreman, 1973b, p. 268, pl. 11, fig. 6, 7; pl. 16, fig. 8.

Remarks: Early forms tend to have larger pores, similar to those of *Podobursa* (?) *polylophia*, and a slightly ridged horn. These early forms differ from *P.* (?) *polylophia* with which they co-occur in lacking the spines and more prominent median nodes from which these spines arise.

Family WILLIERIEDELLIDAE Dumitrica, 1970

Genus HEMICRYPTOCAPSA Tan, emend. Dumitrica

Hemicryptocapsa Tan, 1927, p. 50. Dumitrica, 1970, p. 70.

Hemicryptocapsa spp. cf. H. capita Tan
(Plate 2I, Figures 18, 20)
(Range chart number 22)

Hemicryptocapsa spp. cf. *H. capita* Tan, 1927, pl. 6, fig. 1-4.
Remarks: The species included under this heading are apparently related to *Syringocapsa agolarium* Foreman, 1973b, from which they differ in lacking a sturdy horn. In the DSDP Leg 32 material studied, no specimens of *S. agolarium* were encountered, perhaps indicating a very short range between Cores 307-7 and 307-8.

Genus HOLOCRYPTOCANIUM Dumitrica

Holocryptocanium Dumitrica, 1970, p. 75.

Holocryptocanium barbui Dumitrica
(Plate 1F, Figure 9; Plate 6, Figure 13)
(Range chart number 47)

Holocryptocanium barbui Dumitrica, 1970, p. 76, pl. 17, fig. 105-108; pl. 21, fig. 36. Petrushevskaya and Koslova, 1972, pl. 1, fig. 3.
Remarks: Unless the internal structures can be observed, it is virtually impossible to identify this species confidently. Therefore, the first and last appearances given in the tabulations and the events list, dependent as they are on preservation, probably do not reflect the true range of this species.
A form identified as *Holocryptocanium* sp. (Plate 1F, Figure 10) differs in having a slightly nodose surface.

Genus ZHAMOIDELLUM Dumitrica

Zhamoidellum Dumitrica, 1970, p. 79.

Zhamoidellum ornatum (Zhamoida) (?)
(Plate 2I, Figures 15, 16)
(Range chart number 33)

Tricolocapsa ornata Zhamoida, 1972, p. 117, pl. 4, fig. 2; pl. 5, fig. 5.
Conosphaera sphaeroconus Rüst *in* Heitzer, 1930, p. 386, pl. 27, fig. 4.
Remarks: This species is questionably assigned to Zhamoida's species *Tricolocapsa ornata* because that species is reported from the Jurassic only and because it apparently has fewer nodes. It differs from *Tricolocapsa nodosa* Tan in lacking an aperture.

Cenozoic

Suborder SPUMELLARIA

Family ACTINOMMIDAE Haeckel, 1862, emend. Riedel, 1967b

Axoprunum angelinum (Campbell and Clark)
(Plate 9, Figures 28, 29)
(Range chart number 11)

Axoprunum angelinum (Campbell and Clark) *in* Kling, 1973, p. 634, pl. 1, fig. 13-16; pl. 6, fig. 14-18.

Prunopyle titan Campbell and Clark

Prunopyle titan Campbell and Clark, *in* Campbell and Clark, 1944a, p. 20, pl. 3, fig. 1-3.
This species was searched for but only found as three isolated specimens in Samples 310-8-1, 125-127; and 310-9-4, 124-126.

Genus SPHAEROPYLE Dreyer

Sphaeropyle Dreyer, 1889, p. 12. Type species (subsequent designation by Campbell, 1954, p. D66) *Sphaeropyle langii* Dreyer, 1889.

Sphaeropyle langii Dreyer
(Plate 9, Figures 30, 31)
(Range chart number 21)

Sphaeropyle langii Dreyer, 1889, p. 13, pl. 4, fig. 54. Kling, 1973, p. 634, pl. 1, fig. 5-10; pl. 13, fig. 6-8.
Prunopyle tetrapila Hays, 1965 (partim), p. 172, pl. 2, fig. 5.
Sphaeropyle robusta Kling, 1973 (partim), pl. 1, fig. 11; pl. 13, fig. 1-3.
Description: The forms encountered here agree well with the description of Dreyer, differing only in that the outer shell is not consistently smooth, but may have short thorny by-spines. Longer spines, when present, are up to six in number, disposed as for the Cubosphaeridae; one of these spines, particularly on younger forms, may be associated with the pylome. In addition, the size of the pores of the outer shell and its thickness vary considerably among individual specimens. The second shell has rounded pores, generally irregular in size, 8 to 12 per half a circumference.
Measurements (based on 50 specimens from 310-1-1 to 310-6, CC). Diameter of outer shell 110-210μ, second shell 70-114μ, third shell 25-45μ, innermost shell 12-15μ. Thickness of outer shell 3-15μ.
Remarks: *S. langii* is distinguished from *S. robusta* as described under that species.

Sphaeropyle robusta Kling emend.
(Plate 9, Figures 24-26)
(Range chart number 10)

Sphaeropyle robusta Kling, 1973, p. 634, pl. 1, fig. 12; pl. 6, fig. 9-13.
Description: As indicated by Kling (1973), with the exception that forms with both thick and thin shells are included, and that the second shell has rounded, regular, closely spaced pores, 12 to 16 per half a circumference. These pores sometimes approach or equal the size of the pores in the outer shell.
Measurements (based on 30 specimens from 310-3, CC to 310-9-4). Diameter of outer shell 135-235μ, second shell 85-125μ, third shell 35-40μ, innermost shell 12-15μ. Thickness of outer shell 7-18μ.
Remarks: *Sphaeropyle robusta* could not be distinguished from *S. langii* on the basis of the relative robustness of the outer shell. Instead it is distinguished from *S. langii* by its second shell which has distinctly smaller pores, more regular in size. Using the size and regularity of the pores of the second shell as the criteria for distinguishing these two species gives a somewhat longer morphological range for *S. langii* than indicated by Kling.

Subfamily ARTISCINAE Haeckel, 1881, emend. Riedel, 1967b

Ommatartus sp.
(Plate 8, Figures 17, 18)
(Range chart number 18)

Remarks: In the interval immediately above the *Ommatartus penultimus* Zone are found artiscin shells without caps or spongy columns. They are apparently related to the artiscins found in the lower zone, but cannot be confidently identified and are tabulated as *Ommatartus* sp.

Ommatartus sp. A
(Plate 8, Figures 20-23)
(Range chart number 2)

Cannartus sp. Riedel and Sanfilippo, 1971, p. 1587, pl. 1D, fig. 1.
Cannartus laticonus Riedel *in* Sanfilippo et al., 1973, p. 216, pl. 1, fig. 6 (not fig. 4, 5).
Description: Artiscins with smooth shells, almost spherical to ellipsoidal or box-like in shape, sometimes with a slight median constriction, and a small clear zone at the base of their spongy columns.
Remarks: Although this form and *Ommatartus* sp. B are obviously closely related to the artiscins of the equatorial Pacific, they are here considered as separate species. See Remarks under *Ommatartus* sp. B.
It is difficult to distinguish the clear zone at the base of the spongy columns in one or two particularly robust forms from 310-9-1, 120-123 (Plate 8, Figure 21). However, as all the forms in the next lower sample—304-2-1, 80-82—show this clear zone, it is judged that the lack of a distinct clear zone is due only to the robustness of the form.

Ommatartus sp. B
(Plate 8, Figures 24, 25)
(Range chart number 3)

Cannartus laticonus Riedel *in* Sanfilippo et al., 1973, p. 216, pl. 1, fig. 4, 5.
Cannartus violina Haeckel *in* Sanfilippo et al., 1973, pl. 1, fig. 12 (not fig. 11).

Ommatartus antepenultimus Riedel and Sanfilippo *in* Sanfilippo et al., 1973, p. 216, pl. 1, fig. 13-15.

Description: Artiscins with a slightly nodular to distinctly nodular shell, almost spherical to ellipsoidal or box-like in shape, sometimes with a slight median constriction, and with a small clear zone at the base of each spongy column.

Remarks: Although these forms could be considered as simply robust forms of *O. antepenultimus* they co-occur with rare specimens of that form and can be seen to differ markedly in the character of the polar caps and columns. *Ommatartus* sp. A and *O.* sp. B are thus considered to constitute a separate and distinct lineage. The illustration in Sanfilippo et al. (1973, pl. 1, fig. 12) of an early form of *O.* sp. B at a much lower level than any considered here serves as the tenuous basis for the suggestion that this is the ancestral species and that the evolutionary progression proceeds from a nodular to a smooth form.

Ommatartus sp. cf. Cannartus bassanii (Carnevale)
(Plate 8, Figures 9-12)
(Range chart number 4)

cf. *Cannartus bassanii* (Carnevale) *in* Sanfilippo et al., 1973, p. 216, pl. 1, fig. 1-3.

Description: Shell with a distinct hourglass shape. The surface may be smooth or nodular. It bears, at each end, two polar caps surmounted by a spongy polar column. In the earlier forms the second cap can barely be discerned, but it is well developed in the younger forms, which, however, have much reduced polar columns.

Remarks: This form may be a descendant of *Cannartus bassanii* which occurs in older material. It differs from *C. bassanii* in having polar caps and a smooth or nodular surface rather than lacking caps and having a spiny surface as does *C. bassanii.* Alternately, the absence of this form from the oldest sample in this sequence, 304-2-1, 80-82, suggests that there is no connecting form to *Cannartus bassanii* and that the ancestor might be the form illustrated as *Cannartus laticonus* Plate 8, Figure 4.

Ommatartus antepenultimus Riedel and Sanfilippo
(Plate 8, Figures 13, 14)
(Range chart number 14)

Ommatartus antepenultimus Riedel and Sanfilippo, 1971, p. 1588, pl. 1C, fig. 11, 12.

Remarks: Rare forms differ from *Ommatartus* sp. B in the character of the polar caps and columns.

Ommatartus avitus (?) (Riedel)

[?] *Ommatartus avitus* (Riedel) *in* Riedel and Sanfilippo, 1971, p. 1588, pl. 4, fig. 6.

Remarks: The rare forms observed in this material are only questionably identified because they lack the nodular surface described for *O. avitus.*

Ommatartus hughesi (Campbell and Clark)
(Plate 8, Figure 3)
(Range chart number 15)

Ommatartus hughesi (Campbell and Clark) *in* Kling, 1973, p. 634, pl. 7, fig. 6.

Ommatartus penultimus (Riedel)
(Plate 8, Figures 15, 16)
(Range chart number 16)

Ommatartus penultimus (Riedel) *in* Riedel and Sanfilippo, 1971, p. 1588, pl. 1C, fig. 8-10.

Ommatartus tetrathalamus (Haeckel)
(Plate 8, Figure 19)
(Range chart number 20)

Panartus tetrathalamus Haeckel, *in* Nigrini, 1967, p. 30, pl. 2, fig. 4a-d.
Panartus tetrathalamus coronatus Haeckel, 1887, *in* Nigrini, 1970, p. 168, pl. 1, fig. 13, 14; fig. 12.

Family OROSPHAERIDAE Haeckel, 1887

Oroscena sp.
(Range chart number 1)

Oroscena sp. *in* Bandy et al., 1971, pl. 2, fig. 2, 3.

Remarks: In the material studied the last occurrence of oroscenids with digitate spines is at the top of the *Ommatartus antepenultimus* Zone. This may serve to correlate that datum plane with the top of Casey's Upsilon C Zone (Bandy et al., 1971, p. 4).

Family SPONGODISCIDAE Haeckel, 1862, emend. Riedel, 1967a

Spongaster pentas Riedel and Sanfilippo

Spongaster pentas Riedel and Sanfilippo, 1971, p. 1586, pl. 1D, fig. 5-7.

Remarks: This form was searched for, but only two isolated specimens were found, one in the *Eucyrtidium matuyamai* Zone and the other in the *Stichocorys peregrina* Zone.

Spongaster tetras irregularis Nigrini
(Plate 9, Figure 27)
(Range chart number 29)

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

Spongaster tetras tetras Ehrenberg

Spongaster tetras tetras Ehrenberg *in* Riedel and Sanfilippo, 1971, p. 1589, pl. 1D, fig. 2-4.

Suborder NASSELLARIA

Family ACANTHODESMIDIIDAE Hertwig, 1879

Giraffospyris lata Goll

Giraffospyris lata Goll *in* Sanfilippo and Riedel, 1973, p. 529, pl. 18, fig. 3-7; pl. 33, fig. 4.

Dendrospyris bursa Sanfilippo and Riedel
(Plate 8, Figures 1, 2)
(Range chart number 5)

Dendrospyris bursa Sanfilippo and Riedel *in* Sanfilippo et al., 1973, p. 217, pl. 2, fig. 9-13.
Theocampe ? a sp. Nakaseko, 1963, p. 183, pl. 2, fig. 8a, b.

Remarks: The forms examined here consistently lack a horn and so resemble more the specimens illustrated by Nakaseko.

Family ARTOSTROBIIDAE Riedel, 1967b

Artostrobium tumidulum (Bailey)
(Plate 9, Figure 23)

Eucyrtidium tumidulum Bailey, 1856, p. 5, pl. 1, fig. 6.
Artostrobium miralestense (Campbell and Clark) *in* Kling, 1973, p. 639, pl. 5, fig. 31-35, pl. 12, fig. 28-31.

Lithomitra docilis Foreman

Lithomitra docilis Foreman, 1973a, p. 431, pl. 8, fig. 20-22; pl. 9, fig. 3-5.

Theocampe amphora (Haeckel) group

Theocampe amphora (Haeckel) group Foreman, 1973a, p. 431, pl. 8, fig. 7, 9-13; pl. 9, fig. 8, 9.

Theocampe urceolus (Haeckel)

Theocampe urceolus (Haeckel) *in* Foreman, 1973a, p. 432, pl. 8, fig. 14-17; pl. 9, fig. 6, 7.

Family AMPHIPYNDACIDAE Riedel, 1967b

Amphipternis clava (Ehrenberg)

Amphipternis clava (Ehrenberg) *in* Foreman, 1973a, p. 430, pl. 7, fig. 16, 17; pl. 9, fig. 2; p. 444, fig. 7.

Family PTEROCORYIDAE Haeckel, 1881 emend. Riedel, 1967a

Lamprocyrtis hannai (Campbell and Clark)
(Plate 9, Figures 17-19)
(Range chart number 19)

Lamprocyrtis (?) *hannai* (Campbell and Clark) *in* Kling, 1973, p. 638, pl. 5, fig. 12-14; pl. 12, fig. 10-14.

Remarks: When at the lower end of its range the abdomen becomes shorter, more inflated, and the pores smaller and more irregular, this species passes over to *Lamprocyrtis margatensis* (Campbell and Clark) (Plate 9, Figure 16).

Lamprocyrtis haysi Kling
(Plate 9, Figure 22)
(Range chart number 28)

Lamprocyrtis haysi Kling, 1973, p. 639, pl. 5, fig. 15, 16; pl. 15, fig. 1-3.

Lamprocyrtis heteroporos (Hays)
(Plate 9, Figure 20)
(Range chart number 23)

Lamprocyrtis heteroporos (Hays) *in* Kling, 1973, p. 639, pl. 5, fig. 19, 20.

[?] *Lamprocyrtis heteroporos* (Hays) *in* Kling, pl. 5, fig. 21.

Remarks: This species is interpreted rather strictly as described by Hays. The pores of the abdomen must be large as well as irregular. Forms with small pores and only a slight irregularity in pore size and arrangement are excluded and assigned to *L. hannai.*

Lamprocyrtis neoheteroporos Kling
(Plate 9, Figure 21)
(Range chart number 26)

Lamprocyrtis neoheteroporos Kling, 1973, p. 639, pl. 5, fig. 17, 18; pl. 15, fig. 4, 5.

Theocorythium trachelium dianae (Haeckel)
(Plate 9, Figure 13)
(Range chart number 25)

Theocorythium trachelium dianae (Haeckel) *in* Nigrini, 1967, p. 77, pl. 8, fig. 1a, b; pl. 9, fig. 1a, b.

Remarks: See *T. trachelium trachelium.*

Theocorythium trachelium trachelium (Ehrenberg)
(Plate 9, Figure 12)
(Range chart number 24)

Theocorythium trachelium trachelium (Ehrenberg) *in* Nigrini, 1967, p. 79, pl. 8, fig. 2; pl. 9, fig. 2.

Remarks: It was not always possible to confidently identify *T. trachelium trachelium* from *T. trachelium dianae.*

Theocorythium vetulum Nigrini
(Plate 9, Figure 11)
(Range chart number 17)

Theocorythium vetulum Nigrini, 1971, p. 447, pl. 34.1, fig. 6a, b.

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

Buryella clinata (Foreman)
(Plate 9, Figures 35, 36)

Buryella clinata Foreman, 1973a, p. 433, pl. 8, fig. 1-3; pl. 9, fig. 19.

Remarks: Because of the rather large time interval between Cores 94-31 and 94-32 of DSDP Leg 10, no immediate ancestor for *Buryella clinata* was observed, and the species was considered to have evolved from *Buryella tetradica.* In the material from Leg 32, however, two cores were recovered, 313-13 and 313-12, which represent part of this interval, and it becomes apparent that *Buryella clinata* evolved not from *B. tetradica* but from another form here named *Pterocodon* (?) *anteclinata* which appears to be closely related to *P.* (?) *ampla* (?) of DSDP Leg 10 (Foreman, 1973a). The details of the evolutionary change are illustrated (Plate 9, Figures 32-36). The distinction between *Buryella clinata* and *Pterocodon* (?) *anteclinata* is made in the remarks for the latter form.

The generic assignment of *Buryella clinata* has not been changed to that of its ancestor because that generic assignment, indicated by a (?), is also unsatisfactory.

Bekoma bidarfensis Riedel and Sanfilippo

Bekoma bidarfensis Riedel and Sanfilippo *in* Foreman, 1973a, p. 432, pl. 3, fig. 20, 21; pl. 10, fig. 6.

Buryella pentadica Foreman

Buryella pentadica Foreman, 1973a, p. 433, pl. 8, fig. 8; pl. 9, fig. 15, 16.

Buryella tetradica Foreman

Buryella tetradica Foreman, 1973a, p. 436, pl. 8, fig. 4, 5; pl. 9, fig. 13, 14.

Cyclampterium (?) sp.
(Plate 8, Figures 5, 6)
(Range chart number 6)

Remarks: Under this heading are considered forms which resemble very much *C.* (?) *tanythorax.* However, their stratigraphic position is well above the range for that species. Both *C.* (?) *brachythorax* and *C.* (?) *neatum,* the descendants of *C.* (?) *tanythorax,* were looked for but not found; and it could be considered that in the northern Pacific *C. tanythorax* continued with a longer upward range and never evolved into *C.* (?) *brachythorax.* Alternately, the stratigraphic position of these specimens could be interpreted to suggest that they may represent forms intermediate in the evolutionary progression from *C.* (?) *brachythorax* to *C.* (?) *neatum.*

Cyrtocapsella cornuta Haeckel
(Plate 8, Figure 8)

Cyrtocapsella cornuta Haeckel *in* Sanfilippo and Riedel, 1970, p. 453, pl. 1, fig. 19, 20.

Cyrtocapsella japonica Nakaseko
(Plate 8, Figure 7)

Eusyringium japonicum Nakaseko, 1963, p. 193, pl. 4, fig. 1-3.

Eucyrtidium calvertense Martin
(Plate 9, Figure 14)

Eucyrtidium calvertense Martin, 1904, p. 450, pl. 130, fig. 5.

Eucyrtidium matuyamai Hays
(Plate 9, Figure 15)
(Range chart number 27)

Eucyrtidium matuyamai Hays, 1970, p. 213, pl. 1, fig. 7-9.

Lamptonium fabaeforme (?) chaunothorax Riedel and Sanfilippo

Lamptonium fabaeforme (?) *chaunothorax* Riedel and Sanfilippo *in* Foreman, 1973a, p. 436, pl. 6, fig. 10-12.

Lamptonium fabaeforme (?) constrictum Riedel and Sanfilippo

Lamptonium fabaeforme (?) *constrictum* Riedel and Sanfilippo *in* Foreman, 1973a, p. 436, pl. 6, fig. 13, 14.

Lamptonium fabaeforme fabaeforme (Krasheninnikov) (?)

Lamptonium fabaeforme fabaeforme (Krasheninnikov) (?) *in* Foreman, 1973a, p. 436, pl. 6, fig. 6-9.

Lamptonium pennatum Foreman

Lamptonium pennatum Foreman, 1973a, p. 436, pl. 6, fig. 3-5; pl. 11, fig. 13.

Lithochytris archaea Riedel and Sanfilippo

Lithochytris archaea Riedel and Sanfilippo *in* Foreman, 1973a, p. 436, pl. 2, fig. 4, 5.

Lithopera bacca Ehrenberg
(Range chart number 12)

Lithopera (Lithopera) bacca Ehrenberg *in* Riedel and Sanfilippo, 1971, p. 1594, pl. 1F, fig. 10-13.

Lychnocanomma bellum (Clark and Campbell)

Lychnocanomma bellum (Clark and Campbell) *in* Foreman, 1973a, p. 437, pl. 1, fig. 17; pl. 11, fig. 9.

Phormocyrtis cubensis (Riedel and Sanfilippo)

Phormocyrtis cubensis (Riedel and Sanfilippo) *in* Foreman, 1973a, p. 438, pl. 7, fig. 11, 12, 14.

Phormocyrtis striata exquisita (Kozlova)

Phormocyrtis striata exquisita (Kozlova) *in* Foreman, 1973a, p. 438, pl. 7, fig. 1-4, 7, 8; pl. 12, fig. 5.

Phormocyrtis striata striata Brandt

Phormocyrtis striata striata Brandt *in* Foreman, 1973a, p. 438, pl. 7, fig. 5, 6, 9.

Phormocyrtis turgida (Krasheninnikov)

Phormocyrtis turgida (Krasheninnikov) *in* Foreman, 1973a, p. 438, pl. 7, fig. 10; pl. 12, fig. 6.

Pterocanium prismatium Riedel
(Plate 9, Figure 9)

Pterocanium prismatium Riedel, 1957, p. 87, pl. 3, fig. 4, 5.

Pterocodon (?) anteclinata Foreman, new species
(Plate 9, Figures 32-34)

Description: Shell small, of four segments, subcylindrical to spindle-shaped. The small subspherical porous cephalis bears a slender, relatively long horn and an upward directed vertical pore. The two post-cephalic segments are smooth without external segmental division and have rounded pores arranged quincuncially in transverse and diagonal rows. Only small fragments of the third post-cephalic segment have been observed.

Measurements (based on 10 specimens from 313-13, CC; 12-5, 124-125; 12-3, 124-126; 12-1, 128-131). Length of first three segments including horn, 125-140μ (majority 125-130μ). Width of abdomen 60-80μ (majority 60-70μ).

Remarks: Early forms have the horn cylindrical with a roughened blunt tip or roughened overall. This gradually becomes conical, sharper, basally ridged with, in late forms, the ridges beginning to extend onto the cephalis. In late forms also, the thorax becomes relatively shorter and the abdomen more inflated, barrel-shaped. When the horn becomes pointed, completely ridged with well-developed ridges extending down to the base of the cephalis so that the change in contour from the cephalis to the horn is obscured and the abdomen is inflated, barrel-shaped, this species passes over to *Buryella clinata.*

Pterocodon (?) tenellus Foreman

Pterocodon (?) *tenellus* Foreman, 1973a, p. 439, pl. 5, fig. 7; pl. 12, fig. 4.

Rhopalocanium ornatum Ehrenberg

Rhopalocanium ornatum Ehrenberg *in* Foreman, 1973a, p. 439, pl. 2, fig. 8-10; pl. 12, fig. 3.

Theocorys acroria Foreman

Theocorys acroria Foreman, 1973a, p. 439, pl. 5, fig. 11-13; pl. 12, fig. 2.

Theocorys anaclasta Riedel and Sanfilippo

Theocorys anaclasta Riedel and Sanfilippo *in* Foreman, 1973a, p. 440, pl. 5, fig. 14, 15.

Theocorys anapographa Riedel and Sanfilippo

Theocorys anapographa Riedel and Sanfilippo *in* Foreman, 1973a, p. 440, pl. 5, fig. 9, 10.

Theocorys (?) phyzella Foreman

Theocorys (?) *phyzella* Foreman, 1973a, p. 440, pl. 5, fig. 8; pl. 12, fig. 1.

Theocorys sp.
(Plate 9, Figure 8)
(Range chart number 7)

Remarks: This form with its three simple segments, wide open mouth, and medianly constricted abdomen resembles in general form *T. anaclasta* from which it differs primarily in its smaller size and having abdominal pores less differentiated in size from those of the thorax. No connecting forms are known.

Theocotyle (Theocotyle) cryptocephala (?) nigriniae Riedel and Sanfilippo

Theocotyle (Theocotyle) cryptocephala (?) *nigriniae* Riedel and Sanfilippo *in* Foreman, 1973a, p. 440, pl. 4, fig. 1-5; pl. 12, fig. 17.

Theocotyle (Theocotylissa) alpha Foreman

Theocotyle (Theocotylissa) alpha Foreman, 1973a, p. 441, pl. 4, fig. 13-15; pl. 12, fig. 16.

Theocotyle (Theocotylissa) auctor Foreman

Theocotyle (Theocotylissa) auctor Foreman, 1973a, p. 441, pl. 4, fig. 8-10; pl. 12, fig. 13.

Theocotyle (Theocotylissa) ficus (Ehrenberg)

Theocotyle (Theocotylissa) ficus (Ehrenberg) *in* Foreman, 1973a, p. 441, pl. 4, fig. 16-20.

Theocotyle (Theocotylissa) (?) fimbria Foreman

Theocotyle (Theocotylissa) (?) *fimbria* Foreman, 1973a, p. 441, pl. 5, fig. 1, 2; pl. 12, fig. 21.

Remarks: The forms present here uniformly have three short ridged feet, rather than the variable number in the early forms described from DSDP Leg 10.

Thyrsocyrtis hirsuta hirsuta (Krasheninnikov)

Thyrsocyrtis hirsuta hirsuta (Krasheninnikov) emend. *in* Foreman, 1973a, p. 441, pl. 3, fig. 3-8; pl. 12, fig. 15.

Remarks: Because of the rather large time interval between Samples 94-32 and 94-31 of DSDP Leg 10, the details of the evolutionary change from *T. tarsipes* → *T. hirsuta hirsuta* were not clearly spelled out in Foreman, 1973a. *T. tarsipes* typically has a smooth slender horn, cephalis with numerous pores, vestigial wings on the thorax, and porous feet, while *T. hirsuta* typically has a smooth sturdier horn, cephalis poreless or with only a few pores, thorax without vestigial wings, and feet thickened medianly, without pores. When the horn becomes sturdy, the feet thickened and poreless, and the thorax loses its vestigial wings, *T. tarsipes* passes over to *T. hirsuta hirsuta.* Late forms of *T. tarsipes* may lack vestigial wings and early forms of *T. hirsuta hirsuta* may still have a few pores on the feet and cephalis, as for *T. tarsipes.*

Thyrsocyrtis hirsuta tensa Foreman

Thyrsocyrtis hirsuta tensa Foreman, 1973a, p. 442, pl. 3, fig. 13-16; pl. 12, fig. 8.

Thyrsocyrtis tarsipes Foreman

Thyrsocyrtis tarsipes Foreman, 1973a, p. 442, pl. 3, fig. 9; pl. 12, fig. 14.

Remarks: *T. tarsipes* is distinguished from *T. hirsuta hirsuta* as described under that species.

Tricolocampe vitrea Krasheninnikov

Tricolocampe vitrea Krasheninnikov *in* Foreman, pl. 7, fig. 3.

Incertae sedis

Lophocyrtis biaurita (Ehrenberg)

Lophocyrtis biaurita (Ehrenberg) *in* Foreman, 1973a, p. 442, pl. 8, fig. 23-26.

Stichocorys delmontensis (Campbell and Clark)
(Plate 9, Figures 5-7)
(Range chart number 8)

Stichocorys delmontensis (Campbell and Clark) *in* Riedel and Sanfilippo, 1971, p. 1595, pl. 1F, fig. 5-7; pl. 2E, fig. 10, 11.

Stichocorys peregrina Riedel
(Plate 9, Figures 1-4)
(Range chart number 9)

Eucyrtidium elongatum peregrinum Riedel, 1953, p. 812, pl. 85, fig. 2.
Stichocorys peregrina (Riedel) *in* Riedel and Sanfilippo, 1971, p. 1595, pl. 1F, fig. 2-4; pl. 8, fig. 5.

ACKNOWLEDGMENTS

The writer wishes to thank her co-scientists on Leg 32, D. Bukry and H. P. Luterbacher, and E. Vincent, for their cooperative effort in providing the calcareous control on which most of the age assignments are based; A. L. Brigger for preparing the most difficult samples; and D. Daub, J. Gilbert, M. Montgomery, and H. Walker for assistance in the final compilation of the manuscript.

REFERENCES

Aliev, Kh. Sh., 1961. Novye vidy radioliarii nizhnego melo severo-vostochnogo Azerbaidzhana. (New radiolarian species of the Lower Cretaceous of northeastern Azerbaidzhan.): Uch. Zap., Izd. Azerbaidz. Univ., Ser. Geol.-Geogr., no. 2, p. 25-38.

_______, 1965. Radioliarii nizhnemelovykh otozhenii severo-vostochnogo Azerbaidzhana i ikh stratigraficheskoe znachenie. (Radiolarians of the Lower Cretaceous deposits of northeastern Azerbaidzhan and their stratigraphic significance.): Izd. Akad. Nauk Azerbaidz. SSR, Baku, p. 3-124.

_______, 1967. Novye vidy radioliarii valanzhinskogo i albskogo iarusov severo-vostochnogo Azerbaidzhana. (New species of Radiolaria of the Valanginian and Albian stages in northeastern Azerbaidzhan.). *In* Melovye otlozheniia vostochnogo Kavkaza i prilegaivshchikh oblastei. (Chalky deposits in the eastern Caucasus and adjacent regions.): Biostrat. paleogeogr. Akad. Nauk SSSR, Inst. Geol. Moskva, p. 23-30.

Bailey, J. W., 1856. Notice of mircoscopic forms found in the soundings of the Sea of Kamtschatka—with a plate: Am. J. Sci. Arts, ser. 2, v. 22, p. 1-6.

Bandy, O. L., Casey, R. E., and Wright, R. C., 1971. Late Neogene planktonic zonation, magnetic reversals, and radiometric dates, Antarctic to the tropics: Am. Geophys. Union, Antarctic Res. Ser., v. 15, p. 1-26.

Burma, B. H., 1959. On the status of *Theocampe* Haeckel, and certain similar genera: Micropaleontology, v. 5, p. 325-330.

Campbell, A. S., 1954. Radiolaria. *In* Treatise on Invertebrate Paleontology, Moore, R. C. (Ed.), Part D. Protista 3. Protozoa (chiefly Radiolaria and Tintinnina): Geol. Soc. Am. and Univ. Kans. Press, Lawrence, p. D11-D163.

Campbell, A. S. and Clark, B. L., 1944a. Miocene radiolarian faunas from southern California: Geol. Soc. Am., Spec. Paper 51, p. 1-76.

_______, 1944b. Radiolaria from Upper Cretaceous of middle California: Geol. Soc. Am., Spec. Paper 57, viii+61 p.

Cita, M. B., 1964. Ricerche micropaleontologiche e stratigrafiche sui sedimenti pelagici del Giurassico superiore e del Cretaceo inferiore nella catena del Monte Baldo: Riv. Ital. Paleontol., Strat., Mem. 10, 183 p.

Deflandre, G., 1953. Radiolaries fossiles. *In* Traité de Zoologie, Grassé, P.-P. (Ed.): Paris (Masson), v. 1, p. 389-436.

Dreyer, F., 1889. Die Pylombildungen in vergleichend-anatomischer und entwicklungsgeschichtlicher Beziehung bei Radiolarien und bei Protisten überhaupt, nebst System und Beschreibung neuer und der bis jetzt bekannten pylomatischen Spumellarien: Jena. Z. Naturwiss., v. 23, new ser. 16, p. 77-214.

Dumitrica, P., 1970. Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania: Rev. Roum. Géol., Géophys., Géogr., Ser. Géol., v. 14, p. 45-124.

Ehrenberg, C. G., 1838. Uber die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen: Kgl. Akad. Wiss. Berlin, Abh., Jahre 1838, p. 59-147.

_______, 1847. Uber die mikroskopischen kieselschaligen Polycystinen als mächtige Gebirgsmasse von Barbados und über das Verhältniss der aus mehr als 300 neuen Arten bestehenden ganz eigenthümlichen Formengruppe jener Felsmasse zu den jetzt lebenden Thieren und zur Kreidebildung. Eine neue Anregung zur Erforschung des Erdlebens: Kgl. Preuss. Akad. Wiss. Berlin, Ber., Jahre 1847, p. 40-60.

_______, 1854a. Die systematische Charakteristik der neuen mikroskopischen Organismen des tiefen atlantischen Oceans: Kgl. Preuss. Akad. Wiss. Berlin, Ber., Jahre 1854, p. 236-250.

_______, 1854b. Mikrogeologie: Leipzig (Voss), xxviii + 374p.; Atlas, 31p., 41 pl.; Fortsetzung (1856).

_______, 1875. Fortsetzung der mikrogeologischen Studien als Gesammt-Uebersicht der mikroskopischen Paläontologie gleichartig analysirter Gebirgsarten der Erde, mit specieller Rücksicht auf den Polycystinen-Mergel von Barbados: Kgl. Akad. Wiss. Berlin, Abh., Jahre 1875, p. 1-225.

Fischli, H., 1916. Beitrag zur Kenntnis der fossilen Radiolarien in der Riginagelfluh: Mitt. Naturwiss. Ges. Winterthur., no. 11, p. 44-47.

Foreman, H. P., 1966. Two Cretaceous radiolarian genera: Micropaleontology, v. 12, p. 355-359.

_______, 1968. Upper Maestrichtian Radiolaria of California: Palaeontol. Assoc., London, Spec. Paper 3, p. iv + 1-82.

_______, 1971. Cretaceous Radiolaria. *In* Winterer, E. L., Riedel, W. R., et al., Initial Reports of the Deep Sea Drilling Project, Volume 7: Washington (U.S. Government Printing Office), p. 1673-1693.

_______, 1973a. Radiolaria of Leg 10 with systematics and ranges for the families Amphipyndacidae, Artostrobiidae, and Theoperidae. *In* Worzel, J. L., Bryant, W., et al., Initial Reports of the Deep Sea Drilling Project, Volume 10: Washington (U.S. Government Printing Office), p. 407-474.

_______, 1973b. Radiolaria from DSDP Leg 20. *In* Heezen, B. C., MacGregor, I. D., et al., Initial Reports of the Deep Sea Drilling Project, Volume 20: Washington (U.S. Government Printing Office), p. 249-305.

Haeckel, E., 1862. Die Radiolarien (Rhizopoda Radiaria): Reimer, Berlin, xiv + 572 p.; Atlas, iv p. + 35 pl.

_______, 1881. Entwurf eines Radiolarien-Systems auf Grund von Studien der Challenger-Radiolarien: Jena. Z. Med. Naturwiss., v. 15 (new ser., v. 8), p. 418-472.

_______, 1887. Report on the Radiolaria collected by H.M.S. Challenger during the years 1873-1876: Rept. Sci. Result. Voyage H.M.S. Challenger, Zool., v. 18, 2 pt., clxxxviii + 1803 p., Atlas.

Hays, J. D., 1970. Stratigraphy and evolutionary trends of Radiolaria in North Pacific Deep-Sea sediments. *In* Geological investigations of the North Pacific: Geol. Soc. Am., Mem. 126, p. 185-218.

Heitzer, I., 1930. Die Radiolarienfauna der mitteljurassischen Kieselmergel im Sonnwendgebirge: Austr., Geol. Bundesanst., Jahrb., v. 80, p. 381-406.
Hertwig, R., 1879. Der Organismus der Radiolarien: Med.-Naturwiss. Ges. Jena, Denkschr., v. 2, p. 129-277.
Hinde, G. J., 1900. Description of fossil Radiolaria from the rocks of Central Borneo. *In* Molengraaff, G. A. F. (Ed.), Borneo-Expeditie: Geologische Verkenningstochten in Centraal Borneo (1893-94): Leiden (E. J. Brill) and Amsterdam (H. Gerlings), p. 1-51, 54-56.
Holmes, W. M., 1900. On Radiolaria from the Upper Chalk at Coulsdon (Surrey): Geol. Soc. London, Quart. J., v. 56, p. 694-704.
Ichikawa, K. and Yao, A., in preparation. Two new genera of Mesozoic cyrtoid radiolarians from Japan.
Kling, S. A., 1971. Radiolaria. *In* Fischer, A. G., Heezen, B. C., et al., Initial Reports of the Deep Sea Drilling Project, Volume 6: Washington (U.S. Government Printing Office), p. 1069-1117.
_______, 1973. Radiolaria from the Eastern North Pacific, Deep Sea Drilling Project, Leg 18. *In* Kulm, L. D., von Huene, R., et al., Initial Reports of the Deep Sea Drilling Project, Volume 18: Washington (U.S. Government Printing Office), p. 617-671.
Lozyniak, P. Yu., 1969. Radioliarii nizhnemelovykh otlozhenii Ukrainskikh Karpat. (Radiolaria of the Lower Cretaceous sediments of the Ukrainian Carpathians.) *In* Vialov, O. C. (Ed.), Iskopaemye i Sovremannye radioliarii (Fossil and Recent radiolarians): L'vov. Geol. O-vo., L'vov. Univ., p. 29-41.
Martin, G. C., 1904. Radiolaria: Maryland Geol. Survey (Miocene), Baltimore, p. 447-459.
Moore, T. C., 1973. Radiolaria from Leg 17 of the Deep Sea Drilling Project. *In* Winterer, E. L., Ewing, J. L., et al., Initial Reports of the Deep Sea Drilling Project, Volume 17: Washington (U.S. Government Printing Office), p. 797-869.
Nakaseko, K., 1963. Neogene Cyrtoidea (Radiolaria) from the Isozaki Formation in Ibaraki Prefecture, Japan: Sci. Rept. v. 12, p. 165-198.
Neviani, A., 1900. Supplemento alla fauna a Radiolari delle rocce mesozoiche del Bolognese: Soc. Geol. Ital., Boll., v. 19, p. 645-670.
Nigrini, C. A., 1967. Radiolaria in pelagic sediments from the Indian and Atlantic oceans: Scripps Inst. Oceanogr., Bull., v. 11, p. 1-125.
_______, 1970. Radiolarian assemblages in the North Pacific and their application to a study of Quaternary sediments in Core V20-130. *In* Geological investigations of the North Pacific: Geol. Soc. Am., Mem. 126, p. 139-183.
_______, 1971. Radiolarian zones in the Quaternary of the equatorial Pacific Ocean. *In* Funnell, B. M. and Riedel, W. R. (Eds.), Micropaleontology of the oceans: Cambridge (Cambridge Univ. Press), p. 443-461.
Parona, C. F., 1890. Radiolarie nei noduli, selciosi del calcare giurese di Cittiglio presso Laverno: Soc. Geol. Ital., Boll., v. 9, p. 132-175.
Pessagno, E. A., Jr., 1963. Upper Cretaceous Radiolaria from Puerto Rico: Micropaleontology, v. 9, p. 197-214.
_______, 1969. Mesozoic planktonic foraminifera and Radiolaria. *In* Ewing, M., Worzel, J. L., et al., Initial Reports of the Deep Sea Drilling Project, Volume 1: Washington (U.S. Government Printing Office), p. 607-621.
_______, 1971. Jurassic and Cretaceous Hagiastridae from the Blake-Bahama Basin (Site 5A, JOIDES Leg I) and the Great Valley sequence, California Coast Ranges: Bull. Am. Paleontol., v. 60, p. 1-83.
_______, 1972. Pseudoaulophacidae Riedel from the Cretaceous of California and the Blake-Bahama Basin (JOIDES Leg I). *In* Cretaceous Radiolaria: Bull. Am. Paleontol., v. 61, p. 281-328.
_______, 1973. Age and geologic significance of radiolarian cherts in the California Coast Ranges: Geology, v. 1, p. 153-156.
_______, in preparation. Radiolarian zonation and stratigraphy of the Upper Cretaceous portion of the Great Valley sequence, California Coast Ranges.
Petrushevskaya, M. G. and Kozlova, G. E., 1972. Radiolaria: Leg 14, Deep Sea Drilling Project. *In* Hayes, D. E., Pimm, A. C., et al., Initial Reports of the Deep Sea Drilling Project, Volume 14: Washington (U.S. Government Printing Office), p. 495-648.
Renz, G. W., 1974. Radiolaria from Leg 27 of the Deep Sea Drilling Project. *In* Veevers, J. J., Heirtzler, J. R., et al., Initial Reports of the Deep Sea Drilling Project, Volume 27: Washington (U.S. Government Printing Office), p. 769-842.
Riedel, W. R., 1953. Mesozoic and late Tertiary Radiolaria of Rotti: J. Paleontol., v. 27, p. 805-813.
_______, 1957. Radiolaria: a preliminary stratigraphy: Rept. Swedish Deep-Sea Exped. 1947-1948, v. 6, p. 59-96.
_______, 1967a. Protozoa [Subclass Radiolaria]. *In* Harland, W. B., et al. (Eds.) The fossil record: London (Geol. Soc. London), p. 291-298.
_______, 1967b. Some new families of Radiolaria: Geol. Soc. London, Proc., no. 1640, p. 148-149.
Riedel, W. R. and Sanfilippo, A., 1970. Radiolaria, Leg 4, Deep Sea Drilling Project. *In* Bader, R. G., Gerard, R. D., et al., Initial Reports of the Deep Sea Drilling Project, Volume 4: Washington (U.S. Government Printing Office), p. 503-575.
_______, 1971. Cenozoic Radiolaria from the western tropical Pacific, Leg 7. *In* Winterer, E. L., Riedel, W. R., et al., Initial Reports of the Deep Sea Drilling Project, Volume 7: Washington (U.S. Government Printing Office), p. 1529-1672.
_______, 1974. Radiolaria from the southern Indian Ocean, DSDP Leg 26. *In* Davies, T. A., Luyendyk, B. P., et al., Initial Reports of the Deep Sea Drilling Project, Volume 26: Washington (U.S. Government Printing Office), p. 771-814.
Rüst, D., 1885. Beiträge zur Kenntniss der fossilen Radiolarien aus Gesteinen des Jura: Palaeontographica, v. 31, ser. 3, p. 273-321.
_______, 1898. Neue Beiträge zur Kenntniss der fossilen Radiolarien aus Gesteinen des Jura und der Kreide: Palaeontographica, v. 45, p. 1-67.
Sanfilippo, A. and Riedel, W. R., 1970. Post-Eocene "closed" theoperid radiolarians: Micropaleontology, v. 16, p. 446-462.
_______, 1973. Cenozoic Radiolaria (exclusive of the theoperids, artostrobiids and amphipyndacids) from the Gulf of Mexico. *In* Worzel, J. L., Bryant, W., et al., Initial Reports of the Deep Sea Drilling Project, Volume 10: Washington (U.S. Government Printing Office), p. 475-611.
Sanfilippo, A., Burckle, L. H., Martini, E., and Riedel, W. R., 1973. Radiolarians, diatoms, silicoflagellates, and calcareous nannofossils in the Mediterranean Neogene: Micropaleontology, v. 19, p. 209-234.
Squinabol, S., 1903a. Radiolarie fossili di Teolo (Euganei): R. Accad. Sci. Lett. Arti Padova, Atti Mem., new ser., v. 19, pt. 2, p. 127-130.
_______, 1903b. Le Radiolarie dei noduli selciosi nella Scaglia degli Euganei. Contribuzione I: Riv. Ital. Paleontol., v. 9, p. 105-151.
_______, 1904. Radiolarie cretacee degli Euganei: R. Accad. Sci. Lett. Arti Padova, Atti Mem., new ser., v. 20, pt. 3, p. 171-244.

———, 1914. Contributo alla conoscenza dei Radiolarii fossili del Veneto. Appendice—Di un genere di Radiolari caratteristico del Secondario: Padova, R. Univ. Ist Geol. Mem., v. 2, p. 249-306.

Tan Sin Hok, 1927. Over de samenstelling en het onstaan van krijt-en mergelgesteenten van de Molukken. (On the composition and origin of chalks and marls in the Moluccas.) *In* Brouwer, H. A. (Ed.), Geologische onderzoekingen in den oostelijken Oost-Indischen Archipel. V. (Geological investigations in the eastern East Indian Archipelago. V.): Jaarb. Mijnwez. Ned. Oost-Indië, v. 55 (1926), pt. 3, p. 3-165.

White, M. P., 1928. Some index foraminifera of the Tampico embayment area of Mexico (Part II): J. Paleontol., v. 2, p. 280-317.

Wiśniowski, T., 1889. Beitrag zur Kenntniss der Mikrofauna aus der oberjurassischen Feuersteinknollen der Umgegend von Krakau: Kaiserl.-Kgl. Geol. Reichsanst., Jahrb., v. 38 (4), Jahrg. 1888, p. 657-702.

Yao, A., 1972. Radiolarian fauna from the Mino Belt in the northern part of the Inuyama Area, central Japan: J. Geosci., v. 15, p. 21-65.

Zhamoida, A. I., 1968. Novye mezozoiskie radioliarii Sikhoté-Alinia i nizhnevo Priamur'ia. (New Mesozoic radiolarians of Sikhoté-Alinia and lower Priamur.) *In* Novye vidy drevnikh rastenii i bespozvonochnykh SSSR (New views of ancient plants and invertebrates of the USSR). VSEGEI Izd. "Nedra," no. 2, pt. 1, p. 162-177.

———, 1969. Pervye rezul'taty izuchenia mezozoiskikh radioliarii Sakhalina. (First results of the study of Mesozoic Radiolaria on Sakhalin.) *In* Iskopaemye i sovremennye Radioliarii (Fossil and Recent radiolarians), Vialov, O. C. (Ed.): L'vov Geol. O-vo., L'vov Univ., p. 17-28.

———, 1972. Biostratigrafiya mezozoiskikh kremnistykh tolshch vostoka SSSR na osnove izucheniya radioliarii. (Biostratigraphy of the Mesozoic siliceous series of the East of the USSR by study of Radiolaria.): Tr. VSEGEI, new ser., v. 183, 243.

Zhamoida, A. I., et al., 1968. Kompleksy mezozoiskikh radioliarii vsstochio-Sakhalinskikh gor. (Complex of Mesozoic Radiolaria in the eastern Sakhalin mountains.) *In* Ezheg. Vses. Paleontol. Obshch.: v. 18, p. 24-47.

Zittel, K. A., 1876. Ueber einige fossile radiolarien aus der norddeutschen Kreide: Deut. Geol. Ges., Z., v. 28, p. 75-86.

EXPLANATION OF PLATES

The plates have been arranged in two groups: synchronopticon plates to show horizontally, species occurring at the same level, and vertically, evolutionary change; and more regular plates to show species at a larger magnification than permitted in the synchronopticon.

The synchronopticon plates are numbered 1A-1D, 1F-1H; and 2C-2L. Plates in the number two series fit under plates in the number one series with corresponding letters.

Other plates are numbered 3-9.

Plates illustrating Cretaceous Radiolaria include all of the synchronopticon plates and in addition Plates 3-7. Cenozoic Radiolaria are illustrated on Plates 8-9.

Synchronopticon levels from youngest to oldest are:

Plates 1A-1D, 1F-1H

Artostrobium urna Zone	310A-10, CC
Artostrobium urna Zone	310A-13, CC
Dictyomitra somphedia Zone	310A-16, CC
Dictyomitra somphedia Zone	310A-17, CC
Dictyomitra somphedia Zone	307-3-1, 126-128
Plates 2C-2L	
Acaeniotyle umbilicata Zone	306-6-1, 116-118
Acaeniotyle umbilicata Zone	306-10-1, 124-125
Eucyrtis tenuis Zone	305-66-1, 110-102
Eucyrtis tenuis Zone	307-7-1, 75-77
Sethocapsa trachyostraca Zone	307-8, CC

In rare cases when a suitable specimen from the indicated level could not be found for illustration, a specimen from the next higher or lower level has been photographed and its sample number given in the plate description. Because of the large differential in size of the Radiolaria considered and the desirability of photographing related Radiolaria at the same magnification, some illustrations resulted which could not always be fitted exactly in the horizontal level to which they belonged. All such discrepancies in the levels of the photographs should be considered as resulting only from their size and not in any way indicating a slightly higher or lower stratigraphic level. All Spumellaria for the synchronopticon have been photographed at a magnification of × 84 and the Nassellaria at × 133.

In order to save space, a few species that are obviously not related have sometimes been placed in the same vertical row (e.g., Plate 2I, *Zhamoidellum ornatum* (?) below *Sethocapsa* sp.).

The letters and symbols indicating abundance: c, common; f, few; r, rare; +, very rare; and ·, isolated specimen, are defined in Presentation of Results in this chapter.

Cenozoic Radiolaria on Plates 8 and 9 are frequently illustrated with more than one picture. These may be from the same or different levels. When the levels differ, the specimens are arranged in sequence from the earliest specimen to the latest, with the earliest specimen having the lowest number.

All specimens with USNM numbers are deposited in the United States National Museum, Washington, D.C.

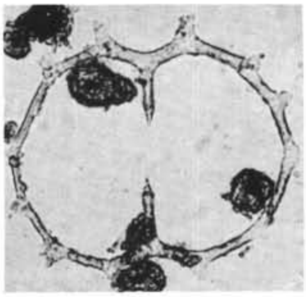
PLATE 1A

All figures magnified ×84

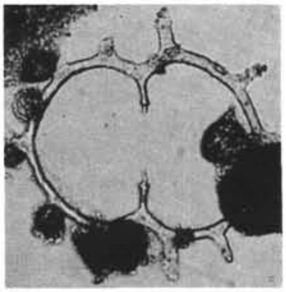
Figures 1-3	*Spongosaturnalis* (?) *multidentatus.* 1. USNM 219339. V30/1. 2. USNM 219353. X35/1. 3. cs. S H14/0.
Figures 4, 5	*Spongosaturnalis* (?) *preclarus.* 4. cs. 1 Q28/0. 5. cs. 1 J20/2.
Figure 6	*Spongosaturnalis hueyi.* cs. 2 P23/2.
Figures 7, 8	*Spongosaturnalis hueyi* group. 7. USNM 219354. T41/0. 8. USNM 219355. F40/1.

PLATE 1A

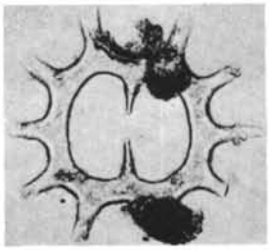
Artostrobium urna



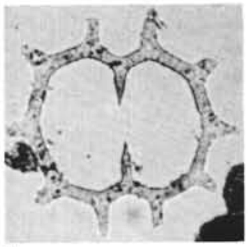
1 r



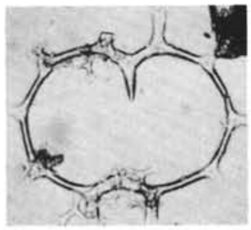
2 r



6 r

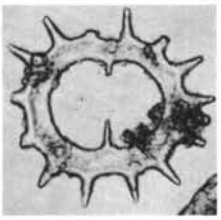


7 c

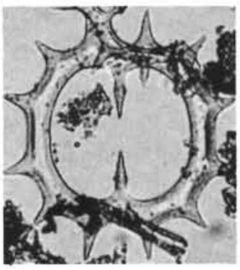


8 r

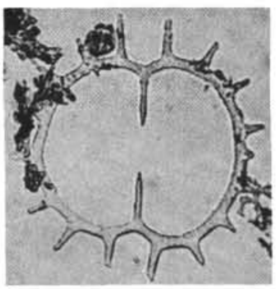
Dictyomitra somphedia



4 f



5 r



3 r

PLATE 1B

All figures magnified ×84

Figures 1-3	*Spongosaturnalis hueyi* group. 1. USNM 219356. R23/0. 2. cs. 1 J12/2. 3. sl. 6 H46/1.
Figures 4, 5	*Spongosaturnalis* (?) *ichikawai.* 4. cs. 1 mm D24/3. 5. USNM 219357. F40/1.
Figures 6, 7	*Spongosaturnalis* (?) *eidalimus.* 6. USNM 219356. V11/2. 7. USNM 219370. X35/1.
Figures 8-10	*Spongosaturnalis* (?) *yaoi.* 8. USNM 219340. C41/0. 9. cs. 2 V24/1. 10. sl. 2 C12/1.
Figure 11	*Spongosaturnalis* (?) *moorei.* USNM 219341. W28/1.

PLATE 1B

Artostrobium urna

Dictyomitra somphedia

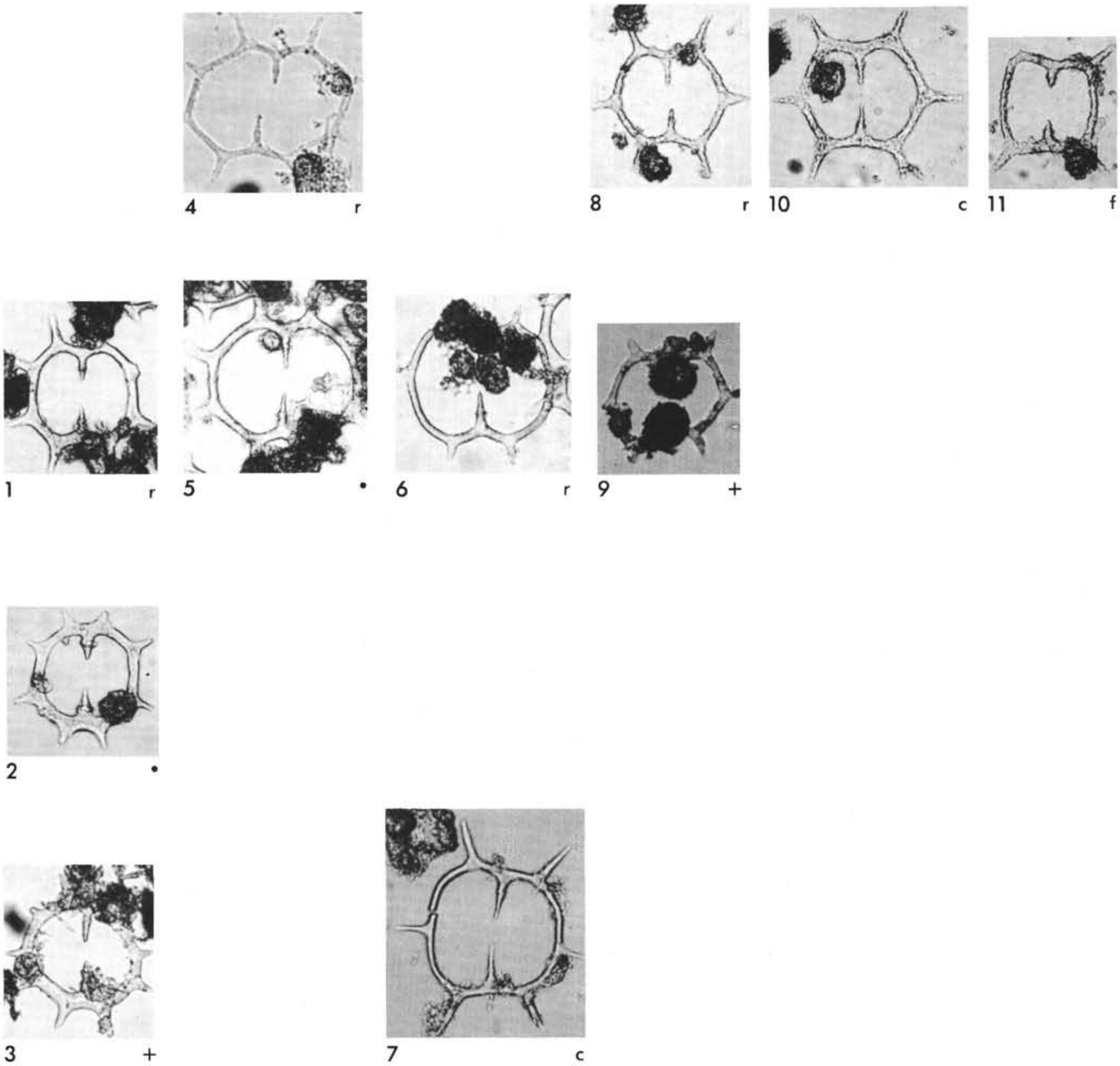


PLATE 1C

All figures magnified ×84

Figures 1, 2	*Spongosaturnalis squinaboli.*	
	1. USNM 219342. N41/3.	
	2. cs. 1 Q21/3.	
Figures 3-10	*Spongosaturnalis* (?) spp.	
	3. USNM 219343. N48/1.	
	4. USNM 219359. K20/1.	
	5. cs. 1 X36/1.	
	6. cs. 1 H50/1.	
	7. sl. 6 K13/4.	
	8. cs. 3 P11/3.	
	9. cs. 2 C16/1.	
	10. cs. S H28/0.	
Figure 11	*Acanthocircus* sp.	
	fn. 1 V32/1.	

PLATE 1C

Artostrobium urna

Dictyomitra somphedia

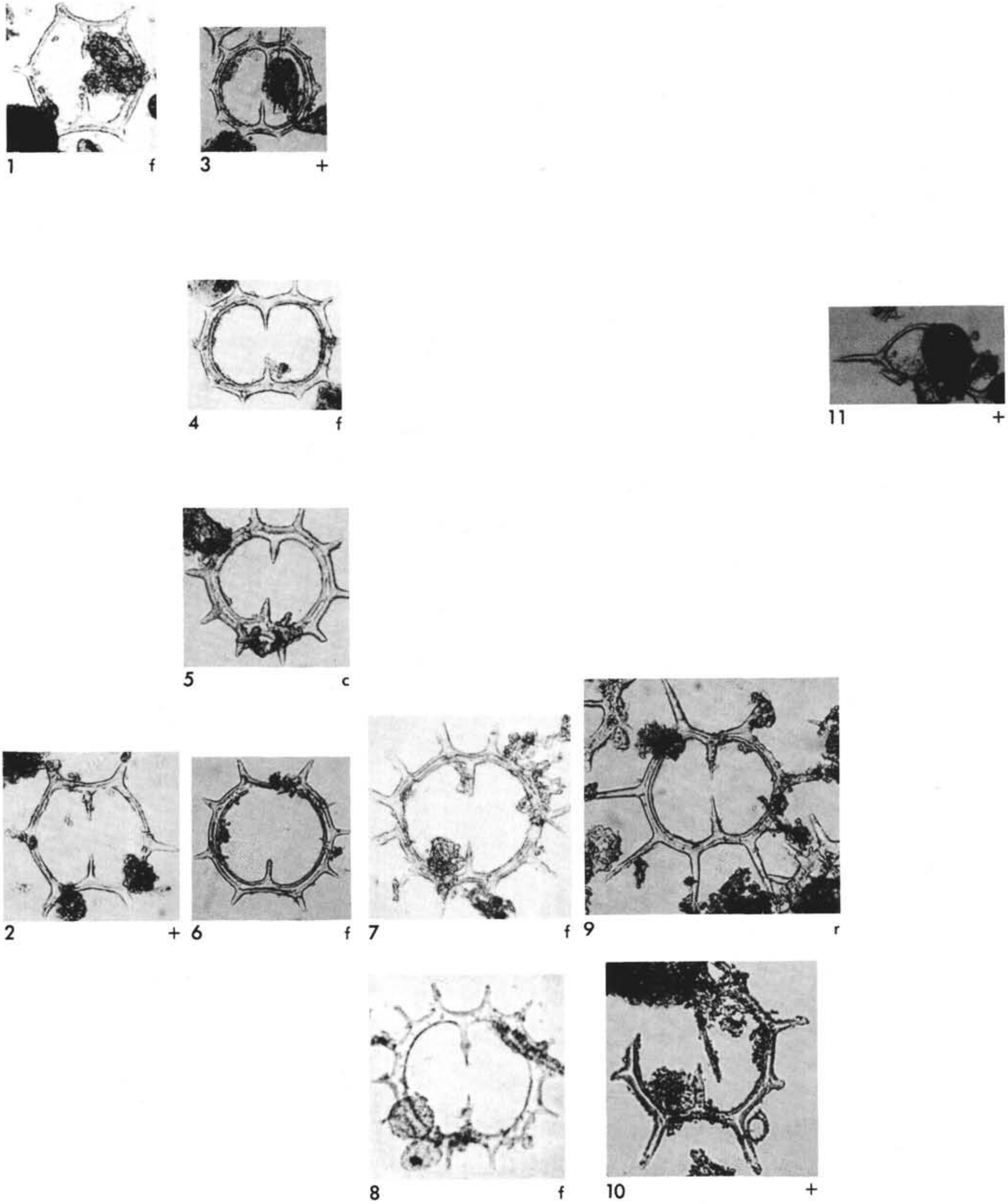


PLATE 1D

All figures magnified ×84

Figure 1	Actinommid, gen. and sp. indet. cs. 1 mm N19/2.
Figures 2, 3	*Alievium gallowayi.* 2. cs. 1 mm R47/4. 3. cs. 1 mm T40/2.
Figures 4, 5	*Alievium praegallowayi.* 4. sl. 2 D15/3. 5. USNM 219360. B47/3.
Figure 6	*Crucella irwini.* USNM 219361. W15/2.
Figure 7	*Crucella* sp. USNM 219362. E39/2.
Figures 8, 9	*Crucella messinae.* 8. cs. 1 O35/1. 9. USNM 219371. W39/0.

PLATE 1D

Artostrobium urna

Dictyomitra somphedia

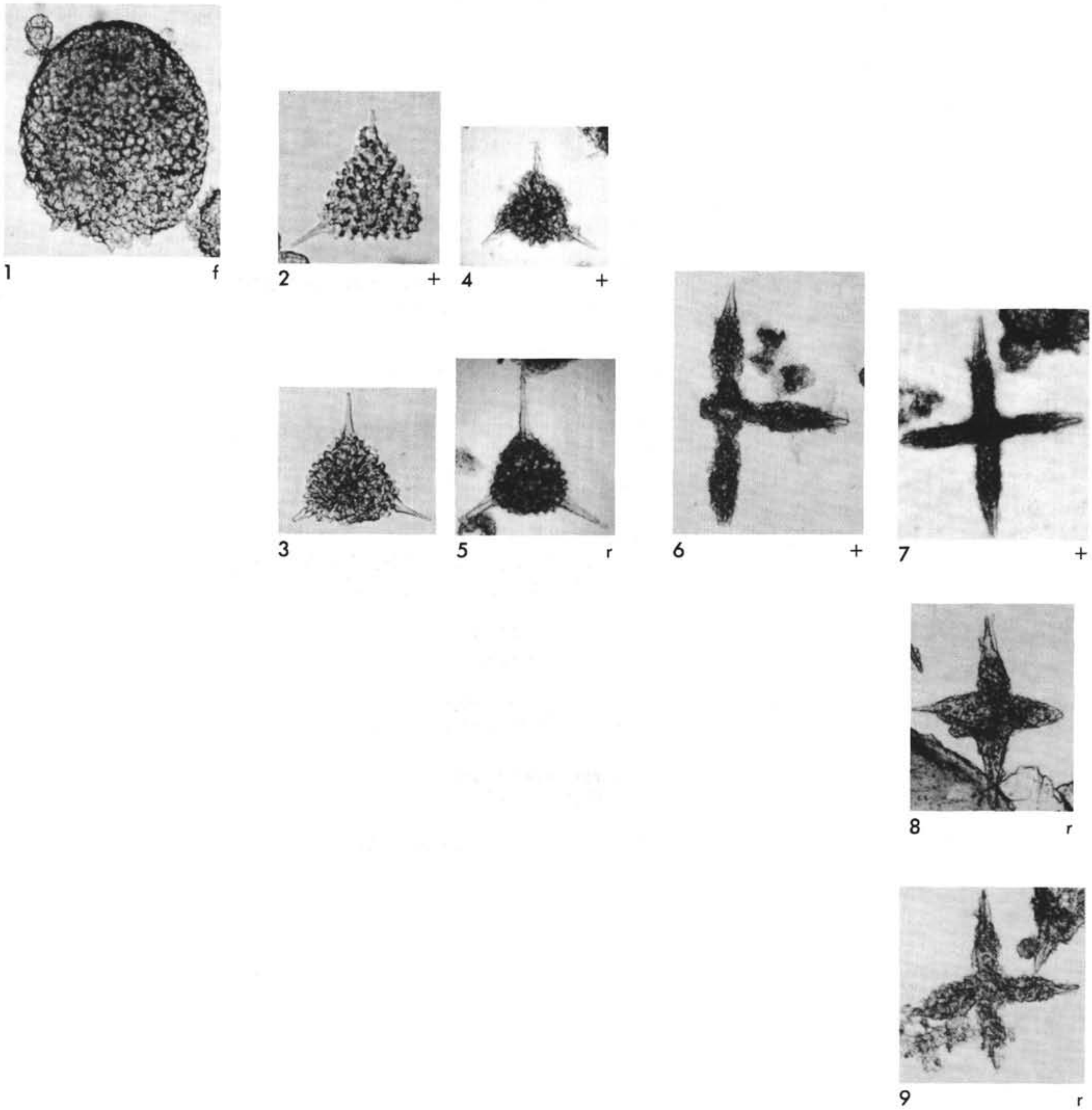


PLATE 1F

Figure 1	*Acaeniotyle* sp. cf. *Acaeniotyle diaphorogona.* USNM 219363. G14/2, ×84.
Figure 2	*Staurosphaeretta hindei.* USNM 219236. M13/1, ×84.
Figures 3-5	*Artostrobium tina.* 3. 310A-8CC. USNM 219333. D14/4, ×133. 4. USNM 219351. B23/4, ×133. 5. USNM 219366. R18/1, ×133.
Figures 6, 7	*Artostrobium urna.* 6. 310A-8CC.USNM 219334. Y46/0, ×133. 7. USNM 219352. N38/2, ×133.
Figure 8	*Theocampe salillum.* sl. 2 S42/0, ×133.
Figure 9	*Holocryptocanium barbui.* USNM 219237. E23/0, ×133.
Figure 10	*Holocryptocanium* sp. cg. 4 G14/4, ×133.

(There is no plate numbered 1E.)

PLATE 1F

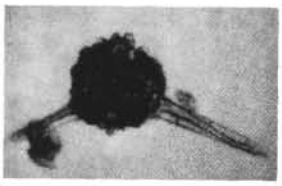
Artostrobium urna

Dictyomirtra somphedia

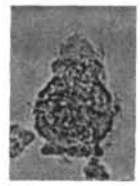

3 r


6 f

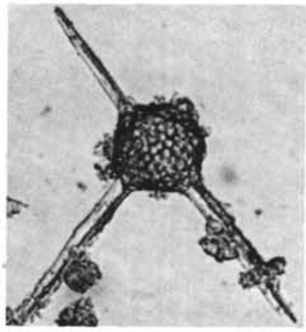

8 c

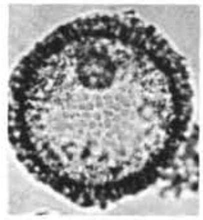

1 •


4 r


7 r


5 +


2 +


9 r

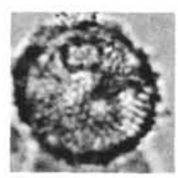

10 +

PLATE 1G

All figures magnified ×133

Figure 1	*Platycryphalus* sp. fn. 2 mm W34/3.
Figures 2, 3	*Lithomelissa* (?) *petila.* 2. sl. A C23/1. 3. USNM 219238. Q16/3.
Figure 4	*Dictyomitra veneta.* USNM 219234. Y27/0.
Figures 5, 6	*Dictyomitra duodecimcostata.* 5. sl. 2 M22/1. 6. USNM 219367. B38/2.
Figure 7	*Dictyomitra* sp. A. USNM 219235. H41/4.

PLATE 1G

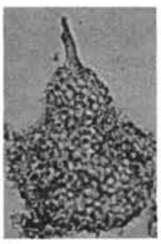
Artostrobium urna

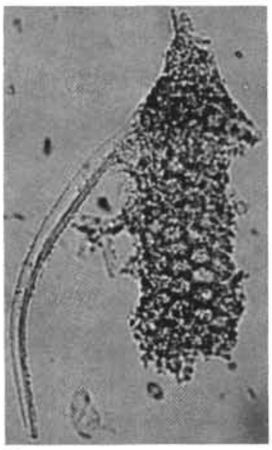

5 c


6 r

Dictyomitra somphedia


2 +


1 •


3 f


4 +


7 f

PLATE 1H

All figures magnified $\times 133$

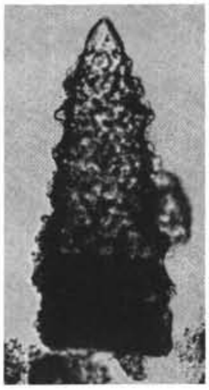
Figure 1	*Dictyomitra* sp. cf. *D. tekschaensis.* fn. 2 mm L21/0.
Figure 2	*Dictyomitra* sp. USNM 219344. O22/1.
Figure 3	*Dictyomitra* sp. USNM 219368. H47/0.
Figure 4	*Dictyomitra* sp. USNM 219364. S46/4.
Figure 5	*Dictyomitra* sp. cs. 2 G43/1.

PLATE 1H

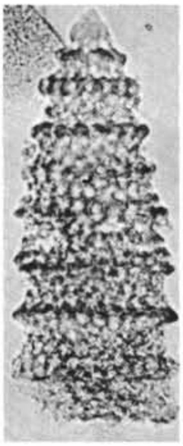
Artostrobium urna

Dictyomitra somphedia

2 +

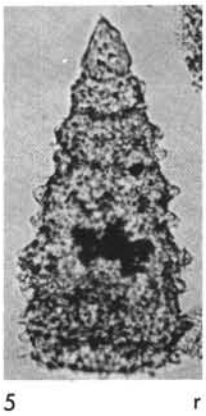


4 r



3 r

1 +



5 r

PLATE 2C

All figures magnified ×84

Figure 1	*Spongosaturnalis horridus.* cg. 4 S45/4.
Figures 2-6	*Spongosaturnalis* (?) spp. 2. USNM 219197. B15/0. 3. USNM 219209. S46/4. 4. cs. D M17/2. 5. cs. 2 G38/0. 6. USNM 219196 G49/1.
Figure 7	*Acanthocircus* sp. cg. 4 U28/0.
Figure 8	*Acanthocircus carinatus.* USNM 219239. K17/0.
Figures 9, 10	*Acanthocircus variabilis.* 9. USNM 219255. F45/0. 10. USNM 219265. G19/1.

(There are no plates numbered 2A and 2B.)

PLATE 2C

Acaeniotyle umbilicata

Eucyrtis tenuis

S. trachyostraca

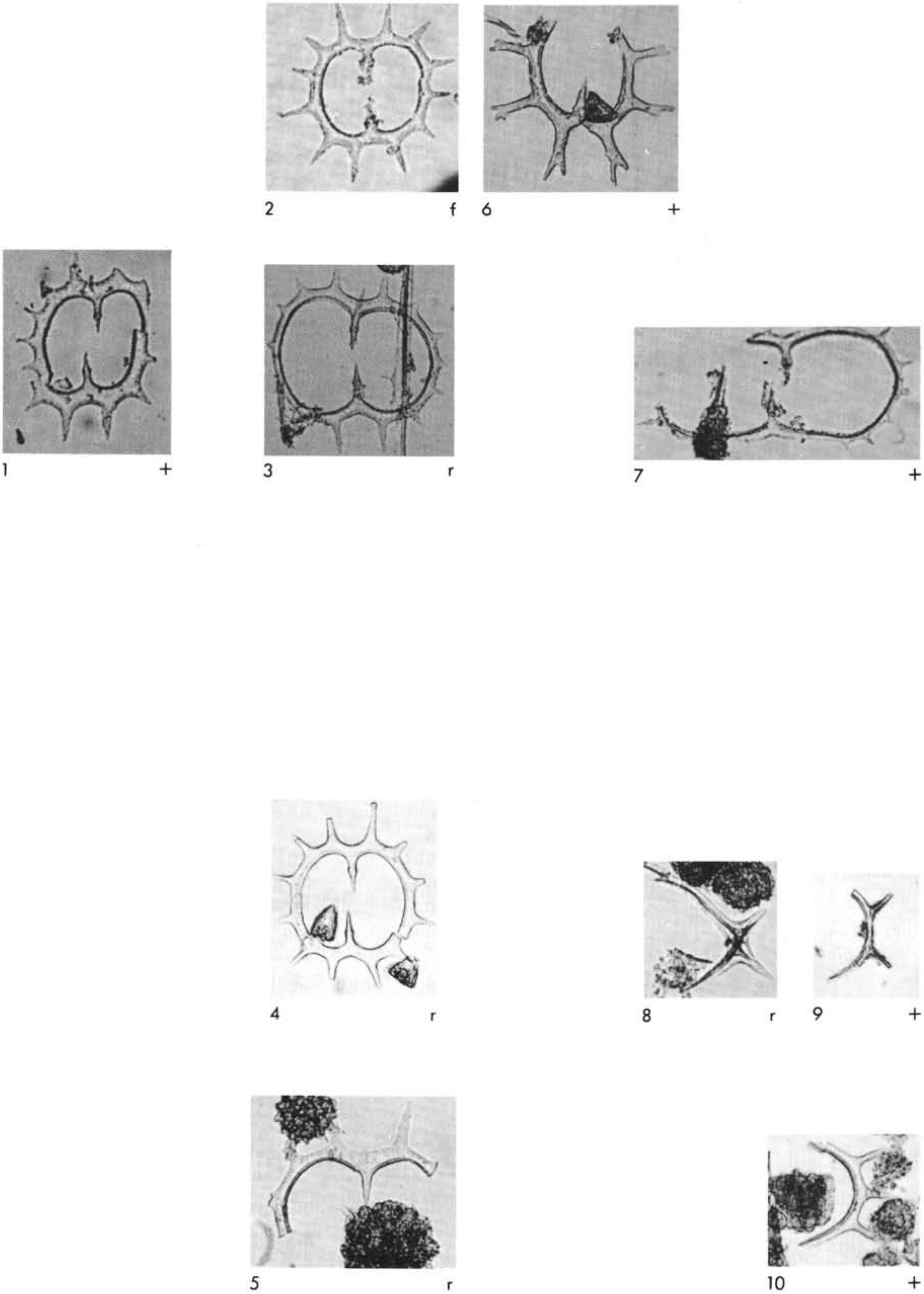


PLATE 2D

All figures magnified ×84

Figures 1-4	*Acanthocircus trizonalis.*	
	1. USNM 219210. D25/0.	
	2. USNM 219219. Q51/0.	
	3. fn. C U32/1.	
	4. USNM 219266. X20/2.	
Figures 5, 6	*Acanthocircus dicranacanthos.*	
	5. sl. B B36/0.	
	6. USNM 219256. N20/2.	
Figures 7, 8	*Alievium* sp.	
	7. cs. AA E38/1.	
	8. USNM 219267. P12/4.	
Figures 9-11	*Crucella* sp.	
	9. cg. 4 F 24/2.	
	10. cs. B mm U52/0.	
	11. sl. 2 H24/4.	

PLATE 2D

Acaeniotyle umbilicata

Eucyrtis tenuis

S. trachyostraca

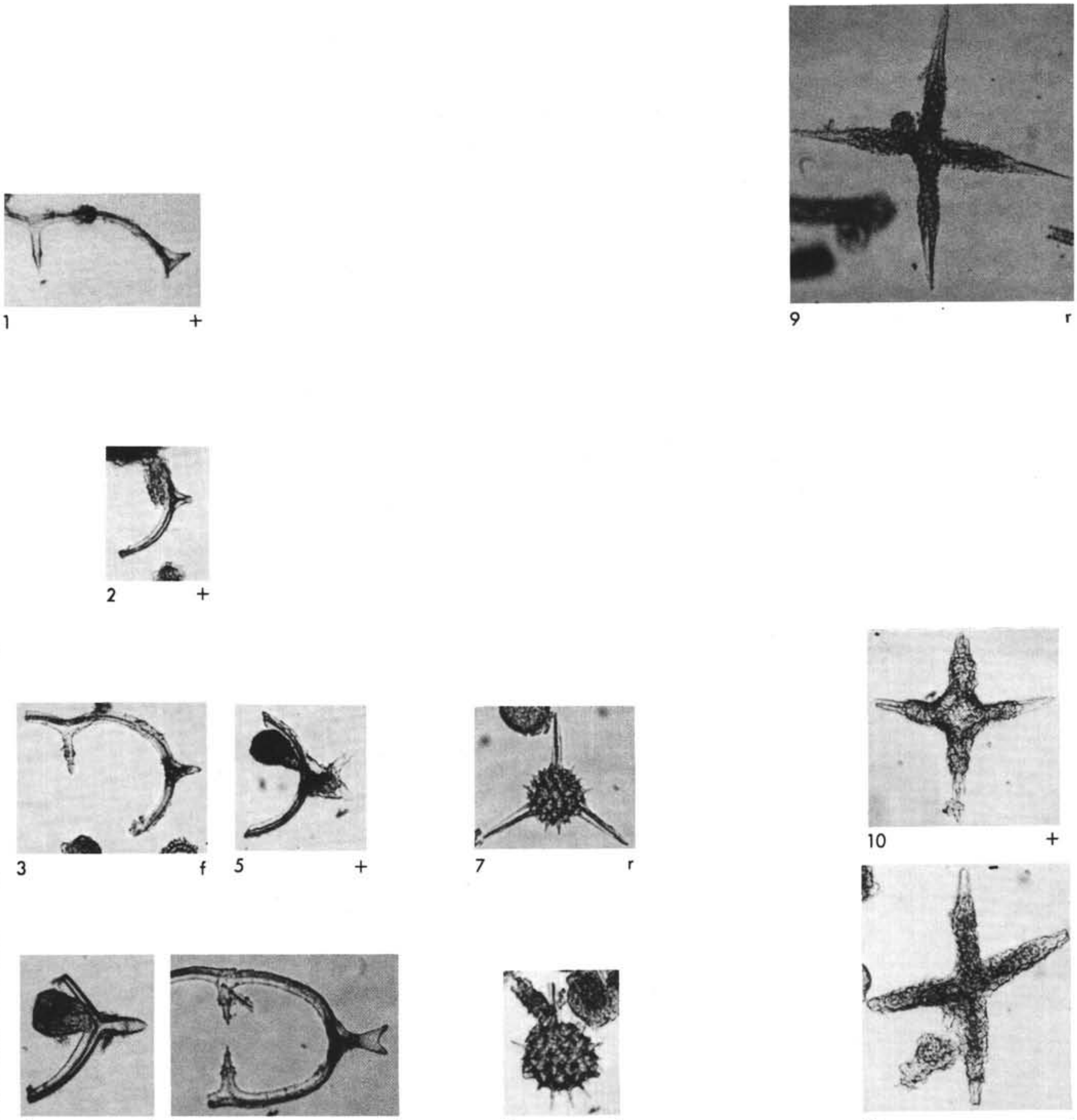


PLATE 2E

All figures magnified ×84

Figures 1, 2	*Paronaella* (?) *hipposidericus.* 1. cs. R S20/0. 2. USNM 219240. W 37/1.
Figures 3-6	*Sphaerostylus lanceola* group. 3. USNM 219250. N22/3. 4. USNM 219183. X18/1. 5. USNM 219251. F30/3. 6. USNM 219268. P15/0.
Figure 7	*Staurosphaera septemporata.* USNM 219252. N37/4.
Figure 8	*Dicroa periosa.* cg. 4 D48/4.
Figures 9-11	*Dicroa* sp. A. 9. sl. B Y44/1. 10. sl. B J20/2. 11. USNM 219269. G36/1.
Figures 12, 13	*Acaeniotyle helicta.* 12. fn. B G11/0. 13. USNM 219241. C16/1.
Figures 14-17	*Acaeniotyle umbilicata.* 14. cg. 4 N34/3. 15. USNM 219184. S47/1. 16. USNM 219242. E44/4. 17. USNM 219257. V28/2.
Figure 18	*Acaeniotyle* sp. aff. *A. umbilicata.* cg. 4 J26/1.

PLATE 2E

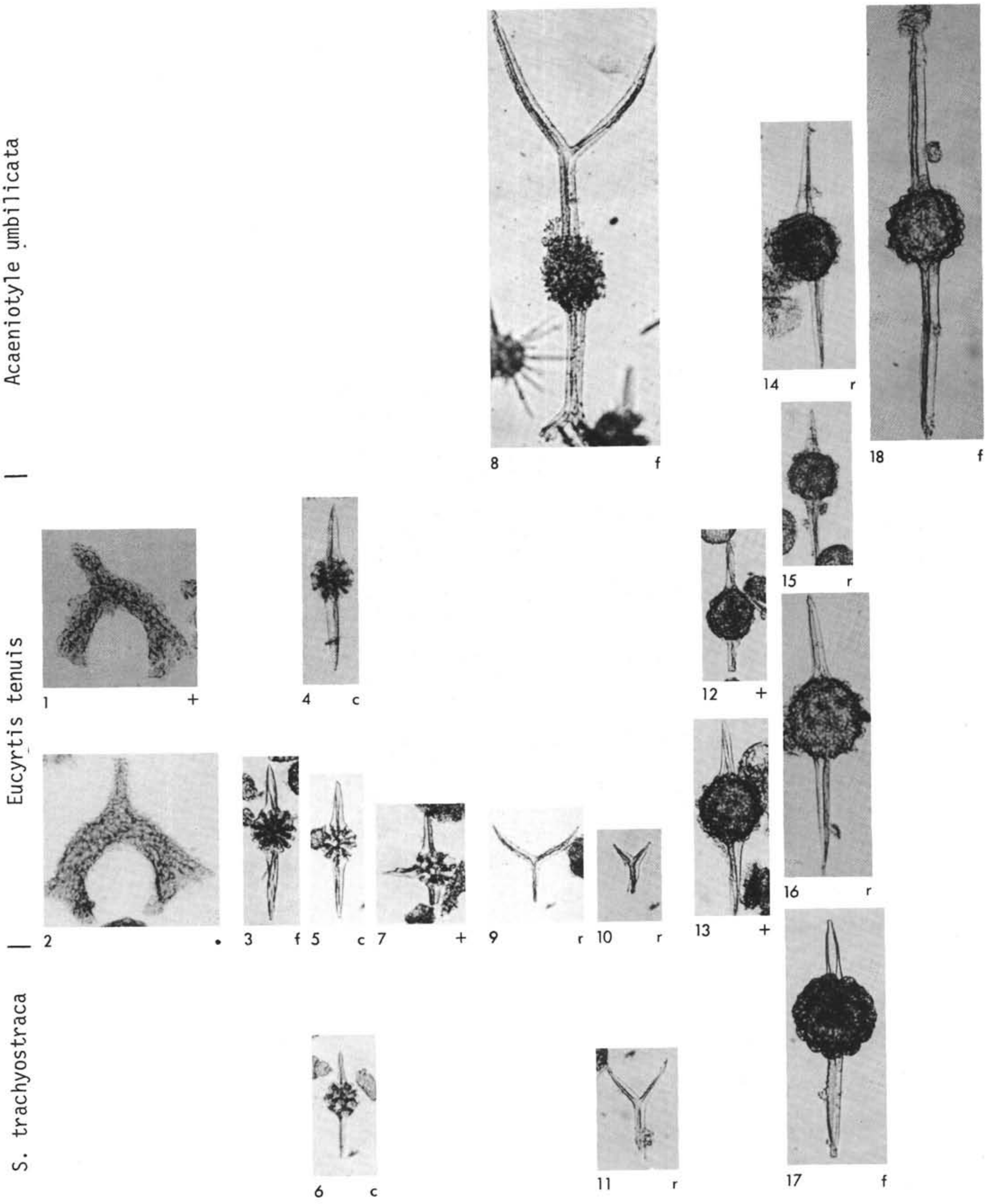

Acaeniotyle umbilicata
Eucyrtis tenuis
S. trachyostraca
1 +
2 •
3 f
4 c
5 c
6 c
7 +
8 f
9 r
10 r
11 r
12 +
13 +
14 r
15 r
16 r
17 f
18 f

PLATE 2F

All figures magnified ×84

Figures 1-5	*Acaeniotyle diaphorogona.* 1. USNM 219199. W30/4. 2. USNM 219211. Q23/1. 3. cs. B E38/0. 4. USNM 219243. R40/2. 5. cs. 2 E18/3.
Figures 6, 7	*Triactoma hybum.* 6. USNM 219185. X47/1. 7. USNM 219244. N38/3.
Figure 8	*Staurosphaeretta hindei.* USNM 219200. E17/1.
Figures 9, 10	*Triactoma echiodes.* 9. USNM 219245. K17/2. 10. cs. 2 Y9/2.
Figure 11	*Trochodiscus exaspina.* USNM 219201. V39/4.
Figures 12-14	Actinommids, gen. and spp. indet. 12. USNM 219202. J32/1. 13. cg. 4 O25/1. 14. cs. 2 X15/0.

PLATE 2F

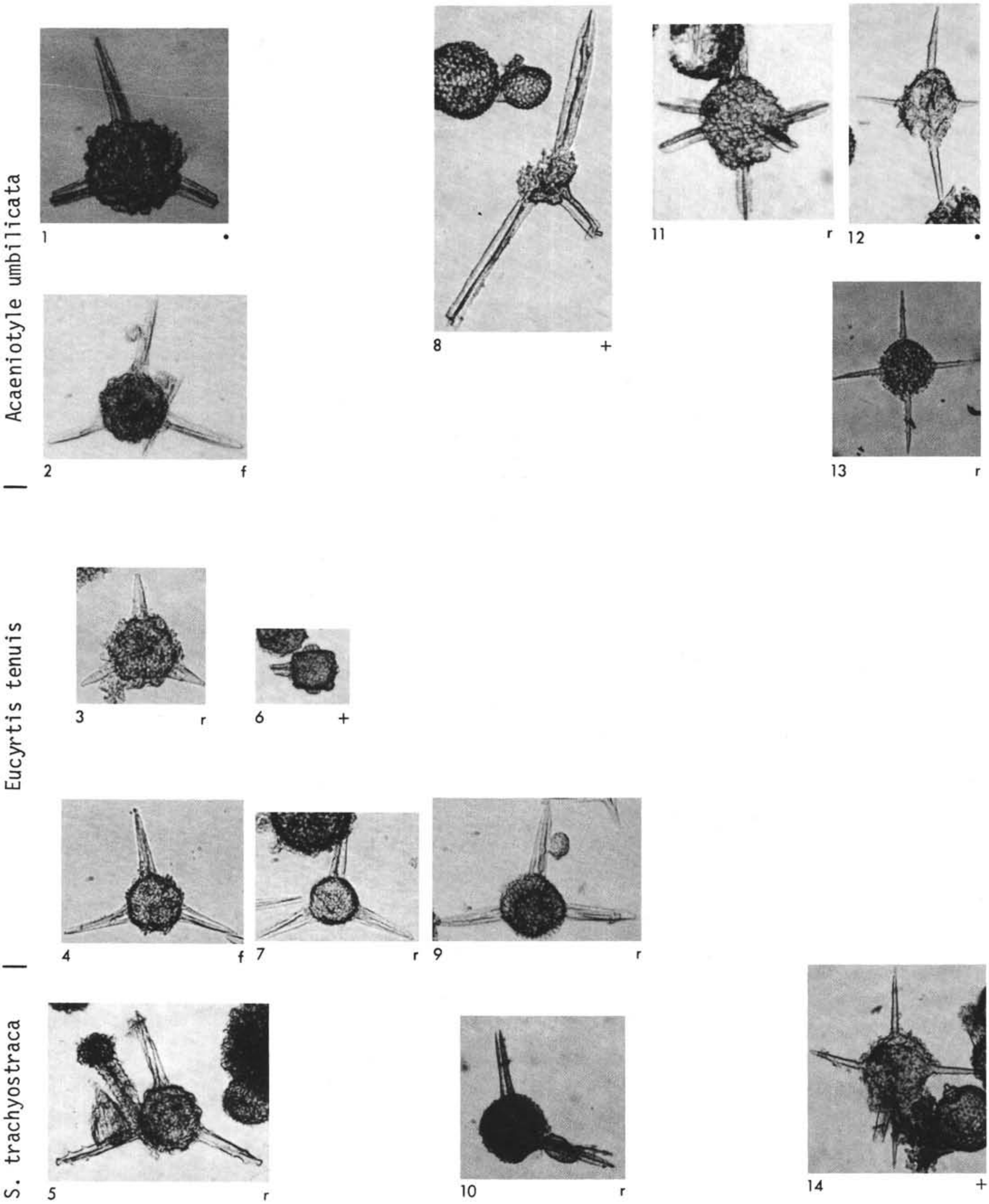

Acaeniotyle umbilicata
Eucyrtis tenuis
S. trachyostraca
1 •
2 f
3 r
4 f
5 r
6 +
7 r
8 +
9 r
10 r
11 r
12 •
13 r
14 +

PLATE 2G

All figures magnified ×133

Figure 1	*Platycryphalus* sp. sl. A W52/0.
Figure 2	*Platycryphalus* sp. aff. *P. hirsuta.* sl. A P30/2.
Figures 3, 4	*Lithocampe elegantissima.* 3. USNM 219186. H41/2. 4. cs. AA W36/0.
Figures 5, 6	*Dictyomitra* (?) *lacrimula.* 5. USNM 219187. H22/0. 6. fn. BB V23/1.
Figures 7, 8	*Dictyomitra apiarium.* 7. fn. B K19/0. 8. cs. 2' G27/0.
Figures 9, 10	*Dictyomitra* sp. B. 9. sl. 1 H22/3. 10. USNM 219213. S32/0.
Figures 11-14	*Dictyomitra carpatica* (?). 11. cs. R P43/3. 12. fn. B B20/0. 13. sl. 4 H41/4. 14. USNM 219270. U22/4.
Figures 15-17	*Dictyomitra* sp. C. 15. cs. B A19/1. 16. cs. D C40/4. 17. USNM 219271. S38/0.
Figures 18-20	*Dictyomitra* sp. A. 18. USNM 219203. B29/2. 19. USNM 219214. S27/0. 20. cg. 2 X35/2.

PLATE 2G

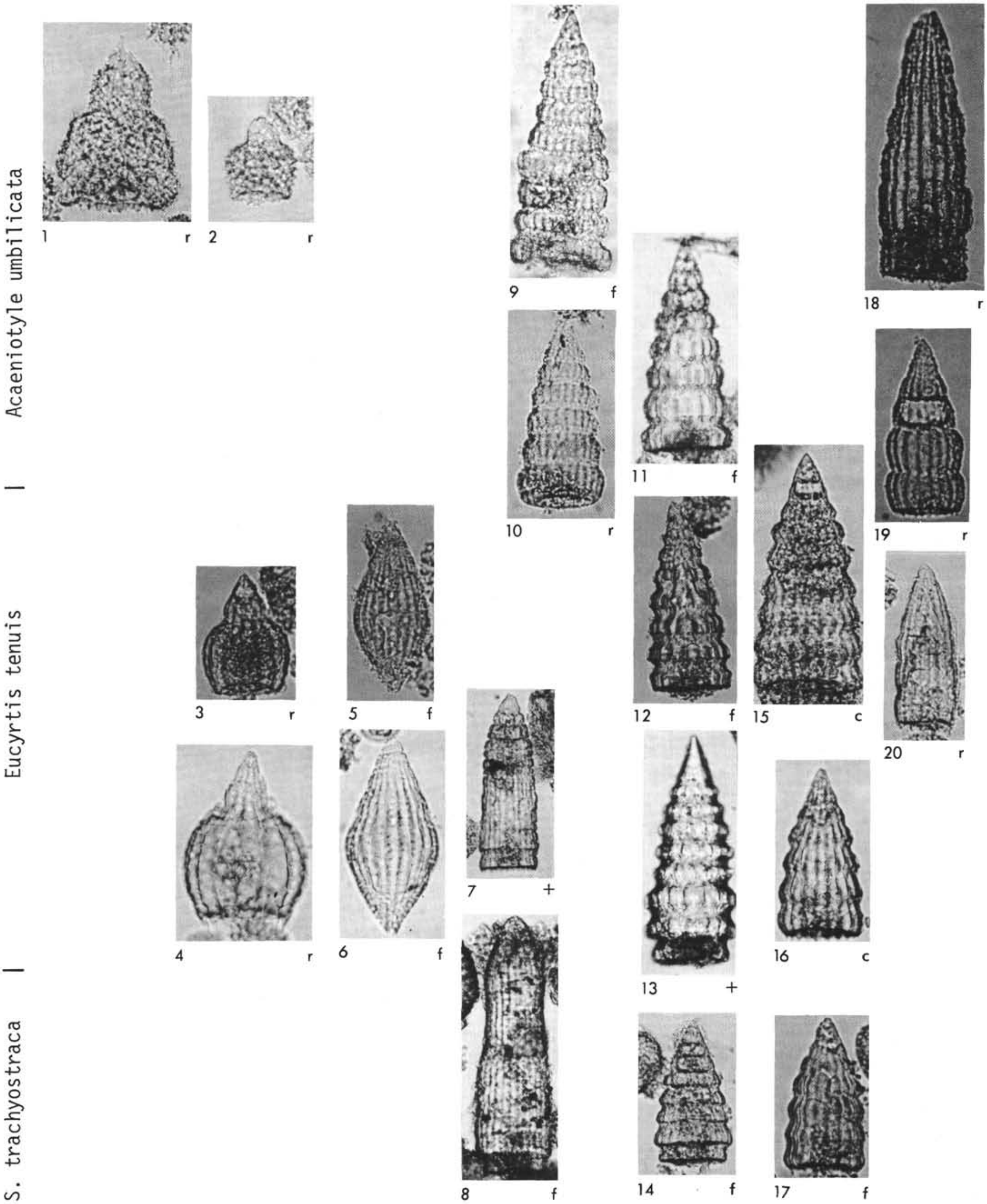

Acaeniotyle umbilicata
Eucyrtis tenuis
S. trachyostraca
1 r
2 r
3 r
4 r
5 f
6 f
7 +
8 f
9 f
10 r
11 f
12 f
13 +
14 f
15 c
16 c
17 f
18 r
19 r
20 r

PLATE 2H

All figures magnified ×133

Figure 1	*Dictyomitra* sp. cf. *D. tekaschaensis.* USNM 219215. M10/0.
Figure 2	*Dictyomitra* sp. USNM 219204. E31/0.
Figure 3	*Dictyomitra cosmoconica.* cs. 2 K45/3.
Figure 4	*Dictyomitra* (?) sp. cs. AA R 11/2.
Figure 5	*Dictyomitra* sp. USNM 219205. T39/1.
Figures 6, 7	*Dictyomitra* sp. 6. USNM 219246. P48/4. 7. USNM 219272. X38/3.
Figures 8, 9	*Dictyomitra alievi.* 8. cs. B J31/0. 9. USNM 219247. S15/3.
Figures 10, 11	*Dictyomitra boesii.* 10. fn. BB C51/2. 11. USNM 219258. B34/4.

PLATE 2H

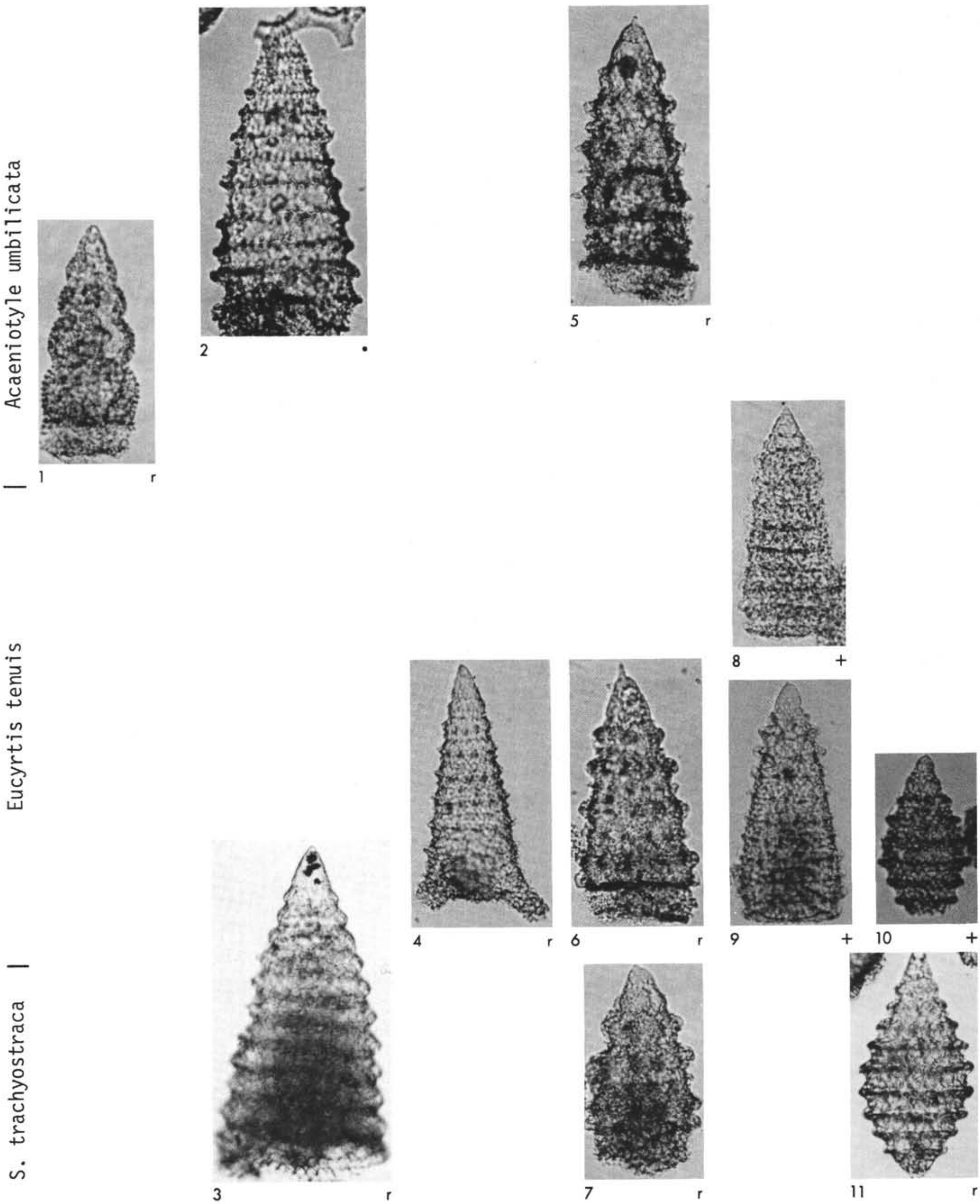

Acaeniotyle umbilicata
Eucyrtis tenuis
S. trachyostraca
1 r
2 •
3 r
4 r
5 r
6 r
7 r
8 +
9 +
10 +
11 r

PLATE 2I

All figures magnified ×133

Figure 1	*Eucyrtis micropora* (?). USNM 219216. Q6/4.
Figures 2-5	*Eucyrtis micropora.* 2. USNM 219188. E23/3. 3. fn. C W20/1. 4. USNM 219273. X 17/2. 5. USNM 219253. Q43/0. Cast.
Figure 6	*Eucyrtis tenuis* (?). USNM 219217. P31/0.
Figures 7-9	*Eucyrtis tenuis.* 7. USNM 219189. Q29/0. 8. fn. BB O27/2. 9. USNM 219254. D32/3. Cast.
Figures 10-12	*Sethocapsa* sp. 10. cs. 1 mm F12/2. 11. cg. 4 C33/2. 12. fn. B D28/2.
Figure 13	Spyrid gen. and sp. indet. USNM 219274. P21/1.
Figure 14	*Sethocapsa* sp. sl. A W37/4.
Figures 15, 16	*Zhamoidellum ornatum* (?). 15. fn. B C14/1. 16. cs. D Y40/2.
Figure 17	*Diacanthocapsa communis.* 306-6CC.USNM 219207. K12/3.
Figures 18, 20	*Hemicryptocapsa* spp. cf. *H. capita.* 18. USNM 219259. Y18/4. 20. USNM 219260. O19/2.
Figure 19	*Eucyrtis columbaria.* fn. BB T25/0.
Figures 21, 22	*Sethocapsa* sp. cf. *Theocapsa uterculus.* 21. fn. BB P13/4. 22. USNM 219275. D19/4.

PLATE 21

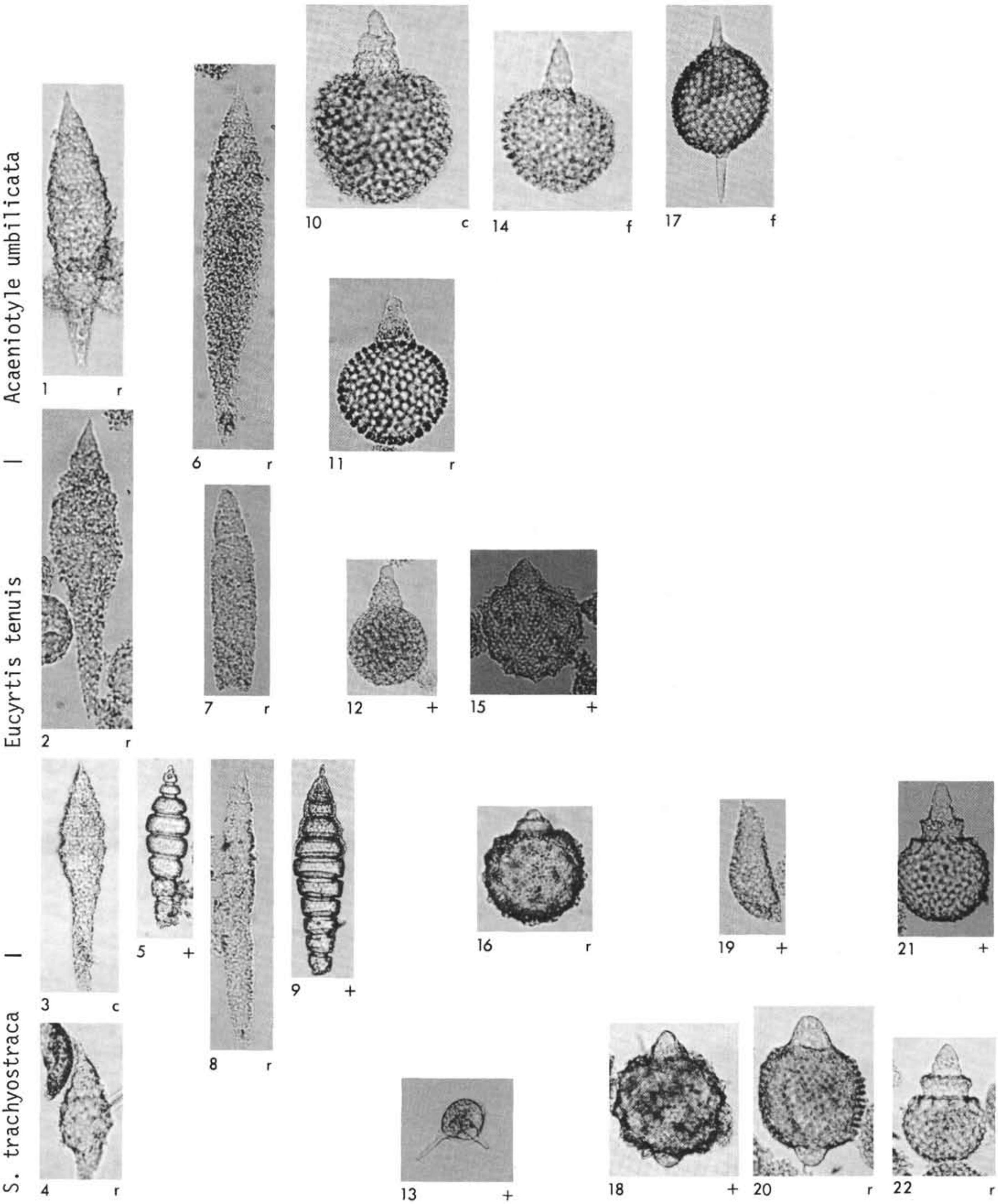

Acaeniotyle umbilicata
Eucyrtis tenuis
S. trachyostraca
1 r
2 r
3 c
4 r
5 +
6 r
7 r
8 r
9 +
10 c
11 r
12 +
13 +
14 f
15 +
16 r
17 f
18 +
19 +
20 r
21 +
22 r

PLATE 2J

All figures magnified ×133

Figures 1, 2	*Sethocapsa* (?) *orca.* 1. cs. B D31/0. 2. USNM 219248. O46/0.
Figures 3, 4	*Sethocapsa trachyostraca.* 3. sl. 4 U50/1. 4. USNM 219261. H50/0.
Figure 5	*Sethocapsa leiostraca.* cs. 2 F18/2.
Figure 6	*Stichocapsa* (?) *rotunda.* Cast. cs. 2 U38/1.

PLATE 2J

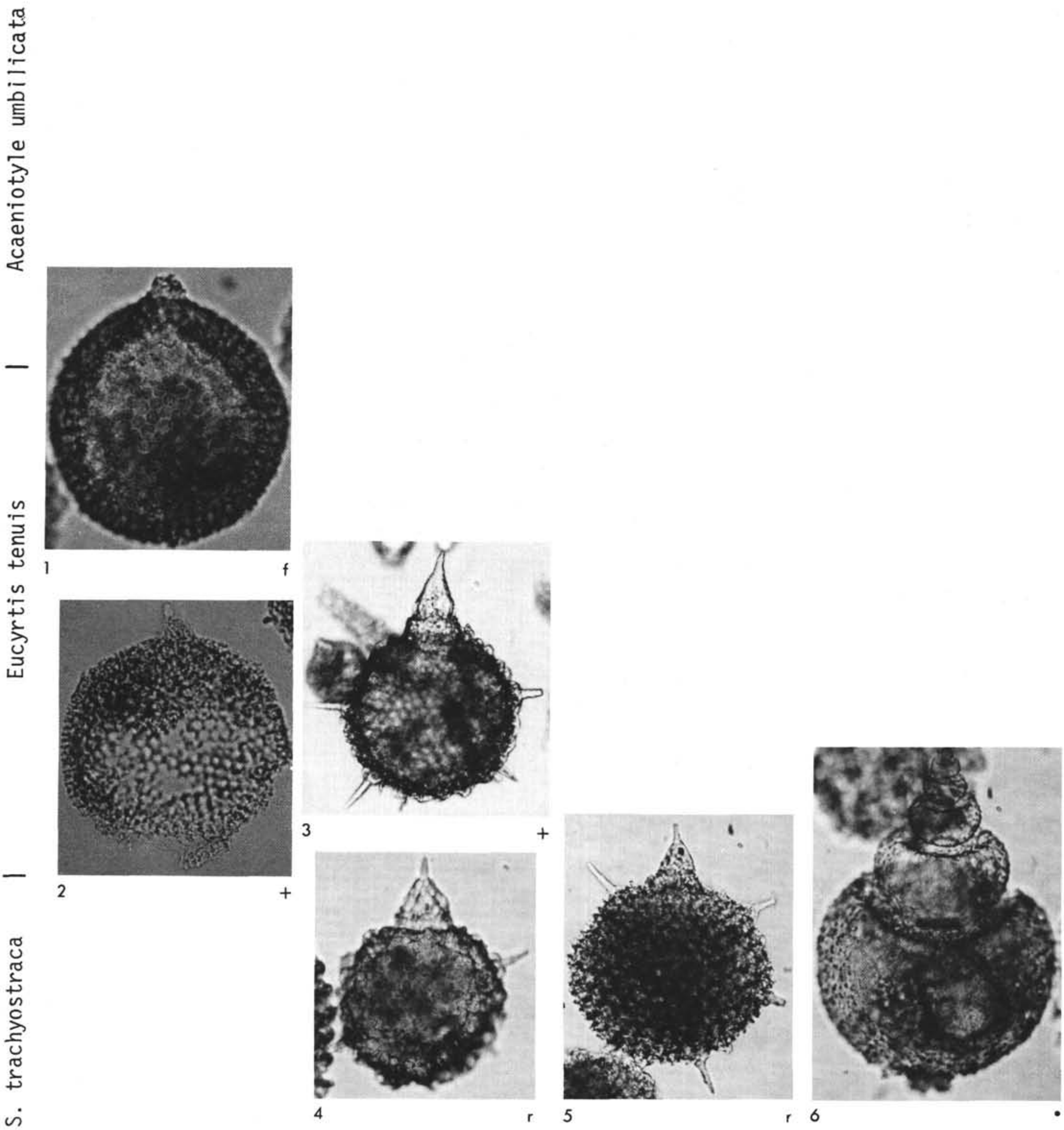
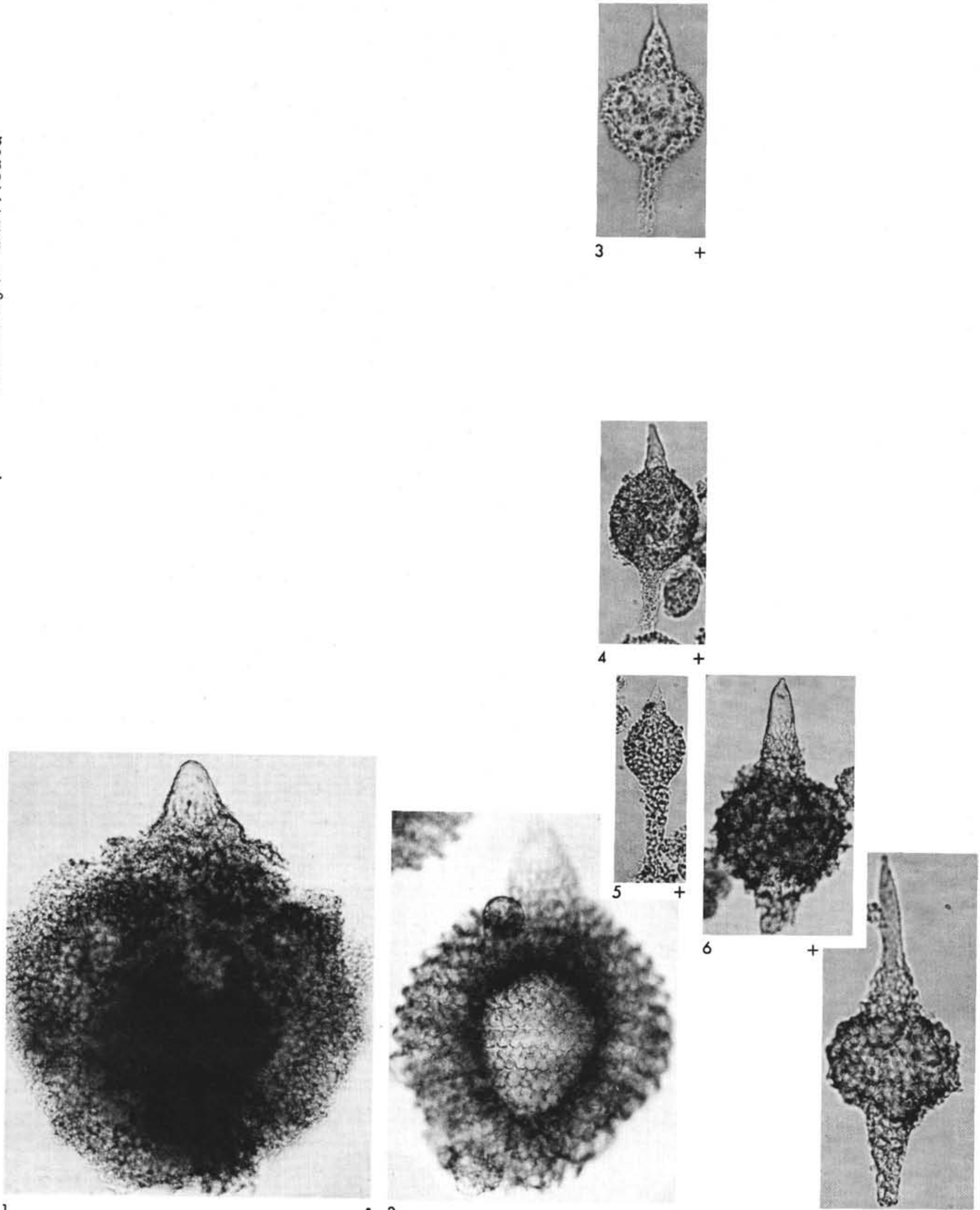

Acaeniotyle umbilicata
Eucyrtis tenuis
S. trachyostraca
1 f
2 +
3 +
4 r
5 r
6 •

PLATE 2K

All figures magnified $\times 133$

Figure 1	*Sethocapsa cetia* (?). cs. 2 M34/4.
Figure 2	*Lithocampe mediodilatata.* USNM 219262. R50/0.
Figures 3-5	*Eucyrtis bulbosa* (?). 3. sl. A N23/1. 4. fn. B C16/0. 5. fn. BB V40/3.
Figure 6	*Lithocampe chenodes.* cs. D M36/3.
Figure 7	*Syringocapsa limatum.* USNM 219263. R39/4.

PLATE 2K



S. trachyostraca | Eucyrtis tenuis | Acaeniotyle umbilicata

PLATE 2L

All figures magnified ×133

Figure 1	*Podobursa* (?) *polylophia.* USNM 219264. H39/4.
Figures 2, 3	*Dibolachras tytthopora.* 2. USNM 219192. O51/1. 3. cs. AA J47/3.
Figures 4-6	*Podobursa triacantha.* 4. USNM 219193. O33/1. 5. cs. AA V31/1. 6. cs. 2 M49/4.
Figures 7, 8	*Podobursa tricola.* 7. USNM 219190. K40/2. 8. fn. BB M49/4.

PLATE 2L

Acaeniotyle umbilicata | Eucyrtis tenuis | S. trachyostraca

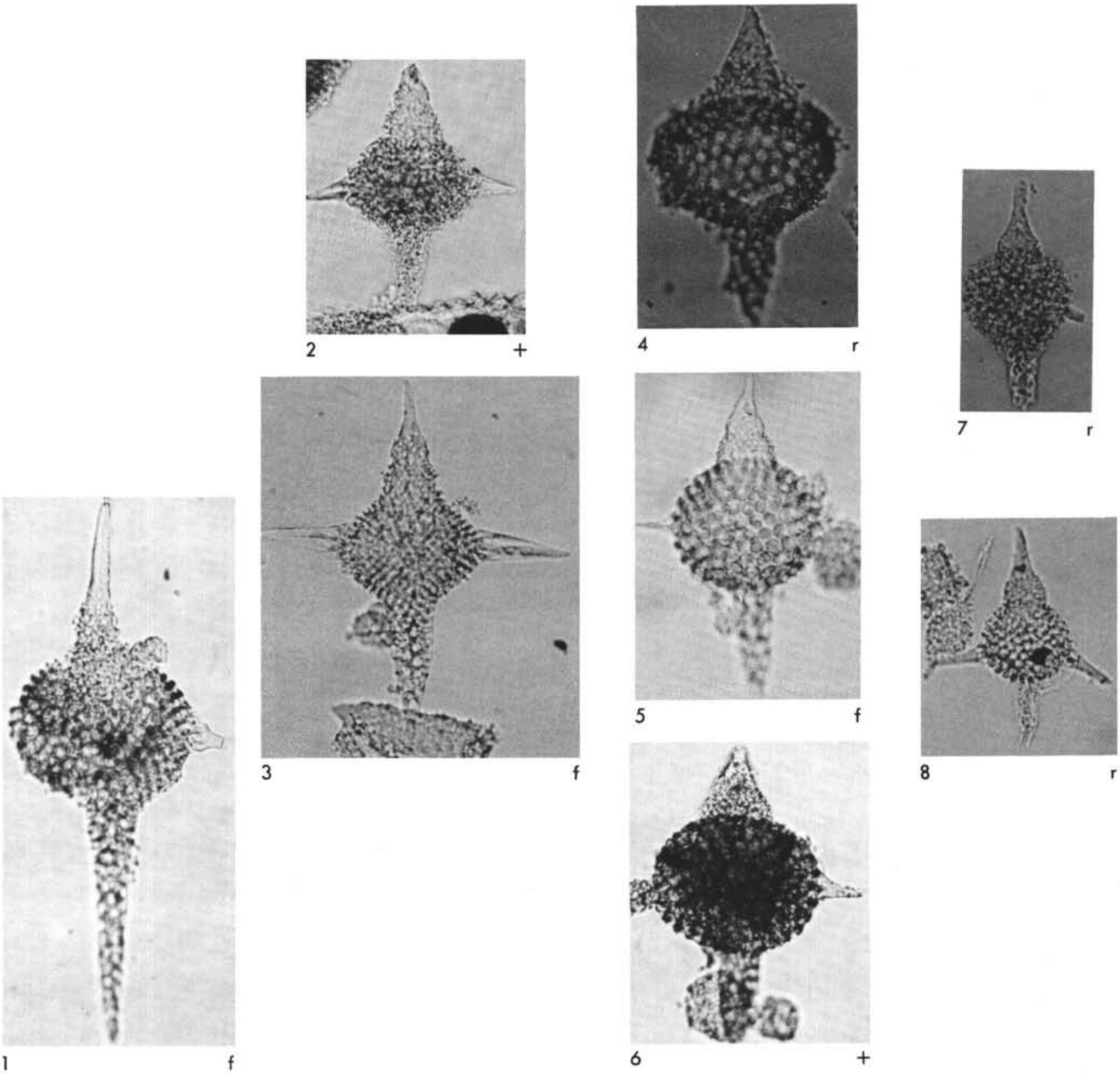


PLATE 3

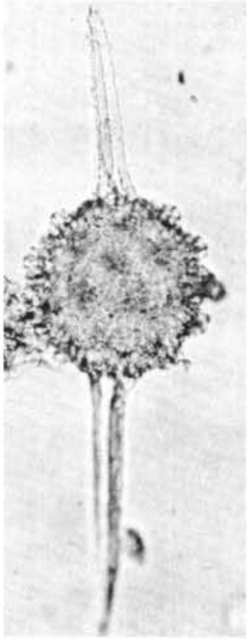
Cretaceous Radiolaria

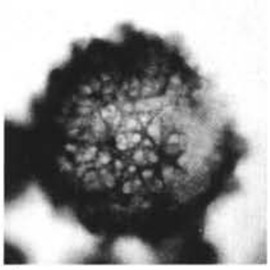
All figures magnified ×133

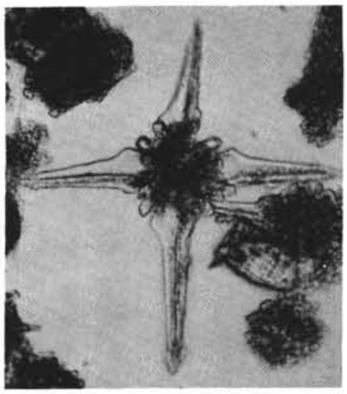
Figures 1, 2	*Acaeniotyle diaphorogona.* 1. 304-9-1, 101-103. sl. 2 S19/2. 2. 306-14, CC. USNM 219220. M13/0.
Figure 3	*Acaeniotyle umbilicata.* 307-7-1, 75-77. USNM 219249. F44/0.
Figure 4	*Cenosphaera* sp. 306-42-1, 105-107. USNM 219227. B22/1.
Figure 5	*Acaeniotyle helicta.* 305-65-1, 108-110. USNM 219182. B28/0. Holotype.
Figure 6	*Staurosphaera septemporata.* 307-9-1, 80-82. USNM 219278. O26/0.
Figures 7, 9	*Triactoma hybum.* 7. 306-14, CC. USNM 219221. O33/0. Holotype. 9. 306-11, CC. sl. 2 T37/3. Side view.
Figure 8	*Dicroa periosa.* 306-10-1, 124-125. USNM 219212. S27/2. Holotype.
Figure 10	*Triactoma echiodes.* 306-14, CC. USNM 219222. N31/0.
Figure 11	*Dicroa* sp. A. 306-12-1, 60-62. USNM 219218. M34/0.
Figure 12	*Dicroa* sp. 303A-3, CC (#2). fn. B C42/1.
Figure 13	*Triactoma tithonianum.* 306-42-1, 116-118. USNM 219229. U14/1.

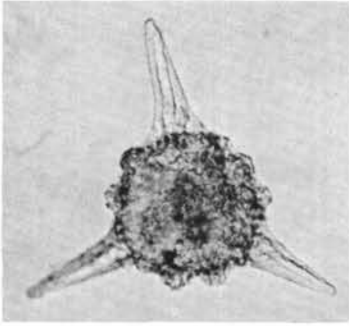
PLATE 3


1

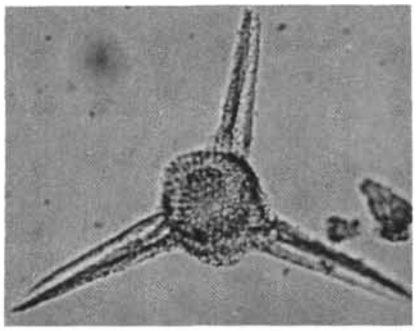

3

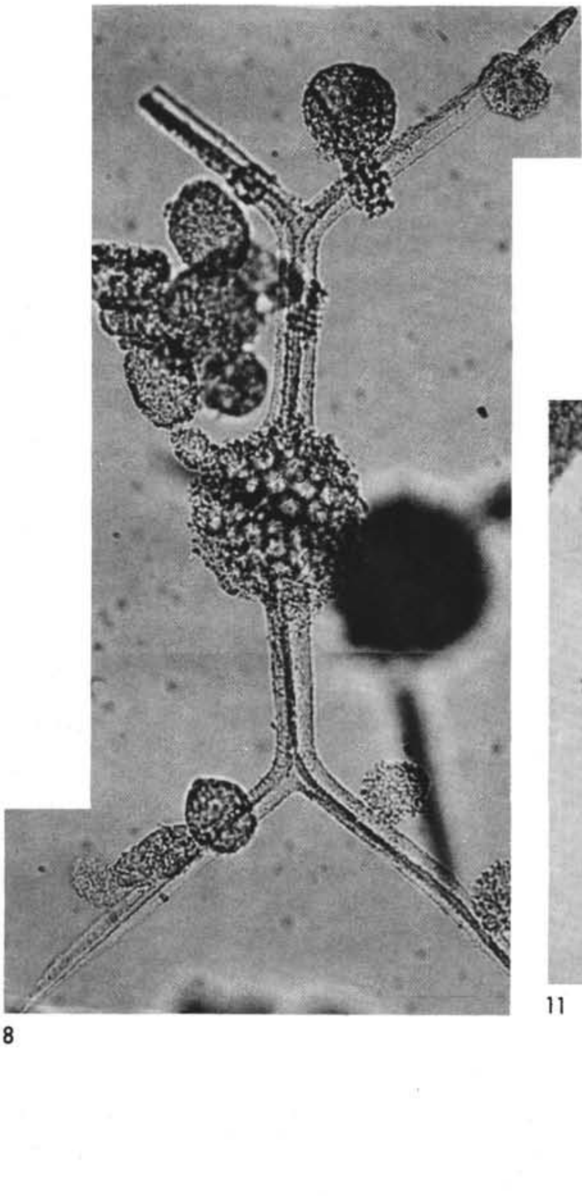

4


6

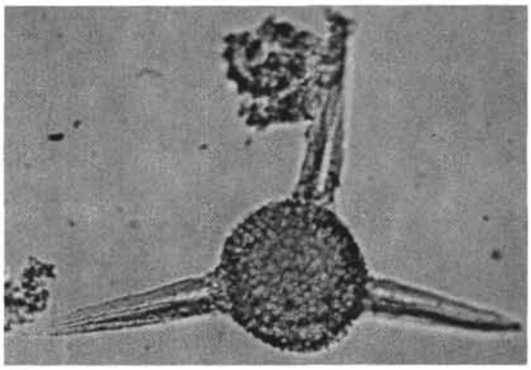

2


5

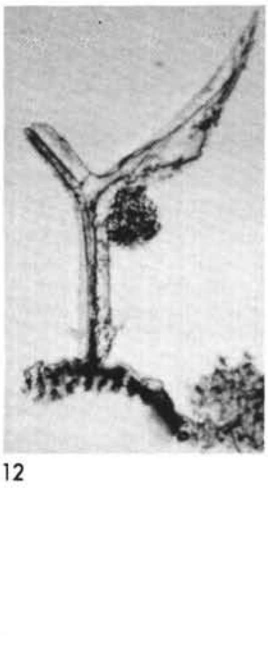

7


8


9


10


11


12

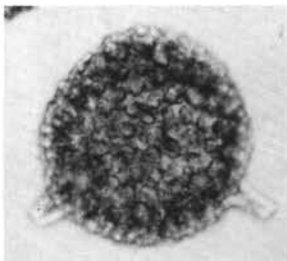

13

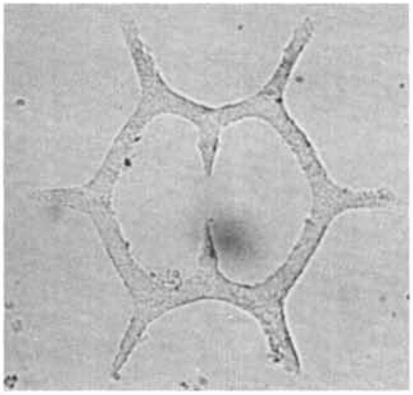
PLATE 4

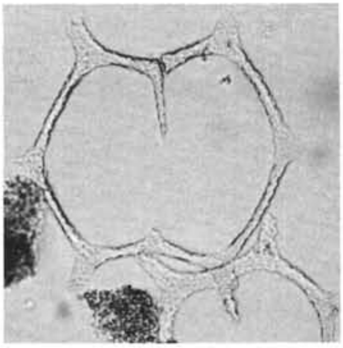
Cretaceous Radiolaria

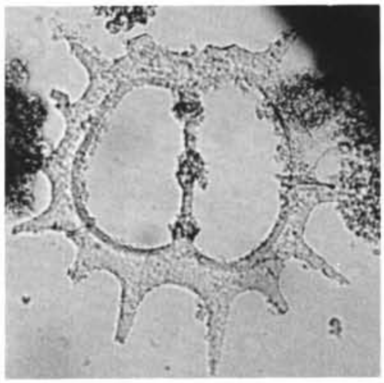
All figures magnified ×133

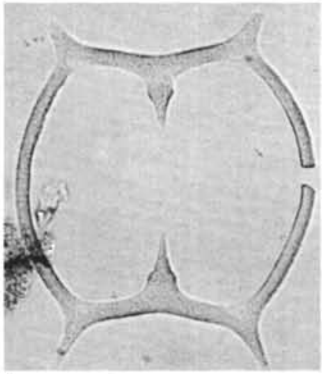
Figures 1, 2	*Spongosaturnalis* (?) *yaoi.* 1. 310A-10, CC. USNM 219345. L50/0. Holotype. 2. 310A-12, CC. USNM 219350. E52/0.
Figure 3	*Spongosaturnalis horridus.* 305-64-1, 148-150. USNM 219180. O11/3.
Figure 4	*Spongosaturnalis* (?) sp. cf. *S.* (?) *moorei.* 307-2, CC. USNM 219232. O28/0.
Figure 5	*Spongosaturnalis* (?) *eidalimus.* 310A-17, CC. Holotype. USNM 219372. K17/4.
Figure 6	*Spongosaturnalis squinaboli.* 310A-10, CC. Holotype. USNM 219346. V35/0.
Figure 7	*Spongosaturnalis* (?) *ichikawai.* 310A-11, CC. Holotype. USNM 219349. Q28/0.
Figure 8	*Spongosaturnalis* (?) *preclarus.* 310A-16, CC. Holotype. USNM 219369. K32/2.
Figure 9	*Spongosaturnalis* (?) *moorei.* 310A-10, CC. USNM 219347. F48/1. Holotype.
Figure 10	*Spongosaturnalis hueyi.* 310A-13, CC. cs. 1 mm S32/1.
Figure 11	*Trochodiscus exaspina.* 306-6-1, 116-118. USNM 219206. B36/0.
Figure 12	*Acanthocircus carinatus.* 307-6, CC (#5). fn. B Q43/0.

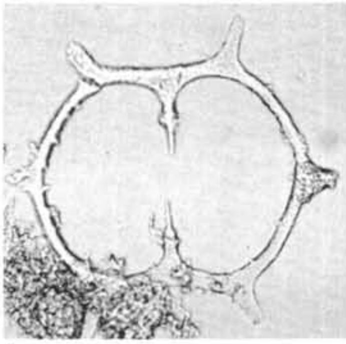
PLATE 4

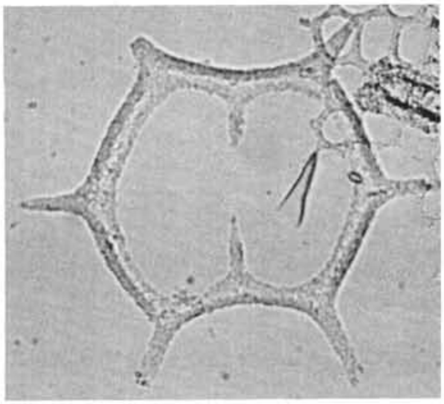

1

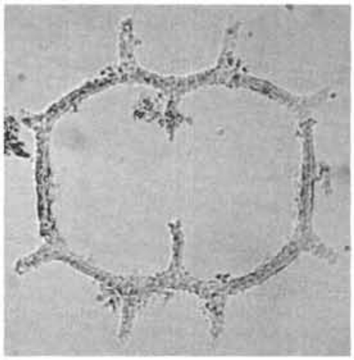

2

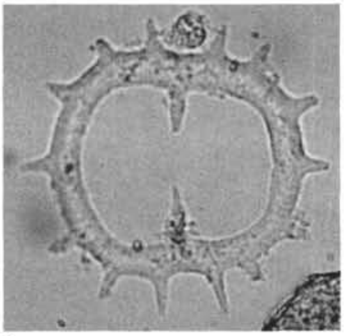

3

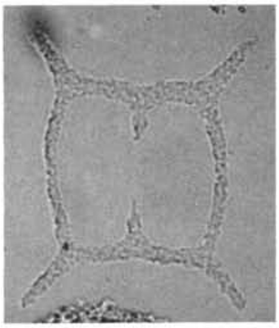

4

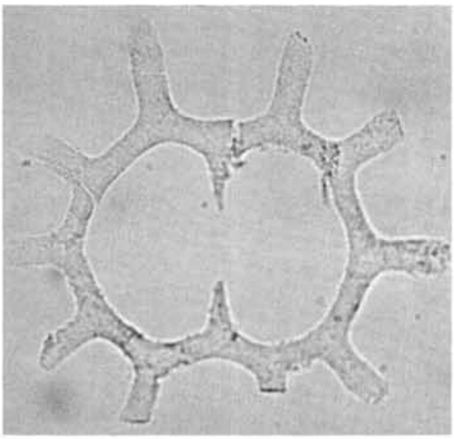

5

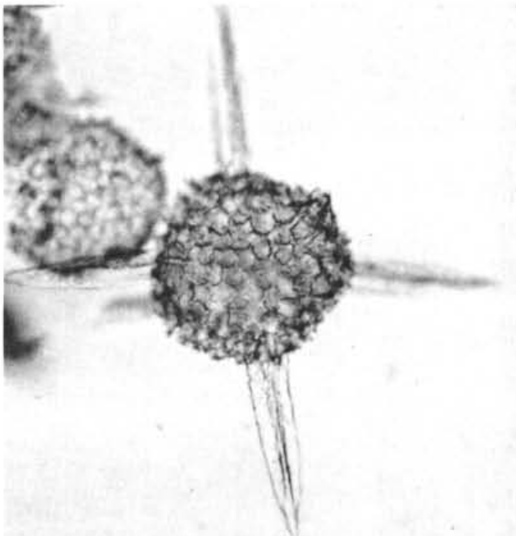

6


7


8


9


10


11

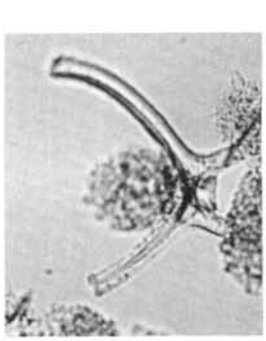

12

PLATE 5

Cretaceous Radiolaria

All figures magnified $\times 133$

Figure 1	*Crucella irwini.* 310A-13, CC. USNM 219365. W15/2.
Figure 2	*Crucella messinae.* 310A-16, CC. cs. 1 O35/1.
Figures 3, 7, 10	*Paronaella* (?) *hipposidericus.* 3. 305-66-1, 118-120. cs. 2 B22/2. 7. 307-7-1, 75-77. USNM 219240. W37/1. Holotype. 10. 305-64-1, 148-150. USNM 219181. T35/3.
Figures 4, 5	*Paronaella* (?) *diamphidia.* 4. 306-12-1, 60-62. USNM 219219. G42/3. 5. 306-42-1, 116-118. USNM 219230. D36/0.
Figure 6	*Crucella cachensis.* 310A-8, CC. USNM 219331. Q13/0.
Figure 8	*Pseudoaulophacus pargueraensis.* 310A-8, CC. USNM 219332. K38/3.
Figure 9	*Alievium praegallowayi.* 310A-13, CC. USNM 219360. B47/3.
Figure 11	*Alievium gallowayi.* 310A-13, CC. cs. 1 mm T40/2.
Figures 12, 13	*Emiluvia chica* 12. 306-41-1, 126-128. sl. 1 Q41/0. Cast. 13. 306-42-1, 116-118. USNM 219231. V16/4.
Figure 14	*Alievium* sp. 307-7-1, 75-77. cs. AA E38/1.

PLATE 5

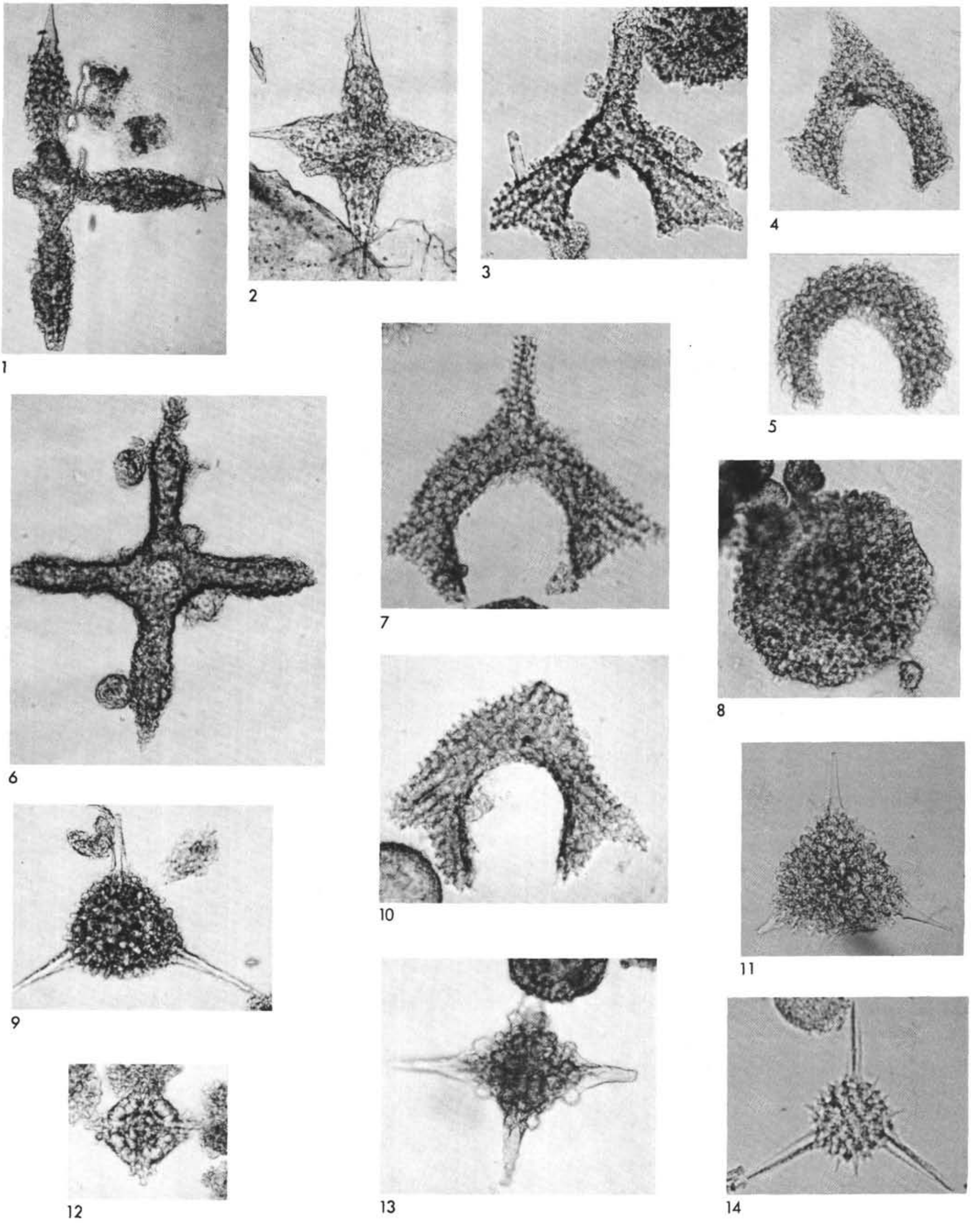


PLATE 6

Cretaceous Radiolaria

All figures magnified ×171, except figures 14 and 17, ×165

Figure 1	*Dictyomitra* (?) *lacrimula.* 307-7-1, 75-77. sl. D U47/1.
Figure 2	*Dictyomitra* sp. 307-9-1, 80-82. USNM 219279. R32/1.
Figure 3	*Lithomelissa petila.* 307-3-1, 126-128. USNM 219233. H25/4. Holotype.
Figure 4	*Theocampe salillum.* 310A-8, CC. USNM 219335. Y28/0.
Figure 5	*Artostrobium tina.* 310A-8, CC. USNM 219333. D14/4.
Figure 6	*Artostrobium urna.* 310A-8, CC. USNM 219336. Q23/4.
Figures 7-9	*Platycryphalus* spp. aff. *P. hirsuta.* 7. 306-6-1, 116-118. sl. A P30/2. 8. 306-8-1, 15-17. USNM 219208. M38/3. 9. 305-52, CC. fn. 1, U44/2.
Figure 10	*Clathropyrgus titthium.* 310A-8, CC. USNM 219337. D33/1.
Figure 11	*Diacanthocapsa communis.* 304-4, CC. USNM 219177. S47/4.
Figure 12	*Sethocapsa* (?) *orca.* 305-66-1, 118-120. USNM 219194. Q32/2. Holotype.
Figure 13	*Holocryptocanium barbui.* 304-4, CC. USNM 219178. M27/2.
Figure 14	*Sethocapsa cetia.* 306-41, CC. USNM 219223. G20/4.
Figure 15	*Podocapsa amphitreptera.* 306-41, CC. USNM 219224. B38/0. Cast.
Figure 16	*Dibolachras tytthopora.* 307-7-1, 75-77. cs. AA B13/0. Cast.
Figure 17	*Lithocampe mediodilatata.* 307-9-1, 80-82. USNM 219276. F30/2.

PLATE 6

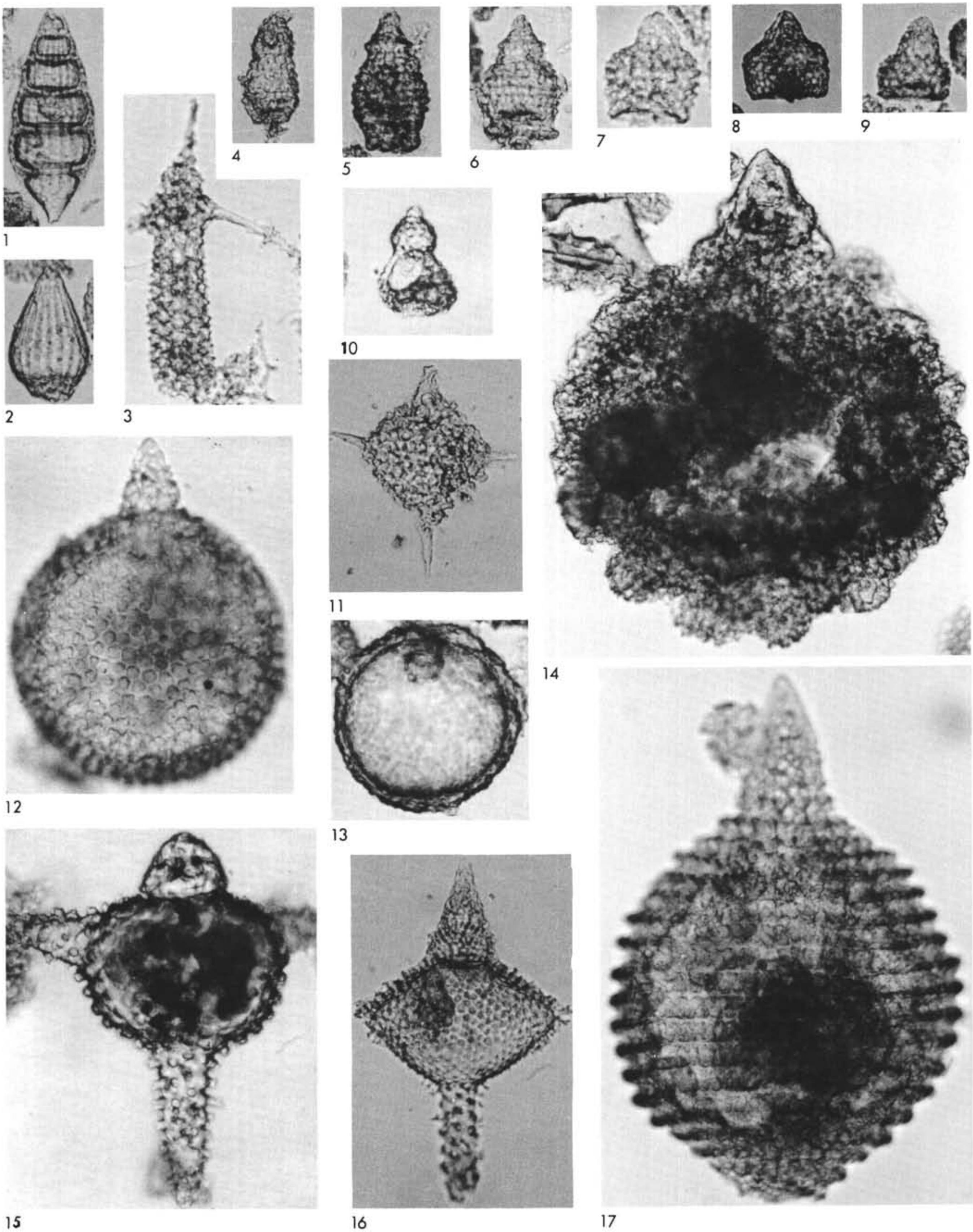


PLATE 7

Cretaceous Radiolaria

All figures magnified ×171, except Figure 5, ×165

Figure 1	*Dictyomitra cosmoconica.* 306-41, CC. USNM 219225. U33/3.
Figure 2	*Dictyomitra alievi.* 196-4-1 (#3). USNM 219173. Q29/0.
Figure 3	*Podobursa tetracola.* 307-9-1, 80-82. USNM 219277. L47/0.
Figure 4	*Dictyomitra koslovae.* 310A-8, CC. USNM 219338. K22/3.
Figure 5	*Stichocapsa* (?) *rotunda.* 306-41, CC. USNM 219226. J19/1.
Figures 6, 7	*Dictyomitra carpatica* (?). 6. 306-10-1, 124-125. cs. R P43/0. Late form. 7. 306-42-1, 105-107. USNM 219228. E20/0. Early form.
Figure 8	*Dictyomitra duodecimcostata.* 310A-10, CC. USNM 219348. T37/4.
Figure 9	*Dictyomitra boesii.* 306-41-1, 126-128. sl. 1 O49/4.
Figure 10	*Dictyomitra pseudomacrocephala.* 305-46, CC. USNM 219179. F17/1.
Figures 11-13	*Dictyomitra somphedia.* 11. 306-2, CC. USNM 219195. V24/2. 12. 306-3, CC. sl. 2 R19/0. 13. 306-3, CC. USNM 219196. Q22/0.

PLATE 7

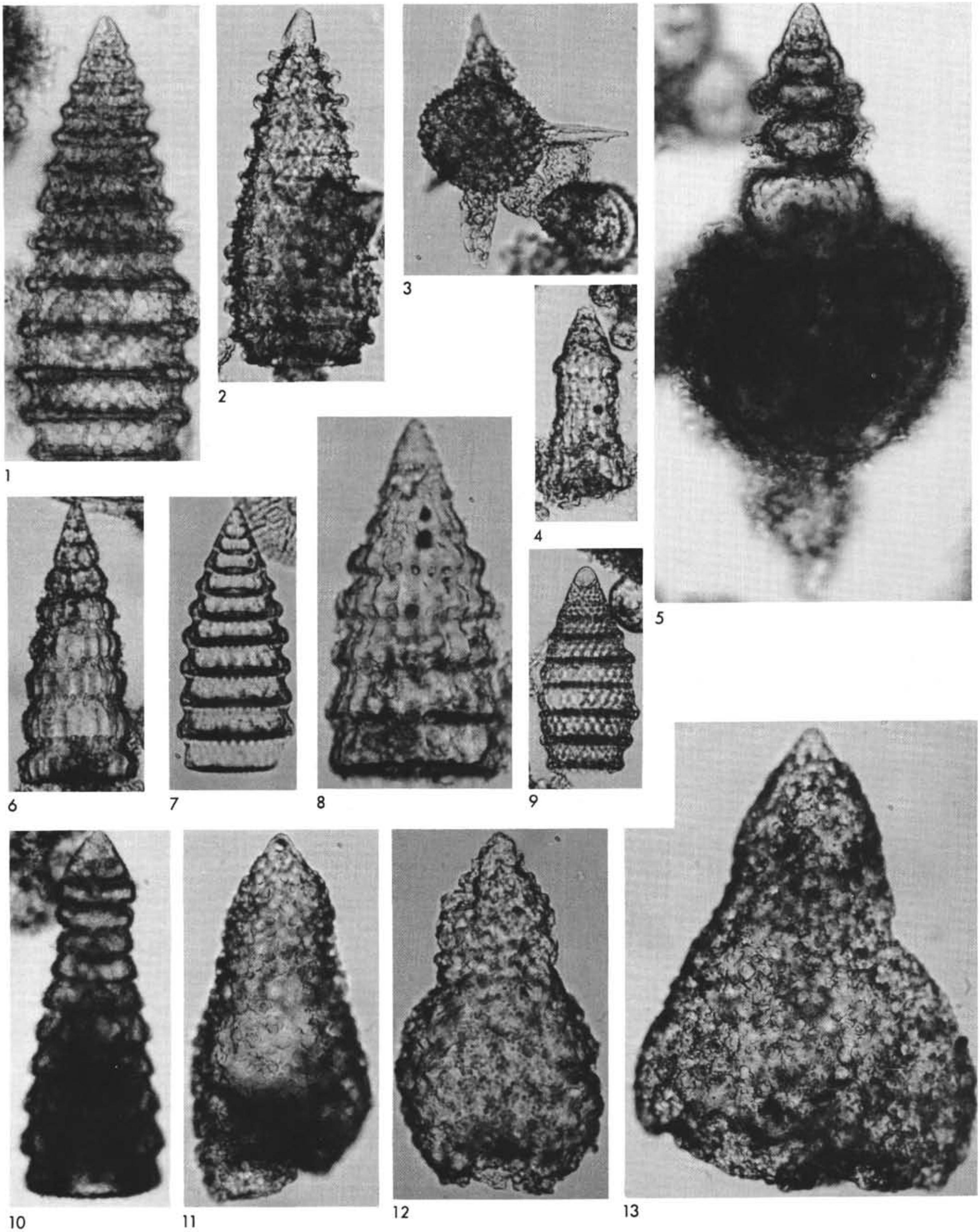


PLATE 8

Neogene Radiolaria

All figures magnified ×171

Figures 1, 2	*Dendrospyris bursa.* 1. 310-8-6, 100-102. USNM 219316. O16/4. 2. 310-8-6, 100-102. USNM 219317. C24/2.
Figure 3	*Ommatartus hughesi.* 310-9-1, 120-123. USNM 219324. N42/4.
Figure 4	*Cannartus laticonus.* 304-2-1, 80-82. USNM 219174. E 28/1.
Figures 5, 6	*Cyclampterium* (?) sp. 5. 310-8-6, 100-102. USNM 219318. U21/1. 6. 310-8-6, 100-102. USNM 219319. Q23/3.
Figure 7	*Cyrtocapsella japonica.* 304-2-1, 80-82. USNM 219175. W30/3.
Figure 8	*Cyrtocapsella cornuta.* 304-2-1, 80-82. USNM 219176. F46/1.
Figures 9-12	*Ommatartus* sp. cf. *Cannartus bassanii.* 9. 310-9-1, 120-123. USNM 219325. C34/3. 10. 310-9-1, 120-123. USNM 219326. P12/4. 11. 310-8-6, 100-102. USNM 219320. Q38/0. 12. 310-8-5, 125-127. USNM 219305. E43/0.
Figures 13, 14	*Ommatartus antepenultimus.* 13. 310-9-1, 120-123. USNM 219327. C14/1. 14. 310-8-6, 100-102. USNM 219321. N44/0.
Figures 15, 16	*Ommatartus penultimus.* 15. 310-8-5, 125-127. USNM 219306. L20/1. 16. 310-8-5, 125-127. USNM 219307. M19/2.
Figures 17, 18	*Ommatartus* sp. 17. 310-8-1, 125-127. USNM 219304. R30/1. 18. 310-7-3, 125-127. USNM 219300. C33/0.
Figure 19	*Ommatartus tetrathalamus.* 310-3-1, 130-132. USNM 219286. X30/0.
Figures 20-23	*Ommatartus* sp. A. 20. 310-9-1, 120-123. USNM 219328. V20/4. 21. 310-9-1, 120-123. USNM 219329. C26/0. 22. 310-8-6, 100-102. USNM 219322. B35/0. 23. 310-8-5, 125-127. USNM 219308. E18/1.
Figures 24, 25	*Ommatartus* sp. B. 24. 310-9-1, 120-123. USNM 219330. U33/1. 25. 310-8-5, 125-127. USNM 219309. H25/4.

PLATE 8

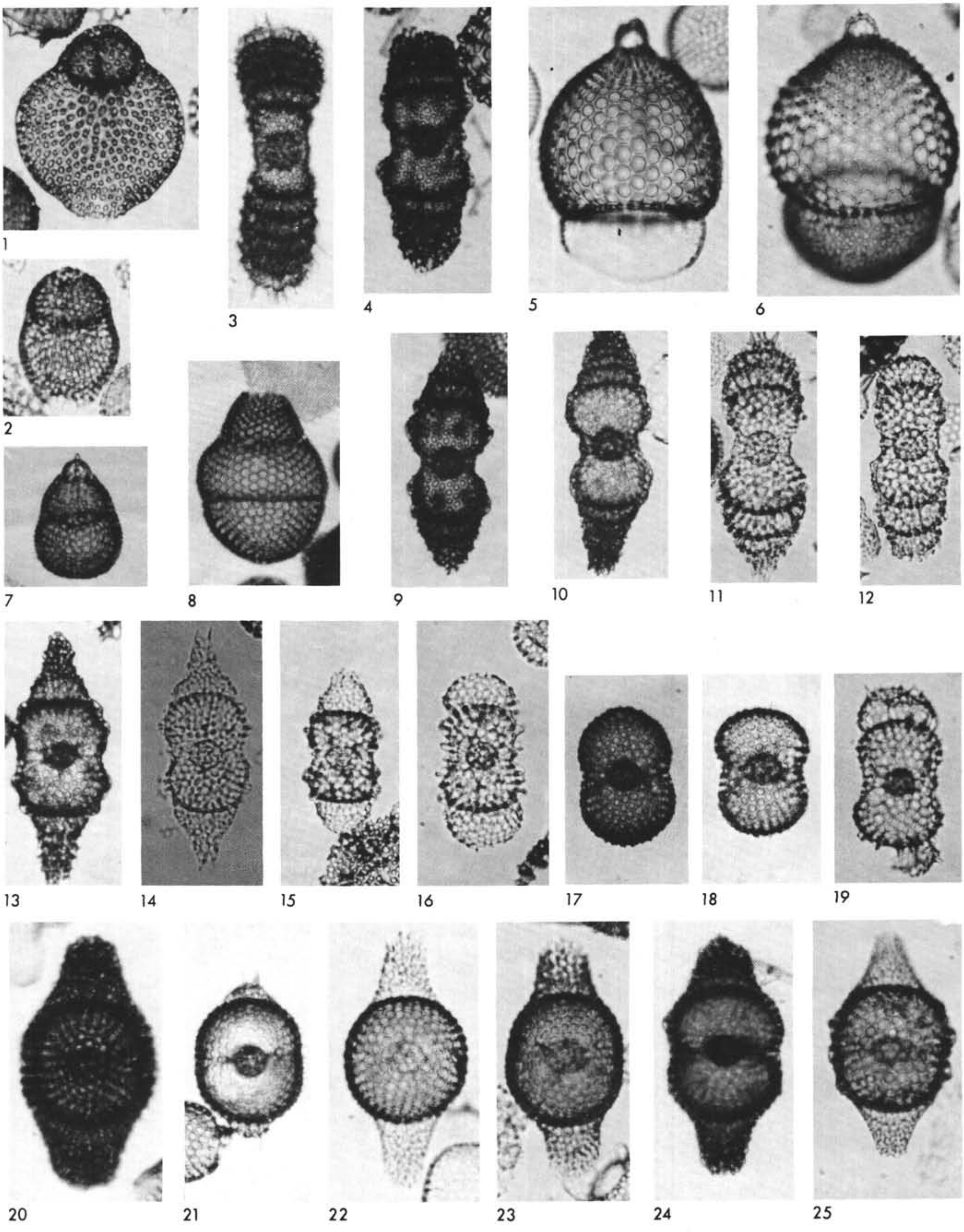


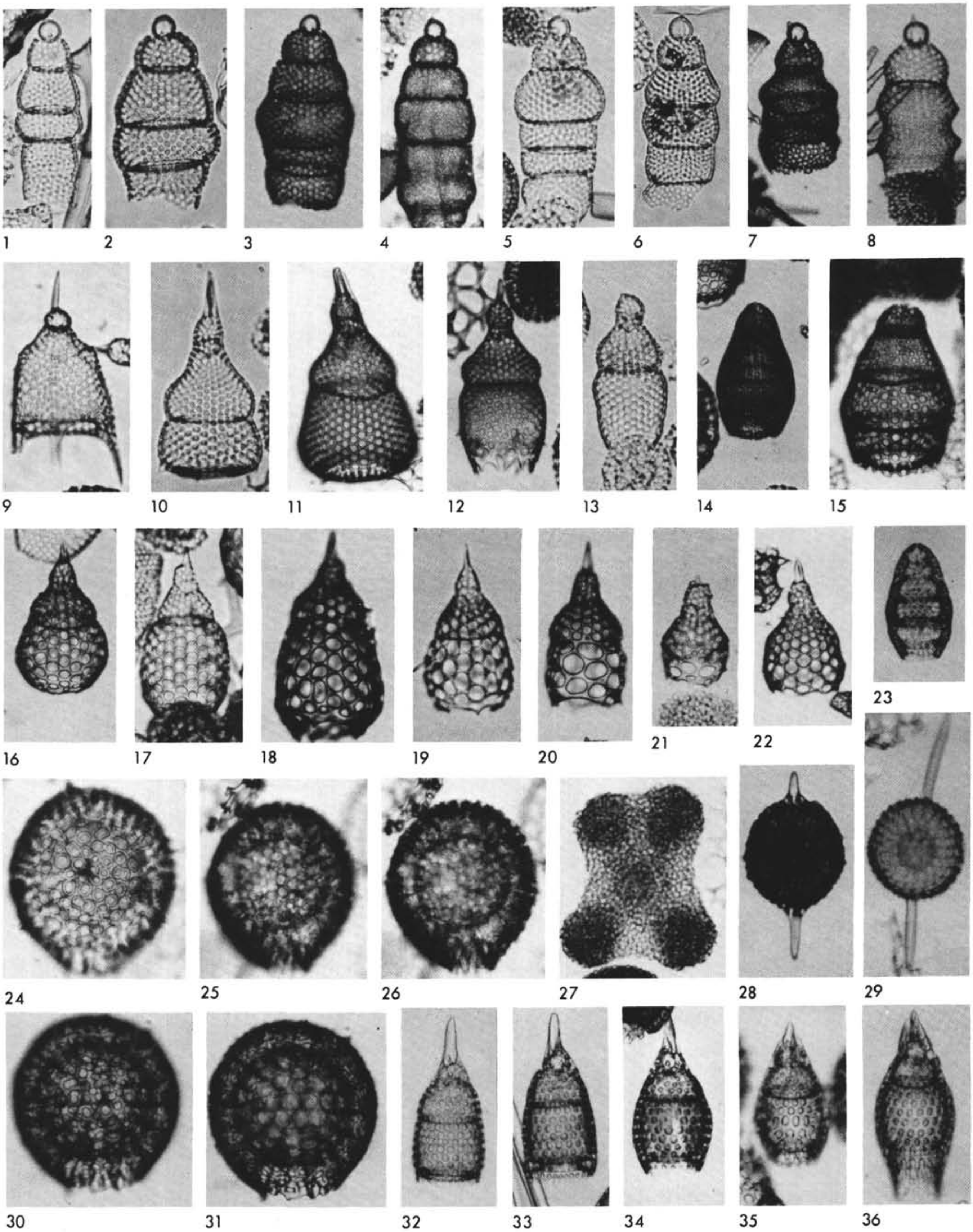
PLATE 9

Neogene and Paleogene Radiolaria

All magnifications ×171, except Figures 30-34, ×212

Figures 1-4	*Stichocorys peregrina.* 1. 310-8-5, 125-127. USNM 219310. N40/3. 2. 310-8-5, 125-127. USNM 219311. C17/1. 3. 310-6, CC. USNM 219296. F36/0. 4. 310-6-5, 138-141. USNM 219293. E31/2.
Figures 5-7	*Stichocorys delmontensis.* 5. 310-8-5, 125-127. USNM 219312. P37/4. 6. 310-8-5, 125-127. USNM 219313. Q12/2. 7. 310-6-5, 138-14-1. USNM 219294. M38/0.
Figure 8	*Theocorys* sp. 310-8, CC. USNM 219323. J29/0.
Figure 9	*Pterocanium prismatium.* 310-6-5, 138-141. USNM 219295. Q23/2.
Figure 10	*Theocorythium* sp. aff. *T. vetulum.* 310-8-5, 125-127. USNM 219314. M38/3.
Figure 11	*Theocorythium vetulum.* 310-3-4, 130-132. USNM 219288. D18/0.
Figure 12	*Theocorythium trachelium trachelium.* 310-3-4, 130-132. USNM 219289. H14/2.
Figure 13	*Theocorythium trachelium dianae.* 310-1-3, 110-112. USNM 219280. V37/4.
Figure 14	*Eucyrtidium calvertense.* 310-6, CC. USNM 219297. S42/0.
Figure 15	*Eucyrtidium matuyamai.* 310-3-4, 130-132. USNM 219290. F41/3.
Figure 16	*Lamprocyrtis margatensis.* 310-7-3, 125-127. USNM 219301. V40/1.
Figures 17-19	*Lamprocyrtis hannai.* 17. 310-7-5, 124-126. USNM 219303. L10/0. 18. 310-7-1, 133-136. USNM 219299. V29/0. 19. 310-1-3, 110-112. USNM 219281. K33/1.
Figure 20	*Lamprocyrtis heteroporos.* 310-3-4, 130-132. USNM 219291. W33/3.
Figure 21	*Lamprocyrtis neoheteroporos.* 310-3-1, 130-132. USNM 219287. S29/4.
Figure 22	*Lamprocyrtis haysi.* 310-1-3, 110-112. USNM 219282. T5/0.
Figure 23	*Artostrobium tumidulum.* 310-1-3, 110-112. USNM 219283. X10/1.
Figures 24-26	*Sphaeropyle robusta.* 24. 310-8-5, 125-127. USNM 219315. B22/4. 25. 310-7-3, 125-127. USNM 219302. C38/2, external view. 26. 310-7-3, 125-127. USNM 219302. C38/2, internal view.
Figure 27	*Spongaster tetras irregularis.* 310-1-3, 110-112. USNM 219284. B30/2.
Figures 28, 29	*Axoprunum angelinum.* 28. 310-3-4, 130-132. USNM 219292. W41/4. 29. 310-1-3, 110-112. USNM 219285. L22/3.
Figures 30, 31	*Sphaeropyle langii.* 30. 310-6, CC. USNM 219298. F13/3, external view. 31. 310-6, CC. USNM 219298. F13/3, internal view.
Figures 32-34	*Pterocodon* (?) *anteclinata.* 32. 313-13, CC. USNM 219377. N29/4. Holotype. 33. 313-12, CC. USNM 219376. L14/3. 34. 313-12-1, 128-131. USNM 219375. E28/0.
Figures 35, 36	*Buryella clinata.* 35. 313-12-1, 128-131. USNM 219374. D52/4. 36. 313-9-1, 123-125. USNM 219373. F18/0.

PLATE 9



INDEX OF RADIOLARIAN NAMES

Only radiolarian genera and species group taxa are indexed. The main entry and illustration are given in boldface type.