32. CENOZOIC RADIOLARIA FROM THE WESTERN TROPICAL PACIFIC, LEG 7

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CONTENTS

1. INTRODUCTION

All of the drilling-sites of Leg 7 of the Deep-Sea Drilling expedition yielded radiolarians. Their localities are the following:

Site 61; 12°05.8'N, 147°03.9'E; water depth 5562 meters.

Site 62; 1°52.2'N, 141°56.3'E; water depth 2591 meters.

Site 63; 0°50.16'N, 147°53.25'E; water depth 4472 meters.

Site 64; 1°44.5'N, 158°36.51'E; water depth 2052 meters.

Site 65; 4°21.21'N, 176°59.16'E; water depth 6130 meters.

Site 66; 2°23.63'N, 166°07.28'W; water depth 5293 meters.

Site 67; 24°22.52'N, 157°39.05'W; water depth 4473 meters.

Cretaceous radiolarians (not included here because they are treated in a separate chapter by H. P. Foreman) were encountered at Sites 61 and 66, Upper Paleocene or Lower Eocene radiolarians at Site 67, Middle to Upper Eocene at Sites 64 and 65, Oligocene at Sites 64, 65 and possibly 66, and Neogene at Sites 61 through 66. The Miocene parts of these sequences produced radiolarian results of the most fundamental significance —the continuously cored sequences provided a firmer basis for the zonation that had previously been based on scattered, short piston cores (Riedel and Sanfilippo, in press), and for correlation of the radiolarian zonation with the foraminiferal and calcareous nannofossil zonations. The Pliocene and Quaternary parts of the sequences were less satisfactory for these purposes because of the scarcity and poor preservation of radiolarians, and the older parts of the sequences were cored only intermittently.

Aboard the drilling vessel, samples for radiolarian investigation were taken at more or less fixed intervals in the cores. It soon became apparent that rates of accumulation at the different sites differed markedly, and that the samples were correspondingly unequally spaced through time. For this reason, some of the samples from the more rapidly accumulated sequences (at Sites 62 and 64, particularly) have not been investigated for this report.

Some of the samples prepared for radiolarian investigation yielded a sufficient number of skeletons to permit the separation of forms larger than 150 microns onto additional slides, after preparation of the regular slides bearing forms larger than 62 microns. These coarse preparations have proven especially useful for the investigation of some large and rare forms of considerable taxonomic and stratigraphic significance.

2. "MORPHOTYPIC" AND "EVOLUTIONARY" LIMITS OF SPECIES

In the course of an investigation such as that reported here, it is possible to define the limits of species in two fundamentally different ways, which we shall term "morphotypic" and "evolutionary". Morphotypic limits must be used when the evolutionary development of a species is not known, whereas when the phylogeny is known evolutionary limits may be applied.

To explain the difference between these two types of limits, Figure 1 illustrates the situation faced by a paleontologist who wishes to divide a series of continuously evolving forms (A→B→C→D→E) into five species. In the tabulation of these successively younger forms in a series of successively younger assemblages, C indicates "common", F "few" and R "rare". The evolutionary change from A to E is clearly indicated by the drift of the C's across the tabulation from lower left to upper right. Morphological characters change continuously with time, and intraspecific variation is such that the dominant form in any assemblage is accompanied by fewer specimens morphologically identical with its ancestor(s) and descendant(s). The ranges of the morphotypes are long, and overlap one another to a considerable extent.

It would be possible to define the five morphotypes as separate species, but it seems more "biologically correct" to classify each population rather than each specimen, and to define the species in such a way that their ranges are contiguous but not overlapping. This requires a statistical definition of the range of variation of the morphological characters, and the resulting limits of the time-ranges of species are of the type here termed "evolutionary". In those cases in which we have plotted the upper or lower limit of a species as "evolutionary" (such as in Figure 1, Table 6 and Figure 2), we have used the level at which more than half of the individuals in the population have the character(s) that distinguishes the species from its ancestor or descendant.

3. SCOPE OF INVESTIGATION AND PRESENTATION OF RESULTS

In addition to our primary objective of determining the occurrences of forms previously known to be stratigraphically useful, we have also made a general survey of some families and selected some species for additional investigation. Simultaneously with determining the ranges of stratigraphically useful forms, a type of illustrated history of a larger number of late Eocene to Quaternary radiolarians has been produced, and is presented in Plates 1 through 3 as a synchronopticon. The arrangement of the illustrations in the synchronopticon is such that by scanning the plates horizontally an impression can be gained of the prominent forms in assemblages of a given age, and changes in a group

Successively younger samples ↑	Successively younger forms → A	B	C	D	E
Spl. 11				R	C
Spl. 10			R	F	C
Spl. 9			R	C	F
Spl. 8			F	C	F
Spl. 7		R	F	C	R
Spl. 6		R	C	F	R
Spl. 5		R	C	F	R
Spl. 4	R	F	C	R	
Spl. 3	R	C	F	R	
Spl. 2	F	C	F	R	
Spl. 1	C	F	R		

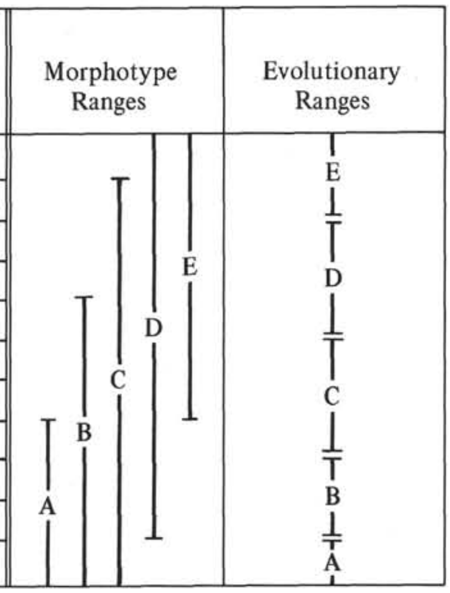

Figure 1. *For explanation see text, Section 2.*

through time are indicated vertically. Each horizontal row of illustrations is labeled to indicate the zone to which the assemblage belongs, but some zones are not represented because of the spacing of samples through the section.

The number of forms illustrated, or briefly mentioned in discussions, is much greater than the number that could be treated exhaustively in the time available for the preparation of this report. Consequently, there is a considerable range in the thoroughness with which the various taxa are treated. Some are merely mentioned in passing, and illustrated by one or a few figures in the synchronopticon, fewer have been investigated sufficiently to permit tabulation of their occurrences at each drilling site (Tables 1 through 5), and most but not all of these have their ranges plotted on a summary range-chart (Figure 2).

Table 6, in which the upper and lower limits of taxa are tabulated and which represents an intermediate step between Tables 1 through 5 and Figure 2, serves also to indicate levels of correlation between Sites 62 through 66. Since it is advantageous for some purposes to have taxa ordered systematically and for other purposes to have them ordered stratigraphically, a systematic arrangement of families (and an alphabetical arrangement within families) is used in Tables 1 through 5, and a stratigraphic arrangement is used in Table 6 and Figure 2.

In these various presentations, we have made a distinction between "evolutionary" and "morphotypic" limits of species, as discussed in Section 2. In general, occurrences recorded on Tables 1 through 5 are on the basis of morphology alone, and their limits are thus "morphotypic", but on the range-chart we have attempted to define limits evolutionary wherever possible–"m" is used to denote morphotypic limits, and "e" to denote evolutionary limits and extinctions.

In the tabulations we have abbreviated the names of certain taxa–their full and correct form is given in the Systematic Section.

4. RADIOLARIANS AT EACH SITE

In this section, the information on occurrences of radiolarians is tabulated for those sites at which significant sequences were recovered (Sites 62 through 66), and given in the text for those sites at which isolated samples were obtained (Sites 61 and 67). In the second column of Tables 1 through 5, the abundance and preservation of radiolarians are indicated for each sample examined: the letters A, C, F and R indicate that radiolarians in the sample are abundant, common, few or rare, respectively; and G, M and P indicate that their preservation is good, moderate or poor, respectively. Preservation which is less than good is always the result of partial dissolution of the skeletons.

In the body of the tables, the letters A, C, F and R indicate the abundance of each species, and a dash is used to indicate absence of a species from a sample in which it was searched for. A positive (+) sign is used to indicate that one or two specimens were found on a single strewn-slide, and an "R" is used when from three to about five specimens were found. "A" is used only for exceptionally abundant occurrences, "C" for common occurrences, and "F" for few specimens (intermediate between C and R).

4a. Site 61

In addition to the Cretaceous radiolarians at this site described in the chapter by H. P. Foreman, the sample from a depth of about 80 meters (61.0-1-CC) contains a well-preserved, diverse assemblage assignable to the *Calocycletta costata* Zone, including *Cannartus mammiferus* (rare), *C. violina* (rare), *Dorcadospyris dentata* (rare), *Cyclampterium leptetrum* (rare), *Cyrtocapsella cornuta* (few), *Lithopera renzae* (rare), *Stichocorys armata* (rare), *S. diploconus* (rare), *S. wolffii* (common), *Carpocanopsis bramlettei* (rare), *C. cingulatum* (rare), *C. favosum* (rare), *Calocycletta costata* (few), *C. virginis* (few) and *Phormostichoartus corona* (rare). No Eocene or Oligocene forms were found admixed in this sample.

4b. Site 62 (with Table 1)

Radiolarians are generally scarce and rather poorly preserved in the upper 200 meters of the section (down to 62.1-21), more common and better preserved to about 350 meters (62.1-37), then again rare and poorly preserved at about 355 meters (62.1-38), absent at about 360 meters (62.1-39), common and moderately well-preserved at about 400 meters and 495 meters (62.0-4 and 62.0-5), and absent in deeper samples.

Within the upper 200 meters, the only zonal boundary that can be recognized, indistinctly, is the base of the *Spongaster pentas* Zone at about 123 to 126 meters (between 62.1-13-3 and 63.1-13-5). The base of the *Stichocorys peregrina* Zone is at 202 to 204 meters (between 62.1-21-5 and 62.1-21-CC); the base of the *Ommatartus penultimus* Zone is at 225 to 227 meters (between 62.1-23-CC and 62.1-24-2); the base of the *Ommatartus antepenultimus* Zone is at 290 to 298 meters (between 62.1-30-CC and 62.1-31-5); the base of the *Cannartus* (?) *petterssoni* Zone is at 329 to 334 meters (between 62.1-35-2 and 62.1-35-5); the base of the *Dorcadospyris alata* Zone is at 350 to 396 meters (between 62.1-37 and 62.0-4); the base of the *Calocycletta costata* Zone is at 404 to 492 meters (between 62.0-4-CC and 62.0-5-2); and the base of the *Calocycletta virginis* Zone is below 499 meters (below 62.0-5-CC).

No reworked older radiolarians were found in any samples from this site.

4c. Site 63 (with Table 2)

Radiolarians are only moderately common, and sometimes poorly preserved, in the continuously cored section from the sea floor to 41 meters (63.0-1, 63.1-1 to 63.1-4, and 63.2-1 to 63.2-3). From 62 to 361 meters (63.0-2 to 63.0-5, and 63.1-5 to 63.1-14) they are common to abundant, and generally well-preserved; none are present in the deeper samples.

Recognition of radiolarian zones in the upper part of the section is difficult, but it appears that the top of the *Pterocanium prismatium* Zone may be at about 4 to 7 meters (between 63.1-1-1 and 63.1-1-3); the base of the *P. prismatium* Zone may be at about 22 to 23 meters (between 63.1-2-CC and 63.1-3-1); the base of the *Spongaster pentas* Zone is at 31 to 35 meters (between 63.2-3-1 and 63.2-3-4); and, the base of the *Stichocorys peregrina* Zone is at 39 to 63 meters (between 63.2-3-CC and 63.0-2-2). Older zonal boundaries can be recognized more confidently: the base of the *Ommatartus penultimus* Zone is at 66 to 69 meters (between 63.0-2-4 and 63.0-2-6); the base of the *Ommatartus antepenultimus* Zone is at 102 to 105 meters (between 63.1-5-1 and 63.1-5-3); the base of the *Cannartus* (?) *petterssoni* Zone is at 131 to 134 meters (between 63.1-8-2 and 63.1-8-4); the base of the *Dorcadospyris alata* Zone is at 149 to 152 meters (between 63.1-10-1 and 63.1-10-3); the base of the *Calocycletta costata* Zone is at 183 to 185 meters (between 63.1-13-CC and 63.1-14-1); and, the base of the *Calocycletta virginis* Zone and the entire *Lychnocanium bipes* Zone are in the interval 239 to 353 meters (between 63.0-4 and 63.0-5). The lowest radiolarian core (63.0-5), at about 350 to 360 meters, is in the *Dorcadospyris ateuchus* Zone.

Practically no reworked older radiolarians were observed in the samples examined from this site.

4d. Site 64 (with Table 3)

Radiolarians are common and fairly well-preserved in all cores taken at this site, except in the bottom of the section (64.1-11) at about 980 meters below the sea floor, where they are altered and partly dissolved.

The assemblage in the surface core (64.0-1) is Quaternary; those at about 100 meters (64.0-2) are in the *Spongaster pentas* Zone; those at about 205 meters (64.0-3) are in the *Ommatartus antepenultimus* Zone; those at about 305 meters (64.0-4) are in the *Cannartus* (?) *petterssoni* Zone; and those from about 410 to 437 meters (64.0-5 and upper part of 64.1-1) are in the *Dorcadospyris alata* Zone. The continuously cored section from 437 to 479 meters (lower part of 64.1-1 through 64.1-5) is in the *Calocycletta costata* Zone. The assemblages at about 510, 570 and 615 meters (64.0-6, 64.1-6 and 64.0-7) are in the *Calocycletta virginis* Zone; those at about 665 meters (64.1-7) are in the *Lychnocanium bipes* Zone; those at about 710, 750 and 775 meters (64.0-8, 64.1-8 and 64.0-9) are in the *Dorcadospyris ateuchus* Zone; those at about 850 meters (upper part of 64.0-10) are in the *Theocyrtis tuberosa* Zone; those at about 851 and 915 meters (lower part of 64.0-10 and 64.1-9) are in the upper part of the *Thyrsocyrtis bromia* Zone; and those at about 970 and possibly 984 meters (64.1-10 and possibly 64.1-11) are in the *Podocyrtis mitra* Zone.

There is probably a hiatus or a compressed section between 915 and 970 meters, because the 55-meter interval between Cores 64.1-9 and 64.1-10 seems too short to accommodate the lower part of the *Thyrsocyrtis bromia* Zone, the *Thyrsocyrtis tetracantha* Zone and the *Podocyrtis chalara* Zone.

4e. Site 65 (with Table 4)

Radiolarians are abundant and well-preserved in all cores from the sea floor to a depth of about 168 meters (65.1-5), but reworked forms of ages back to Middle Eocene are common throughout and hamper interpretation of the sequence. The sample recovered at about 180 meters (65.1-7) was too small for radiolarian separation, and the sample at about 186 meters (65.1-8) contains rather few, poorly preserved radiolarians of approximately the same age as those in 65.1-5-CC. Lumps of semiconsolidated sediment at about 135 meters (65.1-1) contain rare, altered radiolarians of probably Cretaceous age.

Because of the ubiquitous reworking, interpretation of the sequence depends upon the lower limits only of the ranges of taxa, and some zonal boundaries are not clear. The base of the *Spongaster pentas* Zone is probably at 19 to 21 meters (between 65.0-2 and 65.0-3); the base of the *Stichocorys peregrina* Zone is at 42 to 45 meters (between 65.0-5-4 and 65.0-5-6); the base of the *Ommatartus antepenultimus* Zone is at 57 to 60 meters (between 65.0-7-2 and 65.0-7-4; the base of the *Cannartus* (?) *petterssoni* Zone is at 60 to 68 meters (between 65.0-7-4 and 65.0-8-3); the base of the *Calocycletta costata* Zone is at 73 to 75 meters (between 65.0-8 and 65.0-9); the base of the *Calocycletta virginis* Zone is at 101 to 102 meters (between 65.0-11 and 65.0-12); the base of the *Lychnocanium bipes* Zone is at about 106 meters (within 65.0-12-4); the base of the *Dorcadospyris ateuchus* Zone is at 112 to 114 meters (between 65.0-13-2 and 65.0-13-3); the base of the *Theocyrtis tuberosa* Zone is at 126 to 128 meters (between 65.0-14-5 and 65.0-14-CC); the base of the *Thyrsocyrtis bromia* Zone is at about 145 meters (between 65.1-2-1 and 65.0-16-CC); the base of the *Thyrsocyrtis tetracantha* Zone is at 145 to 154 meters (between 65.1-2-1 and 65.1-2-CC); and the base of the *Podocyrtis chalara* Zone is below about 168 meters (65.1-5-CC).

At this site, the *Dorcadospyris alata* Zone can be no more than 5 meters thick (between 65.0-7-4 and 65.0-8-1, at 60 to 65 meters), and may be missing altogether, whereas at Site 62 it occupies at least 16 meters, and at both Site 63 and Site 66 it occupies approximately 20 meters.

4f. Site 66 (with Table 5)

Radiolarians are abundant in all cores to a depth of 126 meters below the sea floor (66.0-3), and are well preserved in all samples except those from the lower few meters which are somewhat corroded. Samples below this are barren of radiolarians to a depth of about 190 meters, where a Cretaceous assemblage was encountered in 66.0-9 (see chapter by H. P. Foreman in this volume).

The continuously cored section from about 16 to 88 meters below the sea floor (66.0-1 to 66.0-2 and 66.1-8) may represent a continuous section from early Quaternary to the upper part of the *Calocycletta costata* Zone. The base of the Quaternary is at 21 to 24 meters (between 66.1-2-1 and 66.1-2-3); the base of the *Pterocanium prismatium* Zone is at 24 to 27 meters (between 66.1-2-3 and 66.1-2-5); the base of the *Spongaster pentas* Zone is at 29 to 30 meters (between 66.1-2-CC and 66.1-3-1); the *Stichocorys peregrina* Zone is indistinct and apparently short at about 39 meters (bottom of 66.1-3-CC and/or top of 66.1-4-1); the base of the *Ommatartus antepenultimus* Zone is at 56 to 61 meters (between 66.1-5-CC and 66.1-6-4); the base of the *Cannartus* (?) *petterssoni* Zone is at 65 to 68 meters (between 66.1-6-CC and 66.1-7-1); and the base of the *Dorcadospyris alata* Zone is at 85 to 88 meters (between 66.1-8-CC and 66.0-2-CC). The base of the *Calocycletta costata* Zone is in the uncored interval between 88 and 118 meters (66.0-2-CC to 66.1-3-1), and the base of the *Calocycletta virginis* Zone is at about 121 to 122 meters (between 66.0-3-3 and 66.0-3-4).

There are a few reworked Miocene radiolarians at some levels in the Quaternary and late Miocene parts of the section, and Core 66.0-3 contains rare Eocene forms.

4g. Site 67

The only radiolarian found in the surface core (67.0-1) was a single specimen, apparently reworked, of the Lower to Middle Eocene form *Thyrsocyrtis hirsuta hirsuta.* Core 67.1-1, from about 23 meters, contains no radiolarians, but the sample from about 59 meters (67.1-2-CC) contains a sufficient number to permit an age determination.

In addition to the diverse, rather well-preserved Paleogene assemblage, the radiolarian preparations from 67.1-2-CC contain many well-formed, twinned zeolites and ferromanganese micronodules, and much fish skeletal debris. This association suggests an artificial admixture of a non-radiolarian zeolitic clay with a radiolarian ooze, which could be caused by caving from the sides of the drill-hole. A few well-preserved Quaternary radiolarians occur together with the Paleogene forms, but there appears to be no admixture of forms of intermediate age. Thus, the radiolarian assemblage in this sample may be used as an indication of the age of a level somewhere between Core 67.1-1 and 67.1-2-CC.

TABLE 1A
Radiolarians at Site 62

Samples	Radiolarian Abundance and Preservation	*Solenosphaera omnitubus*	*Cannartus laticonus*	*C. mammiferus*	*C. (?) petterssoni*	*C. prismaticus*	*C. tubarius*	*C. violina*	*Ommatartus antepenultimus*	*O. avitus*	*O. hughesi*	*O. penultimus*	*O. tetrathalamus*	*Lithocyclia angustum*	*L. aristotelis* group	*L. ocellus* group	*Dictyocoryne ontongensis*	*Spongaster klingi*	*S. pentas*	*S. tetras*
62.1-1-2, 84-85	F, G									–		–								
62.1-1-3, 84-86	R, M																			
62.1-1-CC	F, P																			
62.1-2-2, 84-86	R, M																			
62.1-2-4, 84-85	R, P									–										
62.1-2-CC	F, P																			
62.1-3-CC	F, M																			
62.1-4-2, 84-86	R, P																			
62.1-4-5, 84-86	R, P									–										
62.1-4-CC	F, P																			
62.1-5-CC	C, G											–							–	
62.1-6-2, 84-85	F, G	–										–	+						–	F
62.1-6-5, 84-86	F, G											–							–	
62.1-6-CC	C, G											–							–	
62.1-7-2, 82-84	R, M																			
62.1-7-5, 84-86	R, M									–										
62.1-7-CC	F, P																			
62.1-8-2, 84-86	R, M																			
62.1-8-5, 84-86	R, M									–										
62.1-8-CC	R, P																			R
62.1-9-2, 84-86	F, M											–						–	–	F
62.1-9-4, 84-86	F, M									–									–	R
62.1-9-CC	R, P																		–	–
62.0-1-1, 10-12	F, M																			
62.0-1-1, 126-128	F, M																			
62.0-1-2, 10-12	F, M																		R	
62.0-1-2, 118-120	C, G	–										–								
62.0-1-3, 10-12	F, M																		R	
62.1-10-2 84-86	F, M																			
62.0-1-3, 118-120	C, G											–								

Samples	*Dorcadospyris alata*	*D. ateuchus*	*D. dentata*	*D. forcipata*	*D. papilio*	*Liriospyris elevata*	*L. parkerae*	*L. stauropora*	*Psychospyris grandis*	*P. intermedia*	*P. parva*	*Tristylospyris triceros*	*Artophormis barbadensis*	*A. dominasinensis*	*A. gracilis*	*Calocycloma ampulla*	*Cycladophora hispida*	*C. turris*	*Cyclampterium brachythorax*	*C. leptetrum*	*C. milowi*	*C. neatum*	*C. pegetrum*	*C. tanythorax*	*Cyrtocapsella cornuta*	*C. elongata*	*C. japonica*	*C. tetrapera*	*Eusyringium fistuligerum*	*E. lagena*	*Lithochytris vespertilio*	*Lithopera bacca*	*L. baueri*	*L. neotera*	*L. renzae*	*L. thornburgi*
62.1-1-2, 84-85																																				
62.1-1-3, 84-86																																				
62.1-1-CC																																				
62.1-2-2, 84-86																																				
62.1-2-4, 84-85																																				
62.1-2-CC																																				
62.1-3-CC																																				
62.1-4-2, 84-86																																				
62.1-4-5, 84-86																																				
62.1-4-CC																																				
62.1-5-CC																																				
62.1-6-2, 84-85																																				
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62.1-6-CC																																				
62.1-7-2, 82-84																																				
62.1-7-5, 84-86																																				
62.1-7-CC																																				
62.1-8-2, 84-86																																				
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62.1-9-4, 84-86																																				
62.1-9-CC																																				
62.0-1-1, 10-12																																				
62.0-1-1, 126-128																																				
62.0-1-2, 10-12																																				
62.0-1-2, 118-120																																				
62.0-1-3, 10-12																																				
62.1-10-2 84-86																																				
62.0-1-3, 118-120																																				

62.0-1-4, 10-12	F, G																																																							
62.0-1-4, 118-120	F, M																																																							
62.0-1-5, 10-12	C, G																	+																																						
62.0-1-5, 118-120	F, G																																																							
62.0-1-6, 10-12	F, G																																																							
62.1-10-5, 84-86	R, P																																																							
62.0-1-6, 115-117	F, M																																																							
62.0-1-CC	F, G											R						F																																						
62.1-10-CC	R, M											?																																												
62.1-11-2, 84-86	F, M									–		?																														+														
62.1-11-5, 84-86	F, M									–		–	–																																											
62.1-11-CC	F, M																																									+														
62.1-12-2, 129-131	F, G	–								R		R	R					–	R	–																						+														
62.1-12-5, 86-88	F, G																																									+														
62.1-12-CC	F, G																	–																																						
62.1-13-3, 120-122	F, G								–	R		R	F					+																								+														
62.1-13-5, 92-94	F, G									R		R	R					R																								+														
62.1-13-CC	C, G											F						F																								+														
62.1-14-2, 85-87	F, G									–		F	–																													+														
62.1-14-5, 144-146	F, G	–										F					–	R	–																							+														
62.1-14-CC	F, M											F						–																																						
62.1-15-2, 84-86	F, G											F						–																								+														
62.1-15-5, 84-86	F, M																																																							
62.1-15-CC	F, M											F						–																								+														
62.1-16-2, 84-86	F, G											F						–																																						
62.1-16-5, 84-86	F, G	–							–			F					–	–	–																							+														
62.1-16-CC	C, G											F					+	+	–																							+														
62.1-17-2, 93-95	F, G	R							–			F						–																								+														
62.1-17-5, 85-87	F, G	R							–		–	F						–																								+														
62.1-17-CC	F, G											F						–																								+														
62.1-18-2, 84-86	F, M	–										R						–																								+														
62.1-18-5, 84-86	F, G	R							–		–	F					+	+	–																							+														
62.1-18-CC	C, M										–	F						–																								+														
62.1-19-2, 84-86	F, M	F																																																						
62.1-19-5, 75-77	R, M																																																							
62.1-19-CC	C, M																																									+														
62.1-20-2, 84-86	F, M																																																							
62.1-20-5, 84-86	F, M	F																																								+														
62.1-20-CC	F, M																																																							
62.1-21-2, 86-88	R, P																																																							
62.1-21-5, 85-87	F, M	R																																																						
62.1-21-CC	C, G										–	F						–																								+														
62.0-2-1, 94-96	C, G								–		–	F						–																								+														
62.0-2-1, 133-135	C, G								–		–	F																														+														
62.0-2-2, 15-17	F, G		–		–				–		–	F						–																								+														

TABLE 1A – *Continued*

Samples	Radiolarian Abundance and Preservation	*Solenosphaera omnitubus*	*Cannartus laticonus*	*C. mammiferus*	*C. (?) petterssoni*	*C. prismaticus*	*C. tubarius*	*C. violina*	*Ommatartus antepenultimus*	*O. avitus*	*O. hughesi*	*O. penultimus*	*O. tetrathalamus*	*Lithocyclia angustum*	*L. aristotelis* group	*L. ocellus* group	*Distyocoryne ontongensis*	*Spongaster klingi*	*S. pentas*	*S. tetras*	*Dorcadospyris alata*	*D. ateuchus*	*D. dentata*	*D. forcipata*	*D. papilio*	*Liriospyris elevata*	*L. parkerae*	*L. stauropora*	*Psychospyris grandis*	*P. intermedia*	*P. parva*	*Tristylospyris triceros*	*Artophormis barbadensis*	*A. dominasinensis*	*A. gracilis*	*Calocycloma ampulla*	*Cycladophora hispida*	*C. turris*	*Cyclampterium brachythorax*	*C. leptetrum*	*C. milowi*	*C. neatum*	*C. pegetrum*	*C. tanythorax*	*Cyrtocapsella cornuta*	*C. elongata*	*C. japonica*	*C. tetrapera*	*Eusyringium fistuligerum*	*E. lagena*	*Lithochytris vespertilio*	*Lithopera bacca*	*L. baueri*	*L. neotera*	*L. renzae*	*L. thornburgi*
62.0-2-2, 116-118	C, G				–				–		–	F							–																							+														
62.0-2-3, 11-13	C, G								–		–	F							–																							+														
62.0-2-3, 118-120	C, G								–		–	F							–																							+														
62.1-22-2, 84-86	C, G	C			–				–		–	F						–	–	–						–	–	–														R														
62.0-2-4, 29-31	C, G								–		–	F							–																							+														
62.0-2-4, 115-117	C, G								–			F							–																							+														
62.0-2-5, 10-12	C, M								–			F							–																							+														
62.0-2-5, 118-120	C, G								–			F							–																							+														
62.0-2-6, 14-16	C, G								–		–	F							–																							+														
62.0-2-6, 121-123	C, G								–			F							–																							+														
62.1-22-5, 84-86	C, G				–						–	F									–																					+														
62.0-2-CC	F, G		–		–				–		–	F							–		–																					R			–	–	–	–				R				
62.1-22-CC	C, G										–	F																																												
62.1-23-2, 84-86	C, M	F			–						–	F														–	–	–																	–			–								
62.1-23-5, 84-86	C, G	F			–				R		–	F																														+			–			–								
62.1-23-CC	C, G										–	F																														C														
62.1-24-2, 84-86	C, G	–			–				F		–	R														–	–	–														+										R				
62.1-24-5, 84-86	C, G	–			–				F		–	+																											–			+														
62.1-24-CC	C, G				–				C		R	–																														+										+				
62.1-25-2, 88-90	C, G				–				C		F															–	–	–											–			+		–												
62.1-25-5, 84-86	C, G				–				C		F	–					–																						–			–		–	–			–								
62.1-25-CC	C, G				–				C		F	–									–																		+			+		–	–											
62.1-26-2, 84-86	C, G				–				C		F															–	–	–											+					–	–			–								
62.1-26-5, 84-86	C, G	–			–				C		C						–	R	–	–																			F						–			–				+	–	–	–	–
62.1-26-CC	C, G		–		–				C		F	–									–																																			
62.1-27-2, 84-86	C, G				–				F		F	–														–	–	–																	–			–								
62.1-27-4, 84-86	C, G				–				C		F	–					–	–	–																										–			–								
62.1-27-CC	C, G				–				C		F							+			–																		+						–	–	–	–								
62.1-28-2, 84-86	C, G				–				C		F	–					+									–	–	–																	–			–								
62.1-28-5, 84-86	C, G				–				C		F						+	R																					R						–			–				R	–	–		–

62.1-29-5, 84-86	C, G		R		-				F		F						R	-	-																																					
62.1-29-CC	C, G		-		-				C		F										-					-	-	-											+						-	-	-	-								
62.1-30-2, 84-86	C, G		+		F				R		-															-	-	-																	-			-								
62.1-30-CC	C, G				C				F		R															R	-	-																												
62.1-30-5, 84-86	C, G		R		F				R		-						R	-	-							R	-	-											R						-			-				R	-	-		-
62.1-31-2, 84-86	C, G		R		F				R		+						-									F													+						-			-								
62.1-31-5, 84-86	C, G		F		F				+		-						-	-	-		-					R																			-			-								
62.0-3-1, 14-16	F, M				F						?																																													
62.1-31-CC	C, G				F						R																												+																	
62.0-3-2, 11-13	F, M																																						+														-			-
62.1-32-2, 84-86	C, G		F		F						-										-					R													+						-			-				+	-	-		-
62.0-3-4, 12-14	F, M				F																																		+																	
62.0-3-5, 11-13	F, M				C																																		+																	
62.0-3-6, 9-11	F, M																																																							
62.1-32-5, 84-86	C, G		F		F						-						-	-	-		-																		+						-			-					-			-
62.0-3-CC	F, M		-		F						-										-					F													R																	
62.1-32-CC	C, M		F		F						-										-		-	-															+						-	-	-	-								
62.1-33-2, 11-13	C, G																-	-	-																																					
62.1-33-2, 84-86	C, G		C		F						-										-					F													+	-			-		-			-				R	+	R	-	
62.1-33-CC	C, M																				-		-	-																												-		-		
62.1-34-3, 11-13	F, M																																																							
62.1-34-3, 84-86	C, G		C		R						-										+		-	-		F													-					R	-	-	F	-				-		R	-	
62.1-34-5, 84-86	C, G		C		-						-										R					F																			-			-								
62.1-34-CC	C, G		F		-						-										+		-	-																					F											
62.1-35-2, 11-13	C, G																				+		-	-																												-	-	F	-	-
62.1-35-2, 84-86	C, G		C		+						-										R					F																		+	R		F	-				-	+	F	-	-
62.1-35-5, 84-86	C, G		F		-						-										R					R																			R			-					-			+
62.1-35-CC	C, M		F		-						-										R		-	-																					R									F		
62.1-36-2, 84-86	C, G		F		-						-										R					R																			F									F		
62.1-36-4, 84-86	C, G		F		-						-										R					+	-	-																+	F		R	-				-	-	R	-	-
62.1-36-CC	C, G		F		-						-										+		-	-																				+	R	-	R	-						R		R
62.1-37-2, 84-86	C, M		F		-						-										+		-	-		+	-	-												-				+	F			-					-	R	-	-
62.1-37-CC	F, G		F		-																+		-			-	-	-	-	-	-								-	-				+	F			-				-	-	+	R	-
62.1-38-CC	R, R																									-	-	-																												
62.0-4-1, 13-15	C, M			R		R	-	F													-	-	R	-	-	-	-	F	-	-	-	-								R			-	-		R		F						-	-	
62.0-4-2, 7-9	C, M							F															F	-		-	-	R																	F	R										
62.0-4-3, 14-16	C, M							F															F	+																F					F	R	-						-	-	-	-
62.0-4-4, 13-15	C, M							F															R	+																					F	R										
62.0-4-5, 10-12	C, M							F															R																						C	R	-	-								
62.0-4-6, 12-14	C, M			R		R	R	F															R					F												R			-		C	R	-	-						-	-	
62.0-4-CC	C, G							F													-	-	R	+	-			F				-								R			-	+	F	R		+								
62.0-5-2, 84-86	C, M			-		F	-															-	-	+	-	-	-	-							-					-			+		F			F								
62.0-5-3, 11-13	C, M																				-	+	-	+	-							-																								
62.0-5-3, 84-86	C, M					F																				-	-	-																				C								
62.0-5-4, 84-86	C, M					F	-	-																									-	-	-		-	-		-	-		R		C			F							-	
62.0-5-CC	C, G					R															-	+	-	+	-							-	-	-	-	-	-	-					+		R	-	-	C	-	-	-					

TABLE 1B
Radiolarians at Site 62

Samples	Radiolarian Abundance and Preservation	*Lophocyrtis jacchia*	*Lychnocanium bellum*	*L.* aff. *bellum*	*L. bipes*	*L. trifolium*	*Pterocanium prismatium*	*Sethochytris babylonis* group	*S. triconiscus*	*Stichocorys armata*	*S. delmontensis*	*S. diploconus*	*S. peregrina*	*S. wolffii*	*Theocorys spongoconum*	*Theocotyle ficus*	*Thyrsocyrtis bromia*	*T. rhizodon*	*T. tetracantha*	*T. triacantha*
62.1-1-2, 84-85	F, G						-						-							
62.1-1-3, 84-86	R, M																			
62.1-1-CC	F, P																			
62.1-2-2, 84-86	R, M																			
62.1-2-4, 84-85	R, P																			
62.1-2-CC	F, P																			
62.1-3-CC	F, M																			
62.1-4-2, 84-86	R, P																			
62.1-4-5, 84-86	R, P																			
62.1-4-CC	F, P																			
62.1-5-CC	C, G						-						-							
62.1-6-2, 84-85	F, G						-						-							
62.1-6-5, 84-86	F, G						-						-							
62.1-6-CC	C, G						-						-							
62.1-7-2, 82-84	R, M																			
62.1-7-5, 84-86	R, M																			
62.1-7-CC	F, P																			
62.1-8-2, 84-86	R, M																			
62.1-8-5, 84-86	R, M																			
62.1-8-CC	R, P																			
62.1-9-2, 84-86	F, M						-						-							
62.1-9-4, 84-86	F, M																			
62.1-9-CC	R, P																			
62.0-1-1, 10-12	F, M																			
62.0-1-1, 126-128	F, M																			
62.0-1-2, 10-12	F, M																			
62.0-1-2, 118-120	C, G						-						C							
62.0-1-3, 10-12	F, M																			
62.1-10-2, 84-86	F, M																			
62.0-1-3, 118-120	C, G						-						C							

Samples	*Carpocanistrum* spp.	*Carpocanopsis bramlettei*	*C. cingulatum*	*C. cristatum*	*C. favosum*	*Calocycletta costata*	*C. virginis*	*Calocycletta* sp.	*Podocyrtis ampla*	*P. chalara*	*P. diamesa*	*P. goetheana*	*P. mitra*	*P. papalis*	*P. sinuosa*	*P. trachodes*	*Theocyrtis annosa*	*T. tuberosa*	*Artostrobium auritum* group
62.1-1-2, 84-85																			
62.1-1-3, 84-86																			
62.1-1-CC																			
62.1-2-2, 84-86																			
62.1-2-4, 84-85																			
62.1-2-CC																			
62.1-3-CC																			
62.1-4-2, 84-86																			
62.1-4-5, 84-86																			
62.1-4-CC																			
62.1-5-CC																			
62.1-6-2, 84-85																			
62.1-6-5, 84-86																			
62.1-6-CC																			
62.1-7-2, 82-84																			
62.1-7-5, 84-86																			
62.1-7-CC																			
62.1-8-2, 84-86																			
62.1-8-5, 84-86																			
62.1-8-CC																			
62.1-9-2, 84-86																			
62.1-9-4, 84-86																			
62.1-9-CC																			
62.0-1-1, 10-12																			
62.0-1-1, 126-128																			
62.0-1-2, 10-12																			
62.0-1-2, 118-120																			
62.0-1-3, 10-12																			
62.1-10-2, 84-86																			
62.0-1-3, 118-120																			

Samples	*A. doliolum*	*A. miralestense*	*Carpocanarium* spp.	*Lithomitra lineata* group	*Phormostichoartus corona*	*Siphocampe corbula*	*Spirocyrtis scalaris*	*Theocampe armadillo* group	*T. mongolfieri*	*T. pirum*	*Acrobotrys tritubus*	*Acrobotrys* spp.	*Botryocyrtis* spp.	*Botryopyle dictyocephalus* group	*Botryopyle* sp. A	*Centrobotrys thermophila*	*Centrobotrys* sp. A
62.1-1-2, 84-85																	
62.1-1-3, 84-86																	
62.1-1-CC																	
62.1-2-2, 84-86																	
62.1-2-4, 84-85																	
62.1-2-CC																	
62.1-3-CC																	
62.1-4-2, 84-86																	
62.1-4-5, 84-86																	
62.1-4-CC																	
62.1-5-CC																	
62.1-6-2, 84-85			R														
62.1-6-5, 84-86																	
62.1-6-CC																	
62.1-7-2, 82-84																	
62.1-7-5, 84-86																	
62.1-7-CC																	
62.1-8-2, 84-86																	
62.1-8-5, 84-86																	
62.1-8-CC																	
62.1-9-2, 84-86																	
62.1-9-4, 84-86																	
62.1-9-CC																	
62.0-1-1, 10-12																	
62.0-1-1, 126-128																	
62.0-1-2, 10-12			+														
62.0-1-2, 118-120																	
62.0-1-3, 10-12																	
62.1-10-2, 84-86																	
62.0-1-3, 118-120																	

62.0-1-4, 10-12	F, G						+						R																																											
62.0-1-4, 118-120	F, M												R																																											
62.0-1-5, 10-12	C, G						+						F																																											
62.0-1-5, 118-120	F, G												R																																											
62.0-1-6, 10-12	F, G												F																																											
62.1-10-5, 84-86	R, P																																																							
62.0-1-6, 115-117	F, M																																																							
62.0-1-CC	F, G						–						F																												R															
62.1-10-CC	R, M												R																																											
62.1-11-2, 84-86	F, M												R																																											
62.1-11-5, 84-86	F, M												+																																											
62.1-11-CC	F, M												C																																											
62.1-12-2, 129-131	F, G						–						C																																–				–							
62.1-12-5, 86-88	F, G						?						C																												R															
62.1-12-CC	F, G												C																																											
62.1-13-3, 120-122	F, G						+						C																																				–							
62.1-13-5, 92-94	F, G						–						C																																				–							
62.1-13-CC	C, G						–						C																																				–							
62.1-14-2, 85-87	F, G						–						C																																											
62.1-14-5, 144-146	F, G												F																										–				–													
62.1-14-CC	F, M												F																																											
62.1-15-2, 84-86	F, G												C																												R															
62.1-15-5, 84-86	F, M																																																							
62.1-15-CC	F, M						–						F																																											
62.1-16-2, 84-86	F, G						–						F																																											
62.1-16-5, 84-86	F, G						–						C																										–				–		–				–							
62.1-16-CC	C, G						–						C																																				–							
62.1-17-2, 93-95	F, G						–						C																																				–							
62.1-17-5, 85-87	F, G						–						C																																				–							
62.1-17-CC	F, G						–						C																																											
62.1-18-2, 84-86	F, M						–						C																																				–							
62.1-18-5, 84-86	F, G						–						C																										–		R		–	–	–				R							
62.1-18-CC	C, M						–						F																																				–							
62.1-19-2, 84-86	F, M										–		+																																				R							
62.1-19-5, 75-77	R, M																																												–											
62.1-19-CC	C, M												+																																											
62.1-20-2, 84-86	F, M												R																										–																	
62.1-20-5, 84-86	F, M																																																							
62.1-20-CC	F, M																																																							
62.1-21-2, 86-88	R, P										–		–																																–											
62.1-21-5, 85-87	F, M												R														–														R															
62.1-21-CC	C, G										F		R																																				R							
62.0-2-1, 94-96	C, G						–				C		–																																				+							
62.0-2-1, 133-135	C, G						–				C		–																																				–							
62.0-2-2, 15-17	F, G						–				C		–																																				–							

TABLE 1B – *Continued*

Samples	Radiolarian Abundance and Preservation	*Lophocyrtis jacchia*	*Lychnocanium bellum*	*L.* aff. *bellum*	*L. bipes*	*L. trifolium*	*Pterocanium prismatium*	*Sethochytris babylonis* group	*S. triconiscus*	*Stichocorys armata*	*S. delmontensis*	*S. diploconus*	*S. peregrina*	*S. wolffii*	*Theocorys spongoconum*	*Theocotyle ficus*	*Thyrsocyrtis bromia*	*T. rhizodon*	*T. tetracantha*	*T. triacantha*	*Carpocanistrum* spp.	*Carpocanopsis bramlettei*	*C. cingulatum*	*C. cristatum*	*C. favosum*	*Calocycletta costata*	*C. virginis*	*Calocycletta* sp.	*Podocyrtis ampla*	*P. chalara*	*P. diamesa*	*P. goetheana*	*P. mitra*	*P. papalis*	*P. sinuosa*	*P. trachodes*	*Theocyrtis annosa*	*T. tuberosa*	*Artostrobium auritum* group	*A. doliolum*	*A. miralestense*	*Carpocanarium* spp.	*Lithomitra lineata* group	*Phormostichoartus corona*	*Siphocampe corbula*	*Spirocyrtis scalaris*	***Theocampe armadillo* group**	*T. mongolfieri*	*T. pirum*	*Acrobotrys tritubus*	*Acrobotrys* spp.	*Botryocyrtis* spp.	*Botryopyle dictyocephalus* group	*Botryopyle* sp. A	*Centrobotrys thermophila*	*Centrobotrys* sp. A
62.0-2-2, 116-118	C, G						-				C		-																																					-						
62.0-2-3, 11-13	C, G						-				C		-																																					-						
62.0-2-3, 118-120	C, G						-				C		-																																					-						
62.1-22-2, 84-86	C, G						-				C		-															-												F		R		+						R						
62.0-2-4, 29-31	C, G						-				C		-																																					R						
62.0-2-4, 115-117	C, G						-				C		-																																					-						
62.0-2-5, 10-12	C, M						-				C		-																																					-						
62.0-2-5, 118-120	C, G						-				C		-																																					R	-	-	-	-	-	-
62.0-2-6, 14-16	C, G						-				C		-																																					-						
62.0-2-6, 121-123	C, G						-				C		-																																					-						
62.1-22-5, 84-86	C, G						-				C		-																																	-				R						
62.0-2-CC	F, G						-				C		-																																					R						
62.1-22-CC	C, G										C																																													
62.1-23-2, 84-86	C, M										C																	-																						R						
62.1-23-5, 84-86	C, G										C		-															+																												
62.1-23-CC	C, G										C																																													
62.1-24-2, 84-86	C, G										C																	R												F		R		R	-					R						
62.1-24-5, 84-86	C, G										C																	-																						R						
62.1-24-CC	C, G										C		-																																					-						
62.1-25-2, 88-90	C, G										C																																													
62.1-25-5, 84-86	C, G										C																	R																						R						
62.1-25-CC	C, G										C																																							-						
62.1-26-2, 84-86	C, G						-				C																																													
62.1-26-5, 84-86	C, G										C																	R														R								-	+	+	+			
62.1-26-CC	C, G										C		-																																					-						
62.1-27-2, 84-86	C, G										C																																							R						
62.1-27-4, 84-86	C, G										C																																													
62.1-27-CC	C, G										C																																													
62.1-28-2, 84-86	C, G										C																																													
62.1-28-5, 84-86	C, G										C		+								F	-	-	-	-																	R			+					-						

62.1-29-2,	84-86	C, G										C																																												
62.1-29-5,	84-86	C, G										C																																												
62.1-29-CC		C, G										C																																					–						
62.1-30-2,	84-86	C, G										C																																												
62.1-30-CC		C, G										C																																												
62.1-30-5,	84-86	C, G										C		+									–	–	–	–													F		R														
62.1-31-2,	84-86	C, G										C																																												
62.1-31-5,	84-86	C, G										C												–																	–														
62.0-3-1,	14-16	F, M										C																													+														
62.1-31-CC		C, G										C																																												
62.0-3-2,	11-13	F, M										F																																												
62.1-32-2,	84-86	C, G										C																											F		+			–											
62.0-3-4,	12-14	F, M										F																																												
62.0-3-5,	11-13	F, M										C																																												
62.0-3-6,	9-11	F, M																																							–														
62.1-32-5,	84-86	C, G										C																																												
62.0-3-CC		F, M										R																																												
62.1-32-CC		C, M										C																																												
62.1-33-2,	11-13	C, G																																																							
62.1-33-2,	84-86	C, G									–	C	–		–								–	–	R	–															–														
62.1-33-CC		C, M										C																																												
62.1-34-3,	11-13	F, M																																																						
62.1-34-3,	84-86	C, G										A																																												
62.1-34-5,	84-86	C, G										C														–																														
62.1-34-CC		C, G										C														–																														
62.1-35-2,	11-13	C, G									–															–												R	F																	
62.1-35-2,	84-86	C, G										C											–	–	R	–												R																		
62.1-35-5,	84-86	C, G										C											–				–	–																												
62.1-35-CC		C, M										C															–																													
62.1-36-2,	84-86	C, G										C															–	–																												
62.1-36-4,	84-86	C, G									–	C	–		–							R	+	–	R	–	–	–										R	F		–		F	–					–	+	R	+	–	+	–
62.1-36-CC		C, G										C															–																													
62.1-37-2,	84-86	C, M									–	F	–		–									–	R	–	–	–	R																										
62.1-37-CC		F, G									–	C	–													–	–	–	F											R																
62.1-38-CC		R, R																																																						
62.0-4-1,	13-15	C, M									–	R	R		A											+	C	F																+												
62.0-4-2,	7-9	C, M										R			A												C	F																–												
62.0-4-3,	14-16	C, M									–		R		A								R	F	–	R	C	F	–									–	–		–		–						–	–	–	–	–	–	–
62.0-4-4,	13-15	C, M													A												C	F																											
62.0-4-5,	10-12	C, M				–						F			A									F			C	F									–			–				–												
62.0-4-6,	12-14	C, M				–					–		+		A	–							R	F	–	R	C	F												–				–						–	–	–	–	–	–	–
62.0-4-CC		C, G										R	R		A												C										–							–												
62.0-5-2,	84-86	C, M				R						R	–		–	R								+		–	–	C	–								R														R			R		
62.0-5-3,	11-13	C, M										R												–																				–												
62.0-5-3,	84-86	C, M				R	–		–	–					–	R												C									R																			
62.0-5-4,	84-86	C, M				R					–	R	–		–	R						F	–	–	–	–	–	C	–								R	–				–				–				–	R	+	+	F	+	–
62.0-5-CC		C, G	–	–	–	F	–					R				R	–	–	–	–								F									R	–																		

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TABLE 2A
Radiolarians at Site 63

Samples	Radiolarian Abundance and Preservation	*Solenosphaera omnitubus*	*Cannartus laticonus*	*C. mammiferus*	*C. (?) petterssoni*	*C. prismaticus*	*C. tubarius*	*C. violina*	*Ommatartus antepenultimus*	*O. avitus*	*O. hughesi*	*O. penultimus*	*O. tetrathalamus*	*Lithocyclia angustum*	*L. aristotelis group*	*L. ocellus group*	*Dictyocoryne ontongensis*	*Spongaster klingi*	*S. pentas*	*S. tetras*
63.0-1-2, 84-86	C, G											–							–	
63.1-1-1, 61-63	C, G											–							–	
63.1-1-3, 84-86	C, G									–		–	F							F
63.0-1-6, 84-86	C, G									–		–	F						–	F
63.1-1-CC	A, G											–							–	
63.2-1-2, 15,17	F, G									–		–	–							
63.2-1-4, 15-17	R, G									–			R							F
63.2-1-CC	C, G									–		–	F						–	F
63.2-2-1, 15-17	R, G									–		+	+							R
63.1-2-CC	A, G									–		–	F							
63.2-2-3, 15-17	R, P									–		–	–							
63.1-3-1, 84-86	C, G									–		–	R							
63.1-3-2, 84-86	R, P									–		–	–							
63.1-3-CC	F, P																			
63.2-2-6, 15-17	R, G																			
63.2-2-CC	R, G									–		–	–							
63.2-3-1, 30-32	F, G	–								–		–	–					–	–	–
63.2-3-4, 11-13	F, G											R						–		
63.2-3-CC	C, G	–									+	C							+	
63.1-4-CC	C, G				–						–	F							–	
63.0-2-2, 84-86	A, G	F							F		–	F						F	–	–
63.0-2-4, 84-86	A, G	F			–				R		–	F								
63.0-2-6, 84-86	A, G	–			–				F		–	R					–	F	–	–
63.0-2-CC	A, G				–				F		–	R					–			
63.1-5-1, 60-62	C, G	–	R		F				F		R						+	+	–	–
63.1-5-3, 84-86	C, G		F		F				R		+						–	–	–	–
63.1-5-CC	A, G		F		F				–		–									
63.1-6-1, 84-86	C, G		F		C				+		–							–	–	–
63.1-6-3, 84-86	C, G		F		F						–									
63.1-6-4, 12-14	C, M																			

Samples	*Dorcadospyris alata*	*D. ateuchus*	*D. dentata*	*D. forcipata*	*D. papilio*	*Liriospyris elevata*	*L. parkerae*	*L. stauropora*	*Psychospyris grandis*	*P. intermedia*	*P. parva*	*Tristylospyris triceros*	*Artophormis barbadensis*	*A. dominasinensis*	*A. gracilis*	*Calocycloma ampulla*	*Cycladophora hispida*	*C. turris*
63.0-1-2, 84-86																		
63.1-1-1, 61-63																		
63.1-1-3, 84-86																		
63.0-1-6, 84-86																		
63.1-1-CC																		
63.2-1-2, 15,17																		
63.2-1-4, 15-17																		
63.2-1-CC																		
63.2-2-1, 15-17																		
63.1-2-CC																		
63.2-2-3, 15-17																		
63.1-3-1, 84-86																		
63.1-3-2, 84-86																		
63.1-3-CC																		
63.2-2-6, 15-17																		
63.2-2-CC																		
63.2-3-1, 30-32																		
63.2-3-4, 11-13																		
63.2-3-CC																		
63.1-4-CC																		
63.0-2-2, 84-86																		
63.0-2-4, 84-86						–	–	–										
63.0-2-6, 84-86						–	–	–										
63.0-2-CC						–	–	–										
63.1-5-1, 60-62	–					F												
63.1-5-3, 84-86	–	–	–	–	–							–						
63.1-5-CC	–																	
63.1-6-1, 84-86	–					F												
63.1-6-3, 84-86	–																	
63.1-6-4, 12-14	–	–	–	–	–							–						

Samples	*Cyclampterium brachythorax*	*C. leptetrum*	*C. milowi*	*C. neatum*	*C. pegetrum*	*C. tanythorax*	*Cyrtocapsella cornuta*	*C. elongata*	*C. japonica*	*C. tetrapera*	*Eusyringium fistuligerum*	*E. lagena*	*Lithochytris vespertilio*	*Lithopera bacca*	*L. baueri*	*L. neotera*	*L. renzae*	*L. thornburgi*
63.0-1-2, 84-86																		
63.1-1-1, 61-63																		
63.1-1-3, 84-86																		
63.0-1-6, 84-86																		
63.1-1-CC																		
63.2-1-2, 15,17																		
63.2-1-4, 15-17																		
63.2-1-CC														R				
63.2-2-1, 15-17																		
63.1-2-CC																		
63.2-2-3, 15-17																		
63.1-3-1, 84-86				R														
63.1-3-2, 84-86																		
63.1-3-CC																		
63.2-2-6, 15-17																		
63.2-2-CC																		
63.2-3-1, 30-32																		
63.2-3-4, 11-13																		
63.2-3-CC																		
63.1-4-CC																		
63.0-2-2, 84-86																		
63.0-2-4, 84-86	–			R										R	–	–	–	–
63.0-2-6, 84-86				R														
63.0-2-CC				R														
63.1-5-1, 60-62	F			–		–								R				R
63.1-5-3, 84-86	R					R	–	–	–	–				+	–	R	–	–
63.1-5-CC																		
63.1-6-1, 84-86	+						–			–				+	+	R		+
63.1-6-3, 84-86	R					–	–			–				R	+	F		+
63.1-6-4, 12-14																		

63.1-6-5, 84-86	C, G		C		F																-					F	-	-												R						-	-	R	-					+	F		R
63.1-6-CC	C, G		F		?						-										+	-	-	-	-							-												+	R									C		F
63.1-7-2, 11-13	C, G		F		R						-										-																							R	R	-	-	-					R	C		F
63.1-7-4, 11-13	C, G		F		R																+	-	-	-	-	R	-	-				-												F	F	-	R	-				-	R	F	-	R
63.1-7-4, 84-86	C, G																																																							
63.1-7-CC	A, G		F		-																+					-	-	-																	F											
63.1-8-2, 30-32	C, G		F	-	F				-												R					+																		+	R	-	R	-				-	F	F	-	R
63.1-8-3, 84-86	C, M																									-	-	-																												
63.1-8-4, 84-86	C, G		R	R	-				-												R					-	-	-																+	F	-	-	-				-	R	R	R	-
63.1-8-6, 13-15	C, G		+	F	-		-	R													F					-	-	-										-	-					R	F	-	-	R					R	R	R	-
63.0-3-1, Top	C, G				-						-										R																								F			F						R	R	
63.1-8-CC	A, G			F																	R																							+	F											
63.1-9-1, 53-55	C, G			F	-																F																			R				F	C	-	-	F					+	R	R	R
63.0-3-2, 95-97	A, G				-						-										R					-	-	-																	F			R								
63.1-9-2, 11-13	C, G		R	F			-	R	-												F					-	-	-												R				+	F	-	-	F					-	+	R	-
63.1-9-3, 84-86	C, G		+	F			+	R													F					-	R	-												F					F	-	+	-								
63.0-3-4, 84-86	A, G				F																					-	R	-																	F			-								
63.1-9-4, 15-16	C, M																									-	F	-																												
63.1-9-5, 15-17	C, G		-	F			R	R													F																			R					F	-	-	-								
63.0-3-CC	C, G			-	-						-										F																								F		R						?	-	R	
63.1-9-CC	A, M																				R	-	-	-	-	-	F	-	-	-	-	-													F								-		R	
63.1-10-1, 15-17	C, G		-	R		-	R	F													R		-	-		-	F	-												F					R	-	-	-				-	-	-	-	-
63.1-10-3, 15-17	C, G							F													-		F	R		-	-	F												R					R			F								
63.1-10-3, 84-86	C, M																				-	-	R	+	-	-	-	F				-																							-	
63.1-10-CC	A, G							?																R					-	-	-														F											
63.1-11-1, 15-17	C, G		-	R		-	R	F															F	R																					R			-								
63.1-11-3, 84-86	C, G			F			R	C														-	R	R	-							-							-	R	-		-	-	F	+	-	R				-	-	-	-	-
63.1-11-5, 84-86	C, G					-		F															F	F																R					F	-	-	-								
63.1-11-CC	C, G																						+					F																				-								
63.1-12-2, 10-12	F, G																												-	-	-																									
63.1-12-2, 84-86	C, M																																																							
63.1-12-CC	A, G																				-	-	+	+	-				-	+	-	-													F											
63.1-13-1, 10-12	C, G					-		F															F																	+					F	+	-	-								
63.1-13-3, 10-12	C, G					+		F															F																	+					C	-	-	-								
63.1-13-3, 84-86	C, M																																																							
63.1-13-5, 84-86	C, G		-	R		-	R	F															R						-	-	-									+					F	R	-	-								
63.1-13-CC	A, G							F															F	R				F	-	-	-														F											
63.1-14-1, 10-12	C, G			-		+	F	R															R																-	R	-		-	-	F	R	-	-				-	-	-	-	-
63.1-14-3, 9-11	C, G			-		+	F	R																		-	-	R												R			+		F	R		-								
63.1-14-5, 15-17	C, G			-		R	F	R															+	R																+			-		F	R	-	R								

TABLE 2A – *Continued*

Samples	Radiolarian Abundance and Preservation	*Solenosphaera omnitubus*	*Cannartus laticonus*	*C. mammiferus*	*C. (?) petterssoni*	*C. prismaticus*	*C. tubarius*	*C. violina*	*Ommatartus antepenultimus*	*O. avitus*	*O. hughesi*	*O. penultimus*	*O. tetrathalamus*	*Lithocyclia angustum*	*L. aristotelis* group	*L. ocellus* group	*Dictyocoryne ontongensis*	*Spongaster klingi*	*S. pentas*	*S. tetras*	*Dorcadospyris alata*	*D. ateuchus*	*D. dentata*	*D. forcipata*	*D. papilio*	*Liriospyris elevata*	*L. parkerae*	*L. stauropora*	*Psychospyris grandis*	*P. intermedia*	*P. parva*
63.1-14-CC	A, G					F	F														–	–	+	+	–			R	–	–	–
63.0-4-1, 74-76	C, G					F	+	–														–	–	R	–	–	–	–			
63.0-4-2, 11-13	F, M					F	–	–														R	–	+	–				–	–	–
63.0-4-2, 95-97	A, G																									–	–	–			
63.0-4-CC	C, G					R	–	–													–	+	–	+	–				–	–	–
63.0-5-1, 84-86	C, M					F	–	–						–								F			–						
63.0-5-2, 12-14	C, M																														
63.0-5-2, 84-86	C, G					F	–	–						–								R		R	–						
63.0-5-CC	C, M					+																+		+	+						

Samples	*Tristylospyris triceros*	*Artophormis barbadensis*	*A. dominasinensis*	*A. gracilis*	*Calocycloma ampulla*	*Cycladophora hispida*	*C. turris*	*Cyclampterium brachythorax*	*C. leptetrum*	*C. milowi*	*C. neatum*	*C. pegetrum*	*C. tanythorax*	*Cyrtocapsella cornuta*	*C. elongata*	*C. japonica*	*C. tetrapera*	*Eusyringium fistuligerum*	*E. lagena*	*Lithochytris vespertilio*	*Lithopera bacca*	*L. baueri*	*L. neotera*	*L. renzae*	*L. thornburgi*
63.1-14-CC	–								F			–		F											
63.0-4-1, 74-76				–					+			R		C			C								
63.0-4-2, 11-13									–			+		A											
63.0-4-2, 95-97				–					–			R		A			F					–		–	–
63.0-4-CC	–			–					–			F		R			C								
63.0-5-1, 84-86				F					–	–		–													
63.0-5-2, 12-14																									
63.0-5-2, 84-86	–	–	–	F					–	–		+		–			–								
63.0-5-CC	–	–	–	+		–	–		–	–		R													

The radiolarian assemblage in 67.1-2-CC includes *Phormocyrtis striata, Eucyrtidium cubense, Lithocampium* sp. A, *Bekoma bidarfensis* and *Lithochytris archaea* with a very poorly developed abdomen (Plate 7, Figure 13). It lacks members of the *Lithocyclia ocellus* species group and the *Lithocampium* sp. described in our Leg 4 report, and is therefore apparently older than any of the Leg 2 meterial described by Cita *et al* (1970).

The only other Lower Eocene and Paleocene assemblages available to us for comparison are from:

Palmer locality 4131, 22.5 miles N 10°W of Chirino, Yumuri Valley, Matanzas Province, Cuba (from the Dorothy Palmer Collection at the Paleontological Research Institute, Ithaca, New York). Lower Eocene on the basis of calcareous nannofossils–M. N. Bramlette, personal communication.

Upper Paleocene of the coast section at Ibbaritz-Bidarf, France. Adjacent to Triassic diapir to the north–collected by M. N. Bramlette.

Paleocene at Belus, NE of the junction of the rivers Gave and l'Adour, SW France. On the road to Peyrehorade, 200 meters south of the church at Belus, opposite the farm Cassoua–collected by M. N. Bramlette.

Palmer's Lower Eocene Cuban sample has in common with the Site 67 material *Eucyrtidium cubense* and *Lithochytris archaea,* but it lacks *Bekoma bidarfensis,* and its *Lithocampium* sp. has quincuncially arranged pores on the third segment.

The Upper Paleocene assemblage from Ibbaritz-Bidarf and the Paleocene assemblage from Belus both lack *Lithochytris archaea* and *Eucyrtidium cubense* but include *Lithocampium* sp. A with the pores of the third segment longitudinally aligned, and representatives of *Bekoma*–at Ibbaritz-Bidarf the same species as at Site 67, and at Belus an apparently ancestral species.

The above observations suggest that the Site 67 assemblage may be intermediate in age between Palmer's Cuban sample and the Upper Paleocene at Ibbaritz-Bidarf, and thus very near the Eocene/Paleocene boundary.

5. TIME-RANGES OF TAXA, AND BIOSTRATIGRAPHIC ZONATION

For the purposes of establishing levels of correlation between the sequences cored at the various sites, and determining a radiolarian zonation applicable to the western tropical Pacific, it has been necessary to arrange the observed radiolarian "events" (upper and lower limits of taxa, and evolutionary transitions) in chronological order. Table 6 presents this chronological arrangement, using the following abbreviations. In the left- and right-hand columns, T indicates the top of the range of a taxon, B its bottom, and an arrow an evolutionary transition; e and m indicate evolutionary and morphotypic limits, respectively (see Section 2). In the body of the table are given the pairs of core-sections between which an event occurred, followed by the depths in meters below the sediment surface. The letters P, M and G (for poor, moderate and good) are used to indicate the degree of reliability of each event at each site–a low level of reliability is in some cases a result of poor preservation of the radiolarian assemblage, and in others a result of scarcity of the taxon. Because of the extensive reworking at Site 65, only lower limits of taxa could be determined there, and all events are recorded as morphotypic–these are of course not precisely comparable with evolutionary events at other sites.

In addition to serving as a basis for the summary presentation of radiolarian ranges in Figure 2, one of the obvious uses of Table 6 is as a correlation table between the several drilled sequences. Ideally, the depths should increase downward in each column, but there are some departures from this ideal which cause correlation lines to cross. In such cases, we have used our estimations of the degree of reliability of each event in each sequence to determine which is the most probable order of occurrence of events.

Figure 2 shows the ranges of taxa and the boundaries between radiolarian zones, against a vertical scale corresponding to depth below the sediment surface at Site 64. Because that site was not cored continuously, and because in some cases more reliable information on the upper and lower limits of taxa was available from Sites 62, 63 and 66, the relative ranges plotted represent a synthesis of the information available from all sites. The letters e and m are used to distinguish evolutionary and morphotypic limits, broken lines indicate limits of uncertainty in the ranges of taxa, and hachured zones indicate ranges of uncertainty in zonal boundaries. Because of poor preservation of the radiolarians at some sites, and discontinuity of coring at other sites, Leg 7 results are not very useful for zones younger than the *Ommatartus penultimus* Zone and older than the *Theocyrtis tuberosa* Zone. More useful information on those parts of the section are given in our report on the radiolarians from Leg 4 (Riedel and Sanfilippo, in press), and presumably also in the Initial Reports on Legs 5 and 6.

The radiolarian zonation applicable to the Leg 7 sequences differs in some respects from that which we have published earlier (Riedel and Sanfilippo, in press). This is undoubtedly due in large part to the fact that several long sequences not greatly complicated by the effects of reworking are available from the Leg 7 sites, and the ranges of taxa in them can be determined more

TABLE 2B
Radiolarians at Site 63

Samples	Radiolarian Abundance and Preservation	*Lophocyrtis jacchia*	*Lychnocanium bellum*	*L.* aff. *bellum*	*L. bipes*	*L. trifolium*	*Pterocanium prismatium*	*Sethochytris babylonis* group	*S. triconiscus*	*Stichocorys armata*	*S. delmontensis*	*S. diploconus*	*S. peregrina*	*S. wolffii*	*Theocorys spongoconum*	*Theocotyle ficus*	*Thyrsocyrtis bromia*	*T. rhizodon*	*T. tetracantha*	*T. triacantha*	*Carpocanistrum* spp.	*Carpocanopsis bramlettei*	*C. cingulatum*	*C. cristatum*	*C. favosum*	*Calocycletta costata*	*C. virginis*	*Calocycletta* sp.	*Podocyrtis ampla*	*P. chalara*	*P. diamesa*	*P. goetheana*	*P. mitra*	*P. papalis*	*P. sinuosa*	*P. trachodes*	*Theocyrtis annosa*	*T. tuberosa*	*Artostrobium auritum* group	*A. doliolum*	*A. miralestense*	*Carpocanarium* spp.	*Lithomitra lineata* group	*Phormostichoartus corona*	*Siphocampe corbula*	*Spirocyrtis scalaris*	*Theocampe armadillo* group	*T. mongolfieri*	*T. pirum*	*Acrobotrys tritubus*	*Acrobotrys* spp.	*Botryocyrtis* spp.	*Botryopyle dictyocephalus* group	*Botryopyle* sp. A	*Centrobotrys thermophila*	*Centrobotrys* sp. A
63.0-1-2, 84-86	C, G						–						–																										F		F	R		–												
63.1-1-1, 61-63	C, G						–						–																																											
63.1-1-3, 84-86	C, G						R																																			R														
63.0-1-6, 84-86	C, G						–						–																																											
63.1-1-CC	A, G						–						–																																											
63.2-1-2, 15-17	F, G																																																							
63.2-1-4, 15-17	R, G																																																							
63.2-1-CC	C, G												R																																											
63.2-2-1, 15-17	R, G																																													–										
63.1-2-CC	A, G						+						–																																											
63.2-2-3, 15-17	R, P																																																							
63.1-3-1, 84-86	C, G												F															–												–				–		–										
63.1-3-2, 84-86	R, P																																																							
63.1-3-CC	F, P																																							–																
63.2-2-6, 15-17	R, G												R																																	–										
63.2-2-CC	R, G												F																																											
63.2-3-1, 30-32	F, G						R						F															–																		–										
63.2-3-4, 11-13	F, G						–						F																																											
63.2-3-CC	C, G						–				–		C															–																						–						
63.1-4-CC	C, G						–				–		C																																					–						
63.0-2-2, 84-86	A, G						–				C		–															R											–	F										R						
63.0-2-4, 84-86	A, G						–			–	C	–	–																										–	C		+		R		–				R						
63.0-2-6, 84-86	A, G						–				C		–															F																						R						
63.0-2-CC	A, G						–				C		–																																					R						
63.1-5-1, 60-62	C, G										C																	R														–								–						
63.1-5-3, 84-86	C, G									–	C	–									F	–	–	–	–			F												C				F						–						
63.1-5-CC	A, G										C			–																																										
63.1-6-1, 84-86	C, G										C																															–														
63.1-6-3, 84-86	C, G										C			–																										F																
63.1-6-4, 12-14	C, M																																																							

63.1-6-5, 84-86	C, G										C																																			–											
63.1-6-CC	C, G										C			R																																											
63.1-7-2, 11-13	C, G										C			F																																											
63.1-7-4, 11-13	C, G									–	A	–		–								–	–	+	–														F	–		–															
63.1-7-4, 84-86	C, G																																											–											
63.1-7-CC	A, G										C															–	–																													
63.1-8-2, 30-32	C, G									–	C	–		F																																											
63.1-8-3, 84-86	C, M																																																							
63.1-8-4, 84-86	C, G									–	C	–		F	–																													–											
63.1-8-6, 13-15	C, G										C	–										R																			–															
63.0-3-1, Top	C, G									F	F	–		–	–											–																														
63.1-8-CC	A, G										C															–																														
63.1-9-1, 53-55	C, G									F	C			–												–	–																	–											
63.0-3-2, 95-97	A, G									F	F	–		–												–																														
63.1-9-2, 11-13	C, G										F			–												–	–	C																												
63.1-9-3, 84-86	C, G										A			F												R	R																													
63.0-3-4, 84-86	A, G										A															–	F																													
63.1-9-4, 15-16	C, M																																																		R				
63.1-9-5, 15-17	C, G									+	C	–		R												F	F	R																							+				
63.0-3-CC	C, G										A															F																														
63.1-9-CC	A, M										A			F												C	–																													
63.1-10-1, 15-17	C, G									+	C	+		A								R	–	–	–	F	F	–											–			–										R				
63.1-10-3, 15-17	C, G										A			F												F	C	–																												
63.1-10-3, 84-86	C, M																																																		–				
63.1-10-CC	A, G										A			F												F	C													–																
63.1-11-1, 15-17	C, G										C															F	C																													
63.1-11-3, 84-86	C, G									F	C	–		C							C	R	–	R	–	F	C	–											–			–	+	R						–	+	–	–	–	–	–
63.1-11-5, 84-86	C, G										C			C	–							R	–	+	–	F	C																													
63.1-11-CC	C, G									F	C	+		F												F	C																													
63.1-12-2, 10-12	F, G																																																							
63.1-12-2, 84-86	C, M														–																																			–				
63.1-12-CC	A, G										F	?		C								+	–			F	F																													
63.1-13-1, 10-12	C, G									R	F	+		C	–							+	F	–	–	C	C												–		–															
63.1-13-3, 10-12	C, G									R	C	R		C								R	F	+	–	C	C															–								–	–	+	–	–	–	–
63.1-13-3, 84-86	C, M																																																							
63.1-13-5, 84-86	C, G				–					R	F	F		C	–										–	C	F																													
63.1-13-CC	A, G									+		F		A												F	F																													
63.1-14-1, 10-12	C, G				–					R	R	R		A							F	R	F	–	R	–	F	–											–			–	+	R						–	–	–	–	–	–	–
63.1-14-3, 9-11	C, G				R						R			A	R											–	C																													
63.1-14-5, 15-17	C, G									R	R	R		A	–												C																							–	R	–	–	–	–	–

TABLE 2B – *Continued*

Samples	Radiolarian Abundance and Preservation	*Lophocyrtis jacchia*	*Lychnocanium bellum*	*L.* aff. *bellum*	*L. bipes*	*L. trifolium*	*Pterocanium prismatium*	*Sethochytris babylonis* group	*S. triconiscus*	*Stichocorys armata*	*S. delmontensis*	*S. diploconus*	*S. peregrina*	*S. wolffii*	*Theocorys spongoconum*	*Theocotyle ficus*	*Thyrsocyrtis bromia*	*T. rhizodon*	*T. tetracantha*	*T. triacantha*	*Carpocanistrum* spp.	*Carpocanopsis bramlettei*	*C. cingulatum*	*C. cristatum*	*C. favosum*	*Calocycletta costata*	*C. virginis*	*Calocycletta* sp.
63.1-14-CC	A, G									R		F		A	–											–	F	
63.0-4-1, 74-76	C, G				F						C			–	R							–	F	–			C	
63.0-4-2, 11-13	F, M					–																						
63.0-4-2, 95-97	A, G				F	–				R	C	–		–	R						F	–	F	–	+		C	
63.0-4-CC	C, G				R						C	–															F	
63.0-5-1, 84-86	C, M				–	+					–				–												–	
63.0-5-2, 12-14	C, M					–																					–	
63.0-5-2, 84-86	C, G				–	R				–	–	–			–							–	–	–	–		–	
63.0-5-CC	C, M	–	–	–	?	+									–		–	–	–	–								

Samples	*Podocyrtis ampla*	*P. chalara*	*P. diamesa*	*P. goetheana*	*P. mitra*	*P. papalis*	*P. sinuosa*	*P. trachodes*	*Theocyrtis annosa*	*T. tuberosa*	*Artostrobium auritum* group	*A. doliolum*	*A. miralestense*	*Carpocanarium* spp.	*Lithomitra lineata* group	*Phormostichoartus corona*	*Siphocampe corbula*	*Spirocyrtis scalaris*	*Theocampe armadillo* group	*T. mongolfieri*	*T. pirum*	*Acrobotrys tritubus*	*Acrobotrys* spp.	*Botryocyrtis* spp.	*Botryopyle dictyocephalus* group	*Botryopyle* sp. A	*Centrobotrys thermophila*	*Centrobotrys* sp. A
63.1-14-CC																								–		–		
63.0-4-1, 74-76									–																			
63.0-4-2, 11-13																												
63.0-4-2, 95-97									–			–		–		–						–	F	+	R	F	–	–
63.0-4-CC									–																			
63.0-5-1, 84-86									F	–														–			–	
63.0-5-2, 12-14																												
63.0-5-2, 84-86									F	–		–		–		–						–	R	–	R	R	–	–
63.0-5-CC									+	–																		

reliably than in the short cores on which our earlier zonation was based. However, some of the discrepancies may also be due to real differences between the relative ranges of taxa in different parts of the tropical oceans, though evaluation of the extent to which this is true must await investigation of sequences from other legs of the drilling expedition.

The principal differences between the present and earlier zonations result from the facts that we have found it necessary (1) to eliminate the *Cannartus laticonus* Zone because the upper part of the range of *Dorcadospyris alata* is found to overlap the earliest occurrence of *Cannartus* (?) *petterssoni*, and (2) to insert the new *Dorcadospyris ateuchus* Zone between the *Theocyrtis tuberosa* and *Lychnocanium bipes* Zones to accommodate assemblages of an age from which we had previously no samples.

The radiolarian zones well represented in the Leg 7 sequences, and some events within them, are listed from older to younger.

Theocyrtis tuberosa **Zone**:

Base defined by the earliest evolutionary appearance of *Lithocyclia angustum*, which is approximately synchronous with the earliest evolutionary appearance of *Artophormis gracilis*, the earliest morphotypic appearance of *Centrobotrys* sp. A, and the latest occurrence of *Theocampe pirum*. The transition from *Theocyrtis tuberosa* to *T. annosa* probably occurs near the top of this zone.

Dorcadospyris ateuchus **Zone**:

Base defined by the earliest evolutionary appearance of *Dorcadospyris ateuchus*, which is approximately synchronous with the earliest morphotypic appearances of *D. forcipata* and *Cannartus prismaticus*. Events within this zone include:

The earliest morphotypic appearance of *Dorcadospyris papilio*.

The transition from *Cyclampterium milowi* to *C. pegetrum*.

The earliest morphotypic appearances of *Botryopyle* sp. A and *Lychnocanium trifolium*.

Lychnocanium bipes **Zone**:

Base defined by the earliest morphotypic appearance of *Lychnocanium bipes*. Events within this zone include:

The latest occurrences of *Lithocyclia angustum*, *Lychnocanium trifolium* and *Artophormis gracilis*.

The earliest morphotypic appearances of *Psychospyris parva*, *Carpocanopsis cingulatum* and *Cyrtocapsella tetrapera*.

The transition from *Psychospyris parva* to *P. intermedia*.

Calocycletta virginis **Zone**:

Base defined by the earliest morphotypic appearance of *Calocycletta virginis*, which is approximately synchronous with the earliest morphotypic appearance of *Cyrtocapsella tetrapera* and the latest occurrence of *Dorcadospyris papilio*. Events within this zone include:

The earliest morphotypic appearances of *Botryocyrtis* spp. and *Carpocanopsis favosum*.

The latest occurrences of *Dorcadospyris ateuchus* and *Theocyrtis annosa*.

The earliest morphotypic appearances of *Stichocorys delmontensis*, *S. armata*, *Cannartus tubarius* and *Carpocanopsis bramlettei*.

The transition from *Cyclampterium pegetrum* to *C. leptetrum*.

The earliest morphotypic appearances of *Stichocorys wolffii* and *Liriospyris stauropora*.

The latest occurrences of *Botryopyle* sp. A and *Theocorys spongoconum*. The transition from *Cannartus tubarius* to *C. violina*.

The earliest morphotypic appearances of *Dorcadospyris dentata* and *Stichocorys diploconus*.

Calocycletta costata **Zone**:

Base defined by the earliest evolutionary appearance of *Calocycletta costata*, which is approximately synchronous with the latest occurrence of *Lychnocanium bipes*. Events within this zone include:

The earliest morphotypic appearances of *Carpocanopsis cristatum* and *Phormostichoartus corona*.

The latest occurrences of *Carpocanopsis cingulatum*, *Stichocorys diploconus*, *Cannartus prismaticus*, *Carpocanopsis favosum* and *Dorcadospyris forcipata*.

The earliest morphotypic appearance of *Lithopera renzae*.

The transition from *Cannartus violina* to *C. mammiferus*.

Dorcadospyris alata **Zone**:

Base defined by the earliest evolutionary appearance of *Dorcadospyris alata*, which is approximately synchronous with the transitions from *Liriospyris stauropora* to *L. parkerae* and from *Psychospyris intermedia* to *P. grandis*. Events within this zone include:

The latest occurrences of *Dorcadospyris dentata*, *Calocycletta costata*, *C. virginis* and *Psychospyris grandis*.

The transition from *Cyclampterium leptetrum* to *C. tanythorax*.

The latest occurrences of *Liriospyris parkerae* and *Cyrtocapsella tetrapera*.

The earliest morphotypic appearances of *Lithopera baueri* and *L. thornburgi*.

TABLE 3A
Radiolarians at Site 64

Samples	Radiolarian Abundance and Preservation	*Solenosphaera omnitubus*	*Cannartus laticonus*	*C. mammiferus*	*C. (?) petterssoni*	*C. prismaticus*	*C. tubarius*	*C. violina*	*Ommatartus antepenultimus*	*O. avitus*	*O. hughesi*	*O. penultimus*	*O. tetrathalamus*	*Lithocyclia angustum*	*L. aristotelis* group	*L. ocellus* group	*Dictyocoryne ontongensis*	*Spongaster klingi*	*S. pentas*	*S. tetras*
64.0-1-1, 84-86	C, G									-	F	-	R						-	
64.0-1-3, 84-86	C, G											-							-	
64.0-1-CC	R, G																			
64.0-2-1, 20-22	C, G																		R	
64.0-2-3, 84-86	C, G	-								-		-	-					-	R	F
64.0-2-CC	C, G	-								-		-	R						F	R
64.0-3-1, 10-12	C, G	F							F		-	R					-	?	-	-
64.0-3-3, 84-86	C, G	F							R		-						-	-	-	-
64.0-3-CC	C, G	C							R		-	R					?	+	-	-
64.0-4-1, 40-42	C, M	-	C	-	F	-			+		R	-					-	-	-	
64.0-4-3, 84-86	C, G	-			F						R									
64.0-4-4, 84-86	C, M																			
64.0-4-CC	C, G		F		F						-									
64.0-5-1, 15-17	C, G		-	R	-				-											
64.0-5-4, 84-86	C, G		-	R	-			-	-											
64.0-5-CC	C, G			?																
64.1-1-1, 20-22	A, M		-	F		-	-	R												
64.1-1-3, 30-32	A, G		-	F			+	R												
64.1-1-4, 90-92	A, G																			
64.1-1-5, 30-32	A, G			R	-	-	R	F												
64.1-1-CC	A, G							F												
64.1-2-1, 34-36	A, G																			
64.1-2-3, 84-86	A, G																			
64.1-2-4, 30-32	A, G					-														
64.1-2-CC	A, G																			
64.1-3-1, 30-32	A, G			R		-	R	F												
64.1-3-3, 30-32	A, G																			
64.1-3-3, 84-86	A, G					+		F												
64.1-3-CC	A, G							F												
64.1-4-1, 30-32	A, G			-		R	-	R												

Samples	Radiolarian Abundance and Preservation	*Dorcadospyris alata*	*D. ateuchus*	*D. dentata*	*D. forcipata*	*D. papilio*	*Liriospyris elevata*	*L. parkerae*	*L. stauropora*	*Psychospyris grandis*	*P. intermedia*	*P. parva*	*Tristylospyris triceros*	*Artophormis barbadensis*	*A. dominasinensis*	*A. gracilis*	*Calocycloma ampulla*	*Cycladophora hispida*	*C. turris*
64.0-1-1, 84-86	C, G																		
64.0-1-3, 84-86	C, G																		
64.0-1-CC	R, G																		
64.0-2-1, 20-22	C, G																		
64.0-2-3, 84-86	C, G																		
64.0-2-CC	C, G																		
64.0-3-1, 10-12	C, G						-	-	-										
64.0-3-3, 84-86	C, G																		
64.0-3-CC	C, G						-	-	-										
64.0-4-1, 40-42	C, M	-					R	-	-										
64.0-4-3, 84-86	C, G																		
64.0-4-4, 84-86	C, M																		
64.0-4-CC	C, G	-	-	-	-	-	R	-	-				-						
64.0-5-1, 15-17	C, G	R		-	-		-	R	-										
64.0-5-4, 84-86	C, G	R					-	F	-										
64.0-5-CC	C, G	R		-	-														
64.1-1-1, 20-22	A, M	R		+				R	+										
64.1-1-3, 30-32	A, G	R		-	-														
64.1-1-4, 90-92	A, G	-		R	+	-	-	F	R										
64.1-1-5, 30-32	A, G			F	+			+	R	-	-	-							
64.1-1-CC	A, G			F					F										
64.1-2-1, 34-36	A, G						-	-	R										
64.1-2-3, 84-86	A, G																		
64.1-2-4, 30-32	A, G			F															
64.1-2-CC	A, G			F															
64.1-3-1, 30-32	A, G			F															
64.1-3-3, 30-32	A, G																		
64.1-3-3, 84-86	A, G			F						-	-	-							
64.1-3-CC	A, G			F															
64.1-4-1, 30-32	A, G			F															

Samples	Radiolarian Abundance and Preservation	*Cyclampterium brachythorax*	*C. leptetrum*	*C. milowi*	*C. neatum*	*C. pegetrum*	*C. tanythorax*	*Cyrtocapsella cornuta*	*C. elongata*	*C. japonica*	*C. tetrapera*	*Eusyringium fistuligerum*	*E. lagena*	*Lithochytris vespertilio*	*Lithopera bacca*	*L. baueri*	*L. neotera*	*L. renzae*	*L. thornburgi*
64.0-1-1, 84-86	C, G																		
64.0-1-3, 84-86	C, G																		
64.0-1-CC	R, G																		
64.0-2-1, 20-22	C, G																		
64.0-2-3, 84-86	C, G	-			F														
64.0-2-CC	C, G																		
64.0-3-1, 10-12	C, G	-			F										R	-	-	-	-
64.0-3-3, 84-86	C, G															-			-
64.0-3-CC	C, G				R														
64.0-4-1, 40-42	C, M	R													+	-			-
64.0-4-3, 84-86	C, G	F	-				-								+	-	+	-	-
64.0-4-4, 84-86	C, M	+					+												
64.0-4-CC	C, G	+					+	-			-						R		
64.0-5-1, 15-17	C, G	-	F			-	-	R		-	-				-	-	-	-	-
64.0-5-4, 84-86	C, G		R					R		R	A					-	-	+	-
64.0-5-CC	C, G	-	R			-	-	F											
64.1-1-1, 20-22	A, M		+					F	-	-	-				-	-	-	-	-
64.1-1-3, 30-32	A, G		+					F	-	-	-				-	-	-	-	-
64.1-1-4, 90-92	A, G																		
64.1-1-5, 30-32	A, G							F											
64.1-1-CC	A, G	-	F			-	-	F											
64.1-2-1, 34-36	A, G							F									+		
64.1-2-3, 84-86	A, G																		
64.1-2-4, 30-32	A, G							F											
64.1-2-CC	A, G							F			C								
64.1-3-1, 30-32	A, G							F											
64.1-3-3, 30-32	A, G																		
64.1-3-3, 84-86	A, G							F								-			-
64.1-3-CC	A, G		R					F											
64.1-4-1, 30-32	A, G							F											

64.1-4-3, 84-86	A, G					R		F																																									F															
64.1-4-4, 30-32	A, G																																																								
64.1-4-CC	A, G					R		F																F	F				R																			F															
64.1-5-1, 20-22	A, M			-		+	R	F																																		R			-	-	F											
64.1-5-2, 84-86	A, M																												-	-	-																									
64.1-5-3, 84-86	A, M			-		-	R	R																																		R					F	R	-	-									
64.1-5-CC	A, G						F														-	-	F	R		-		F																F															
64.0-6-1, 11-13	C, G			-		R	F	R															-			-	-	-														F			-	-	F	R	-	?					-			-
64.0-6-4, 11-13	C, G																																																								
64.0-6-4, 84-86	C, M					R	F	-																					-	-	-									R			-		F	R	-	-									
64.0-6-CC	C, G					R	F															-	-		-	-	-	-	-	-	-									R			-		F			-									
64.1-6-1, 30-32	A, G					R	-	-													+			+	-	-	-		+										+			R					C					-			-
64.1-6-3, 30-32	A, G					F	-	-													-	-	-	R	+					+										-	-		R		C			C					-			-
64.1-6-CC	A, G					F																+	-	F	+				-	-	-														F			C									
64.0-7-1, 11-13	A, G					F	-	-													-		F	-	-	-	-	-	-	-									-			R		-	-	-	C									
64.0-7-3, 30-32	A, G																												-	-	-																									
64.0-7-3, 84-86	A, G					F	-	-													-	-	-	F	-											-							R		F	-	-	F									
64.0-7-CC	A, G					F	-															-		F	-											-											F	-	-	C									
64.1-7-1, 95-97	A, G					F	-	-													R			R											-											-	-	-	-									
64.1-7-3, 30-32	A, G					F	-	-						-							-	R	-	+	R							-			R					-			R		-	-	-	-									
64.1-7-CC	A, G					F								-									R		F	R											R					-			R		-	-	-	-									
64.0-8-1, 9-11	A, M					R	-	-						R								F			R																															
64.0-8-2, 84-86	A, G					R	-	-						-								F	-	-	R							-			R					-		+		-			-							
64.0-8-CC	A, G					R								+								F			+												R					-		R															
64.1-8-1, 116-118	A, G					+	-								+								F			-										-	-	F	-	-	-		-	-		R						-	-	-					
64.1-8-2, 84-86	A, G					-	-								R						-	F	-	F	-							-			F					-	F		F		-			-							
64.1-8-CC	A, G					+								R								F		+	-							-	-	-	F		-	-		-	+		F														
64.0-9-CC	C, G					+								R								R		?	-							-			R	-	-	-			-		R						-	-	-					
64.0-10-1, Top	A, G					-								R								-		-	-							R	-		R						F		-													
64.0-10-1, 30-32	A, G					-	-							R																			-		F																						
64.0-10-2, 11-13	A, G														R								-		-								R	-		F	-	-	-			F									-	-	-					
64.0-10-2, 84-86	C, G														+	+							-										R	R	-	F		-	-			R		-						-	-	-					
64.1-9-1, 30-32	A, G															F							-										F	F	-	R	-	-	-			-		-						-	-	-					
64.1-9-2 84-86	A, G															F																				F			-																						
64.1-9-CC	A, G														-	F	-																R	F	-	F	-	-	-			-		-						-	-	-					
64.1-10-1, 30-32	A, G															-	R																-	-	-	-	R	F	-											F	-	-					
64.1-10-2, 84-86	A, G														-	-	+																	-	-	-	F	F	-											F							
64.1-10-CC	A, G															-	+																-		+	-	F	F	+											F		-					
64.1-11-CC	F, P																																																	+		+					

TABLE 3B
Radiolarians at Site 64

Samples	Radiolarian Abundance and Preservation	*Lophocyrtis jacchia*	*Lychnocanium bellum*	*L.* aff. *bellum*	*L. bipes*	*L. trifolium*	*Pterocanium prismatium*	*Sethochytris babylonis* group	*S. triconiscus*	*Stichocorys armata*	*S. delmontensis*	*S. diploconus*	*S. peregrina*	*S. wolffii*	*Theocorys spongoconum*	*Theocotyle ficus*	*Thyrsocyrtis bromia*	*T. rhizodon*	*T. tetracantha*	*T. triacantha*	*Carpocanistrum* spp.	*Carpocanopsis bramlettei*	*C. cingulatum*	*C. cristatum*	*C. favosum*	*Calocycletta costata*	*C. virginis*	*Calocycletta* sp.
64.0-1-1, 84-86	C, G						–						–															
64.0-1-3, 84-86	C, G						–						–															
64.0-1-CC	R, G																											
64.0-2-1, 20-22	C, G						–						F															
64.0-2-3, 84-86	C, G						R						C															–
64.0-2-CC	C, G						R						C															
64.0-3-1, 10-12	C, G						–			–	C	–											–	–				–
64.0-3-3, 84-86	C, G						–				F																	–
64.0-3-CC	C, G										C																	+
64.0-4-1, 40-42	C, M						–				C			–												–		R
64.0-4-3, 84-86	C, G									–	C	–		–							R	–	–	–	–			R
64.0-4-4, 84-86	C, M																											
64.0-4-CC	C, G										C			R										F		–	–	
64.0-5-1, 15-17	C, G						–			+	F	–		A								R	–	R		–	–	–
64.0-5-4, 84-86	C, G									R	C	–		R											–	–	?	R
64.0-5-CC	C, G										C															–	–	F
64.1-1-1, 20-22	A, M									–	A	–		C												F	F	?
64.1-1-3, 30-32	A, G									–	C	–		C								R	–	R	–	F	F	?
64.1-1-4, 90-92	A, G																											
64.1-1-5, 30-32	A, G									F	C	–		R								R	–	R	+	F	C	+
64.1-1-CC	A, G										A															F	C	
64.1-2-1, 34-36	A, G										A	–		F												F	F	
64.1-2-3, 84-86	A, G											+																
64.1-2-4, 30-32	A, G										A			F												F	F	
64.1-2-CC	A, G										C			F												F	C	
64.1-3-1, 30-32	A, G									R	A	–		F	–											F	C	
64.1-3-3, 30-32	A, G											–																
64.1-3-3, 84-86	A, G									R	A											R	R	+	+	F	F	?
64.1-3-CC	A, G									R	C	–		F									R			F	C	
64.1-4-1, 30-32	A, G										C	F		A									F			C	F	

Samples	*Podocyrtis ampla*	*P. chalara*	*P. diamesa*	*P. goetheana*	*P. mitra*	*P. papalis*	*P. sinuosa*	*P. trachodes*	*Theocyrtis annosa*	*T. tuberosa*	*Artostrobium auritum* group	*A. doliolum*	*A. miralestense*	*Carpocanarium* spp.	*Lithomitra lineata* group	*Phormostichoartus corona*	*Siphocampe corbula*	*Spirocyrtis scalaris*	*Theocampe armadillo* group	*T. mongolfieri*	*T. pirum*	*Acrobotrys tritubus*	*Acrobotrys* spp.	*Botryocyrtis* spp.	*Botryopyle dictyocephalus* group	*Botryopyle* sp. A	*Centrobotrys thermophila*	*Centrobotrys* sp. A
64.0-1-1, 84-86																												
64.0-1-3, 84-86												–		R		–		+				–						
64.0-1-CC												–																
64.0-2-1, 20-22												–																
64.0-2-3, 84-86												+		R		–		–				–						
64.0-2-CC												+		R								–	+	R				
64.0-3-1, 10-12												F		–		+	–	–				+		R				
64.0-3-3, 84-86														–								+						
64.0-3-CC																						–						
64.0-4-1, 40-42												R		–			–											
64.0-4-3, 84-86											–	R		–		+	–					–	–	R	–	–	–	–
64.0-4-4, 84-86														–								–	–	R	–	–	–	–
64.0-4-CC												–																
64.0-5-1, 15-17												–				+												
64.0-5-4, 84-86											–	–				R						–	–	R	–	–	+	–
64.0-5-CC																								R				
64.1-1-1, 20-22																+	–					–	–	–	–	–	–	–
64.1-1-3, 30-32																+						–	–	–	–	–	–	–
64.1-1-4, 90-92																												
64.1-1-5, 30-32																R	+					–	–	–	–	–	–	–
64.1-1-CC																												
64.1-2-1, 34-36																+												
64.1-2-3, 84-86																–	–											
64.1-2-4, 30-32																–												
64.1-2-CC																												
64.1-3-1, 30-32											–					+												
64.1-3-3, 30-32																												
64.1-3-3, 84-86																–						–	–	–	–	–	–	–
64.1-3-CC																R												
64.1-4-1, 30-32																–												

64.1-4-3, 84-86	A, G					-				-	R	F		A								R	F	+	+	C	C																								-	-	-	-	-	-	-
64.1-4-4, 30-32	A, G											F																																-												
64.1-4-CC	A, G				-					+	R	R		A												F	C																													
64.1-5-1, 20-22	A,M				-	-				-	+			A								R	F	-	R	F	F												-					-						-	-	-	-	-	-	-
64.1-5-2, 84-86	A,M																																																							
64.1-5-3, 84-86	A,M				F						+			A												F	C																								-	-	-	-	-	-	-
64.1-5-CC	A, G				R									A	-											R	C																													
64.0-6-1, 11-13	C, G									R	R	-		A								F	F	-	R	-																									-	-	-	-	R	-	-
64.0-6-4, 11-13	C, G				+						R			A	-																																									
64.0-6-4, 84-86	C, M				-	-					R			C	+																																				-	-	-	+	R	+	-
64.0-6-CC	C, G										R			A	R												F																													
64.1-6-1, 30-32	A, G				F					-	C	-		-	-												F										-														-	-	+	-	+	-	-
64.1-6-3, 30-32	A, G				F					-	C	-		-	-						C	+	C		R	-	F	-									-				+			-							R	-	+	R		-
64.1-6-CC	A, G				F						C				-												F																													
64.0-7-1, 11-13	A, G				F						-			-	+							-	F		R		C										F															-				-
64.0-7-3 30-32	A, G	-	-	-	F	-	-	-	-		-				R																						F													-	+	-	R	F	-	+
64.0-7-3, 84-86	A, G				F						-			-	+						C	-	F		R		R																									-				-
64.0-7-CC	A, G				F																						+										F																			
64.1-7-1, 95-97	A, G				F	-								-	+												-										F																			
64.1-7-3, 30-32	A, G				F	-								-	+						C	-	C		-	-	-	R									F	-						-						-	+	-	R	F	-	+
64.1-7-CC	A, G				F	-																			-		-										F																			
64.0-8-1, 9-11	A,M				-	R									-																																									
64.0-8-2, 84-86	A, G				-	F									-						C		-		-			-									R	-			+		+	-						-	+	-	R	F	+	-
64.0-8-CC	A, G				-	F																															R	-																		
64.1-8-1, 116-118	A, G	-	-	-	-	-		-	-								-	-	-	-																	F	-												-	-	-	R	-	+	-
64.1-8-2, 84-86	A, G				-	-															F		-		-			-									F	-			-									-	-	-	+	-	-	-
64.1-8-CC	A, G				-																																F	-																		
64.0-9-CC	C, G	-	-	-	-	-		-	-						R	-		-	-	-																	C	-												-	-	-	+	-	F	R
64.0-10-1, Top	A, G														R																						-	C									-	-	-	-	-	-	F	-	R	R
64.0-10-1, 30-32	A, G																																				-	C									-	-	-							
64.0-10-2, 11-13	A, G	-	-	-		-		-	-						R	-		-	-	-	C		-					-									-	C			-			-			-	-	R				R	-	R	F
64.0-10-2, 84-86	C, G	-	-	-	-			-	-						+	-	-	-	-	-																	-	C													-		-	-	-	-
64.1-9-1, 30-32	A, G	F	-	C		-		F	-						-	-	-	-	-	-	F												-	-			-	-									C	-	F				+	-		-
64.1-9-2, 84-86	A, G							F													F												-	-				-									C	-	F	-	-	-	?	-	-	-
64.1-9-CC	A, G	F	-	C		-		F	-							-	-	-	-	-													-	-				-																		
64.1-10-1, 30-32	A, G			-		-									-	R	-	F		F													F	C				-																		
64.1-10-2, 84-86	A, G	-		-		-		F							-	+		F		F	-	-	-	-	-			-					F	C	-	-	-	-									F	C	-	-	-	-	-	-	-	-
64.1-10-CC	A, G	-	+	-		-		F	-						-	R	-	C		F								-					F	C	-	-												C								
64.1-11-CC	F, P																			+													+																							

TABLE 4A
Radiolarians at Site 65

Samples	Radiolarian Abundance and Preservation	*Solenosphaera omnitubus*	*Cannartus laticonus*	*C. mammiferus*	*C. (?) petterssoni*	*C. prismaticus*	*C. tubarius*	*C. violina*	*Ommatartus antepenultimus*	*O. avitus*	*O. hughesi*	*O. penultimus*	*O. tetrathalamus*	*Lithocyclia angustum*	*L. aristotelis* group	*L. ocellus* group	*Dictyocoryne ontongensis*	*Spongaster klingi*	*S. pentas*	*S. tetras*	*Dorcadospyris alata*	*D. ateuchus*	*D. dentata*	*D. forcipata*	*D. papilio*	*Liriospyris elevata*	*L. parkerae*	*L. stauropora*	*Psychospyris grandis*	*P. intermedia*	*P. parva*	*Tristylospyris triceros*	*Artophormis barbadensis*	*A. dominasinensis*	*A. gracilis*	*Calocycloma ampulla*	*Cycladophora hispida*	*C. turris*	*Cyclampterium brachythorax*	*C. leptetrum*	*C. milowi*	*C. neatum*	*C. pegetrum*	*C. tanythorax*	*Cyrtocapsella cornuta*	*C. elongata*	*C. japonica*	*C. tetrapera*	*Eusyringium fistuligerum*	*E. lagena*	*Lithochytris vespertilio*	*Lithopera bacca*	*L. baueri*	*L. neotera*	*L. renzae*	*L. thornburgi*
65.0-1-CC	A, G																																																							
65.0-2-1, 50-52	A, G																			R																																				
65.0-2-3, 30-32	A, G																		+	-																																				
65.0-2-5, 25-27	A, G																	+	+	-																																				
65.0-2-CC	A, G											F																																												
65.0-3-1, 25-27	A, G																	R	+	-																																				
65.0-3-3, 25-27	A, G									R			+						-																							+														
65.0-3-5, 25-27	A, G									R			+																																											
65.0-3-CC	A, G											F							-																																					
65.0-4-2, 25-27	A, G									R	+		+					R	+	-																						R										R				
65.0-4-5, 125-127	A, G																																																							
65.0-4-CC	A, G											F																																												
65.0-5-2, 25-27	A, G									?			-					R	+	-																						R														
65.0-5-4, 25-27	A, G	F																R	-	-																						R														
65.0-5-6, 25-27	A, G	R										F						+	-	-																																				
65.0-5-CC	A, G	-							F		F																																													
65.0-6-2, 25-27	A, G	-							F									+	-	-	-																					+										R	-			-
65.0-6-CC	A, G								F		F															-	+	+																												
65.0-7-2, 25-27	A, G	-							F		R	-					+	-	-	-	-																					+										-				
65.0-7-4, 25-27	A, G	-	F		F				-		-						+	-	-	-	-					R	R	R											R			-										-	-	R	+	-
65.0-7-CC	A, G		F		?																+					+	+	+											-					+									-	-		-
65.0-8-1, 25-27	A, G		-	F													-				-		F			-	-	F												F				+								-	-	-	-	-
65.0-8-3, 25-27	A, G		-	R	-												-				-		R			-	-	F												F			-	-								-	-	-	-	-
65.0-8-5, 25-27	A, G		-	?																	-		R	R	-															F			-	-								-	-	-	-	-
65.0-8-CC	A, G						F																R			-	-	R																-												
65.0-9-1, 30-32	A, G			-				R															-			-	-	-		+														-												
65.0-9-3, 25-27	A, G			-				R													-		-	R	+	-	-	-												R				-									-			-
65.0-9-5, 25-27	A, G			-			R	R															-																	R													-			-
65.0-9-CC	A, G						F																																	R			R	-	C		F									
65.0-10-1, 76-78	A, G			-				R														-																																		

65.0-10-3, 25-27	A, M			-			R	+													-	R	-	R	+						+								-			R										-	-	-	-	-
65.0-10-CC	A, G						R																																																	
65.0-11-2, 75-77	A, G			-		F	-	-																	+						+								-			R										-	-	-	-	-
65.0-11-4, 125-127	A, G					F	-	-														+	-	R	-														-			R		C			F									
65.0-11-CC	A, G																																														C									
65.0-12-1, 25-27	A, M					R	-																		-														-			R		-			-									
65.0-12-3, 25-27	A, M					R	-																								+								-			R		-			-									
65.0-12-4, 25-27	A, M																																																							
65.0-12-4, 125-127	A, G																																																							
65.0-12-5, 25-27	A, G					R																F			-															R				-			-									
65.0-12-5, 125-127	A, M																					+	-	R	-							R																								
65.0-12-6, 25-27	A, M																																																							
65.0-12-6, 125-127	A, G																					R										R																								
65.0-12-CC	A, G					R																																			R		R														
65.0-13-1, 40-42	A, G					+																+																																		
65.0-13-1, 125-127	A, G																																																							
65.0-13-2, 25-27	A, G																					+										R																								
65.0-13-2, 125-127	A, G																					+			-																															
65.0-13-3, 25-27	A, G					+																												R	R						R		R													
65.0-13-3, 125-127	A, G													+								-		+																																
65.0-13-4, 25-27	A, G																																																							
65.0-13-4, 125-127	A, G																																																							
65.0-13-5, 25-27	A, G					-								-							-	-	-	+	-							R			F						R															
65.0-13-CC	A, G													R																											F		-													
65.0-14-1, 25-27	A, G					-								R								-			-									+	F						F		-													
65.0-14-3, 25-27	A, G					-								+								-			+										R																					
65.0-14-5, 25-27	A, G													+								-	-	+	R							R	+		R						F															
65.0-14-CC	A, G													-	R									+	R										R																					
65.0-15-CC	A, G													-	+	R								-	-								R		-						-															
65.0-16-2, 55-57	A, G																					-	-	-	-							R	R	R	-						-		-													
65.0-16-4, 25-27	A, G																																R		-		R	F																		
65.0-16-6, 25-27	A, G																				-	-	-	-	-							R	-	R	-																					
65.0-16-CC	A, G														R																						R	R																		
65.1-2-1, 148-150	A; G																																		-	-	R	R																		
65.1-2-CC	A, G																															R	R				R	+																		
65.1-4-1, 40-42	A, G																															-	-	-	-		R	-											F							
65.1-4-3, 25-27	A, G														+																	-																								
65.1-4, appx. 600 cm	A, G																																																F							
65.1-4-5, 25-27	A, G																																	-	-		R	-											F	F						
65.1-5-1, 45-47	A, G														+																		R	+	-		F	-																		
65.1-5-3, 25-27	A, G														-	R																					F	-																		
65.1-5-CC	A, G														-																	-	-	-	-			-											F							

TABLE 4B
Radiolarians at Site 65

Samples	Radiolarian Abundance and Preservation	*Lophocyrtis jacchia*	*Lychnocanium bellum*	*L.* aff. *bellum*	*L. bipes*	*L. trifolium*	*Pterocanium prismatium*	*Sethochytris babylonis* group	*S. triconiscus*	*Stichocorys armata*	*S. delmontensis*	*S. diploconus*	*S. peregrina*	*S. wolffii*	*Theocorys spongoconum*	*Theocotyle ficus*	*Thyrsocyrtis bromia*	*T. rhizodon*	*T. tetracantha*	*T. triacantha*	*Carpocanistrum* spp.
65.0-1-CC	A, G																				
65.0-2-1, 50-52	A, G																				
65.0-2-3, 30-32	A, G																				
65.0-2-5, 25-27	A, G						R						C								
65.0-2-CC	A, G						+						C								
65.0-3-1, 25-27	A, G						–						C								
65.0-3-3, 25-27	A, G						–						C								
65.0-3-5, 25-27	A, G												C								
65.0-3-CC	A, G						–						C								
65.0-4-2, 25-27	A, G						–						C								
65.0-4-5, 125-127	A, G						–						C								
65.0-4-CC	A, G						–						C								
65.0-5-2, 25-27	A, G												F								
65.0-5-4, 25-27	A, G						–						F								
65.0-5-6, 25-27	A, G						–						–								
65.0-5-CC	A, G										C										
65.0-6-2, 25-27	A, G						–						–								
65.0-6-CC	A, G										C										
65.0-7-2, 25-27	A, G																				
65.0-7-4, 25-27	A, G										C										
65.0-7-CC	A, G										C										
65.0-8-1, 25-27	A, G									–		F		C							
65.0-8-3, 25-27	A, G											R									
65.0-8-5, 25-27	A, G									R		F									
65.0-8-CC	A, G									R											
65.0-9-1, 30-32	A, G											R									
65.0-9-3, 25-27	A, G											–									
65.0-9-5, 25-27	A, G																				
65.0-9-CC	A, G									R	C			F							
65.0-10-1, 76-78	A, G									R	F			–							

Samples	*Carpocanopsis bramlettei*	*C. cingulatum*	*C. cristatum*	*C. favosum*	*Calocycletta costata*	*C. virginis*	*Calocycletta*	*Podocyrtis ampla*	*P. chalara*	*P. diamesa*	*P. goetheana*	*P. mitra*	*P. papalis*	*P. sinuosa*	*P. trachodes*	*Theocyrtis annosa*	*T. tuberosa*	*Artostrobium auritum* group	*A. doliolum*	*A. miralestense*
65.0-1-CC																				
65.0-2-1, 50-52																				
65.0-2-3, 30-32																				
65.0-2-5, 25-27																				
65.0-2-CC																				
65.0-3-1, 25-27																				
65.0-3-3, 25-27																				
65.0-3-5, 25-27																				
65.0-3-CC																				
65.0-4-2, 25-27																		R		
65.0-4-5, 125-127																				
65.0-4-CC																				
65.0-5-2, 25-27																				
65.0-5-4, 25-27																				
65.0-5-6, 25-27																				
65.0-5-CC																				
65.0-6-2, 25-27																				
65.0-6-CC																				
65.0-7-2, 25-27																				
65.0-7-4, 25-27			F															R	R	
65.0-7-CC																			–	
65.0-8-1, 25-27					C	F														
65.0-8-3, 25-27			R		F	C												–	–	
65.0-8-5, 25-27	R	F	R	R	F	C													–	
65.0-8-CC						F													–	
65.0-9-1, 30-32					–	F														
65.0-9-3, 25-27					–	?														
65.0-9-5, 25-27					–	?														
65.0-9-CC					–	F														
65.0-10-1, 76-78					–	F														

Samples	*Carpocanarium* spp.	*Lithomitra lineata* group	*Phormostichoartus corona*	*Siphocampe corbula*	*Spirocyrtis scalaris*	*Theocampe armadillo* group	*T. mongolfieri*	*T. pirum*	*Acrobotrys tritubus*	*Acrobotrys*	*Botryocyrtis* spp.	*Botryopyle dictyocephalus* group	*Botryopyle*	*Centrobotrys thermophila*	*Centrobotrys*
65.0-1-CC															
65.0-2-1, 50-52					–										
65.0-2-3, 30-32															
65.0-2-5, 25-27					–										
65.0-2-CC									R						
65.0-3-1, 25-27															
65.0-3-3, 25-27					–										
65.0-3-5, 25-27															
65.0-3-CC															
65.0-4-2, 25-27				+	–										
65.0-4-5, 125-127															
65.0-4-CC									R						
65.0-5-2, 25-27	+														
65.0-5-4, 25-27															
65.0-5-6, 25-27									R						
65.0-5-CC															
65.0-6-2, 25-27	+								R						
65.0-6-CC									+						
65.0-7-2, 25-27	–								–						
65.0-7-4, 25-27	–			R					–						
65.0-7-CC	–								–						
65.0-8-1, 25-27	–														
65.0-8-3, 25-27	–			–											
65.0-8-5, 25-27	–			–											
65.0-8-CC															
65.0-9-1, 30-32															
65.0-9-3, 25-27	–														
65.0-9-5, 25-27															
65.0-9-CC															
65.0-10-1, 76-78															

65.0-10-3, 25-27	A, M									-	R	-		-	-							-	F	-	+	-	F												-												-	+	+	R	F	-	R
65.0-10-CC	A, G																									F																														
65.0-11-2, 75-77	A, G									-	-	-		-									R			-	R																								-	R	+	F	F	R	+
65.0-11-4, 125-127	A, G				F					-	-			-	-							-	-	-	+	-	F																								-	+	+	F	R	+	+
65.0-11-CC	A, G																									R																														
65.0-12-1, 25-27	A, M				F										-											-																									-	+	+	R	+	R	F
65.0-12-3, 25-27	A, M				R						-				+											-																									-	-	-	F	+	R	F
65.0-12-4, 25-27	A, M				R										-																																									
65.0-12-4, 125-127	A, G				-										-																																									
65.0-12-5, 25-27	A, G				-										-							-	?	-	-												F													-	-	-	R	-	R	F
65.0-12-5, 125-127	A, M				-																																																			
65.0-12-6, 25-27	A, M			+	-														F																																					
65.0-12-6, 125-127	A, G				-										-																																									
65.0-12-CC	A, G																																				F	F																		
65.0-13-1, 40-42	A, G														-																						R																			
65.0-13-1, 125-127	A, G																																																							
65.0-13-2, 25-27	A, G																																																							
65.0-13-2, 125-127	A, G																																																							
65.0-13-3, 25-27	A, G														-																						R	F												-	-	-	R	-	R	F
65.0-13-3, 125-127	A, G																																																							
65.0-13-4, 25-27	A, G				-																																																			
65.0-13-4, 125-127	A, G																																																							
65.0-13-5, 25-27	A, G																					-	-	-	-												F	F																-		
65.0-13-CC	A, G																																					F																		
65.0-14-1, 25-27	A, G	+													-																						-	F												-	-	-	F	-	+	R
65.0-14-3, 25-27	A, G																																				-	F																		
65.0-14-5, 25-27	A, G	R		F					R										F		F	-	-	-	-													F						-						-	-	-	F	-	-	F
65.0-14-CC	A, G														-																							F											R							R
65.0-15-CC	A, G														-		F		F																			-											-				F			-
65.0-16-2, 55-57	A, G	F		R					R								F				F	-	-	-	-													-											R	-	-	-	F	-	-	-
65.0-16-4, 25-27	A, G																F																					-																		
65.0-16-6, 25-27	A, G	R		R					R								F		F																			-											R							
65.0-16-CC	A, G			R													F		R																			-															F			-
65.1-2-1, 148-150	A, G	-		-	-	-			+								-		R																														-							
65.1-2-CC	A, G			-					R								?		-																																					
65.1-4-1, 40-42	A, G	?		-	-										-		-	F	-	F	-	-	-	-	-					R		+	F																-							
65.1-4-3, 25-27	A, G								R																					R			F																							
65.1-4, app. 600 cm	A, G							F	R							R		F		F									R	R	R	R	F	C	R																					
65.1-4-5, 25-27	A, G	-		-	-				+						-				-		-									R		R	F																				R			-
65.1-5-1, 45-47	A, G	-		-	-				+						-		-		-											F		R	F														C									
65.1-5-3, 25-27	A, G																				-	-	-	-	-					F		R	F																-							
65.1-5-CC	A, G	-		-	-				+							R		F	-	C										R		F	F	F													F						+			

TABLE 5A
Radiolarians at Site 66

Samples	Radiolarian Abundance and Preservation	*Solenosphaera omnitubus*	*Cannartus laticonus*	*C. mammiferus*	*C. (?) petterssoni*	*C. prismaticus*	*C. tubarius*	*C. violina*	*Ommatartus antepenultimus*	*O. avitus*	*O. hughesi*	*O. penultimus*	*O. tetrathalamus*	*Lithocyclia angustum*	*L. aristotelis* group	*L. ocellus* group	*Dictyocoryne ontongensis*	*Spongaster klingi*	*S. pentas*	*S. tetras*	*Dorcadospyris alata*	*D. ateuchus*	*D. dentata*	*D. forcipata*	*D. papilio*	*Liriospyris elevata*	*L. parkerae*	*L. stauropora*	*Psychospyris grandis*	*P. intermedia*	*P. parva*	*Tristylospyris triceros*	*Artophormis barbadensis*	*A. dominasinensis*	*A. gracilis*	*Calocycloma ampulla*	*Cycladophora hispida*	*C. turris*	*Cyclampterium brachythorax*	*C. leptetrum*	*C. milowi*	*C. neatum*	*C. pegetrum*	*C. tanythorax*	*Cyrtocapsella cornuta*	*C. elongata*	*C. japonica*	*C. tetrapera*	*Eusyringium fistuligerum*	*E. lagena*	*Lithochytris vespertilio*	*Lithopera bacca*	*L. baueri*	*L. neotera*	*L. renzae*	*L. thornburgi*
66.1-1-CC	A, G									–			F						–																				–			–		–	–	–	–	–				–	–	–	–	–
66.1-2-1, 25-27	A, G									R			F					–	–																				–			–		–	–	–	–	–				+	–	–	–	–
66.1-2-3, 25-27	A, G	–								R			F					–	–	+																																				
66.1-2-5, 25-27	A, G	–								R		–	F					–	–	F																																				
66.1-2-CC	A, G									F			F						R																																					
66.1-3-1, 55-57	A, G	F								F	–		R					F	+	–																																				
66.1-3-3, 25-27	A, G	F								+		F							+																																					
66.1-3-5, 25-27	A, G									R	–	F					–	F	+																				–			R		–	–	–	–	–				R	–	–	–	–
66.1-3-CC	A, G																		?																																					
66.1-4-1, 110-111	A, G		–		–				F		+	R																														R														
66.1-4-3, 25-27	A, G	F	–						F		–	R					–																																							
66.1-4-5, 25-27	A, G	R	–		–				F		R	R					–	R																					–			R														
66.0-1-3, Top	A, G	–							F		R																																													
66.1-4-CC	A, G	–							C		F																–																													
66.1-5-1, 25-27	A, G	–			–				F		F						+	R	R								–													R			+														
66.0-1-6, Top	A, G								F		R																												R			+														
66.1-5-3, 30-32	A, G	–	–		R				F		F	–					R	+	+								–												F	–		–	–	–	–	–	–	–				F	–	R	–	–
66.0-1-CC	A, G																	R	–																																					
66.1-5-5, 25-27	A, G		R		R				F		R							–									–																		–							R	–	F		–
66.1-5-CC	A, G				F				F		R																+	–	–																											
66.1-6-2, 25-27	A, G		R	–	F	–			R		+	–						–									R																		–							R	–	F		+
66.1-6-4, 25-27	A, G		C	–	F	–			R		–						+	–			–	–	–	–	–							–							R	–		–	–	R	+	–	R	–				+	+	F	–	R
66.1-6-6, 25-27	A, G		F		F												R				–	–	–	–	–							–							R					–	–	–	R	–				–		F	–	
66.1-6-CC	A, G		F		F																R	–	–	–	–	R	–	–				–																								
66.1-7-1, 25-27	A, G		–	F	–	–	–										–				F					–																		R	F		–	F				–		–	F	

66.1-7-3, 70-72	A, G		-	F	-	-	-	R									-				R					-	-	-																	R	F		-					-	F		F	R
66.1-7-5, 25-27	A, G		-	F	-	-	-	R									-				R	-	-	-	-				-	-	-	-													R	F								R		F	+
66.1-7-CC	A, G			F																	R					-	-	-	-	-	-																										
66.1-8-1, 25-27	A, G			F	-	-	-	R	-								-				R	-	-	-	-		F		-	-	-	-								-				R				F					-		F	-
66.1-8-3, 25-27	A, G		F	F													-				R		-				F	-	+	-	-								-	F		-	-	F	R	-	-	R				-	-	-	C	-
66.0-2-1, 25-27	A, G																				R																							R									+	+	F	
66.1-8-6, 25-27	A, G			F	-	-	R	R													R	-	+	-	-				-	-	-	-								F			-										-		F	-
66.0-2-3, 25-27	A, G			F																			R						+											F			-												R	
66.1-8-CC	A, G			F																	R			-		-	F	+	+				-	-	-	-	-	-		F									-		-				F	
66.0-2-CC	A, G		-	F				F													-		R	-	-		+	F	-	F			-	-	-	-	-			F					F			C							F	
66.0-3-1, 25-27	A, G					F	+	-													-	-	-	R	-			-	-	+		-			-					-			R		R			R							-	
66.0-3-1, 125-127	A, G																								+			-																												
66.0-3-2, 25-27	A, G																					-								R			-	-	-	-	-	+										R	+		+					
66.0-3-2, 125-127	A, G																																																							
66.0-3-3, 25-27	A, G					F																-								F	-		-	-	-										-			R								
66.0-3-3, 125-127	A, G																													R	-																									
66.0-3-4, 25-27	A, G																					+								R	-																									
66.0-3-4, 125-127	A, M																													+	+										-		F													
66.0-3-5, 25-27	A, M					F	+														-	+	-	R	+					+	F	-			R					+	-		F		-			-							-	
66.0-3-5, 125-127	A, M													-																-	F		-		R																					
66.0-3-6, 25-27	A, M													-								R		R	+					-	R		-	-	F			+			+		R						+		+					
66.0-3-6, 125-127	A, M													-																	+																									
66.0-3-CC	A, M					F								-	+	+						R		R	-			-			-	-	-		F						+		R													

TABLE 5B
Radiolarians at Site 66

Samples	Radiolarian Abundance and Preservation	Lophocyrtis jacchia	Lychnocanium bellum	L. aff. bellum	L. bipes	L. trifolium	Pterocanium prismatium	Sethochytris babylonis group	S. triconiscus	Stichocorys armata	S. delmontensis	S. diploconus	S. peregrina	S. wolffii	Theocorys spongoconum	Theocotyle ficus	Thyrsocyrtis bromia	T. rhizodon	T. tetracantha	T. triacantha	Carpocanistrum spp.	Carpocanopsis bramlettei	C. cingulatum	C. cristatum	C. favosum	Calocycletta costata	C. virginis	C. sp.
66.1-1-CC	A, G						-			-	-	-	-	-							C							
66.1-2-1, 25-27	A, G						-			-	-	-	+	-														
66.1-2-3, 25-27	A, G						F						-															
66.1-2-5, 25-27	A, G						F						C															
66.1-2-CC	A, G						R						C															
66.1-3-1, 55-57	A, G						-						C															
66.1-3-3, 25-27	A, G						-						C															
66.1-3-5, 25-27	A, G									-	R	-	C	-							C							-
66.1-3-CC	A, G						-						C															
66.1-4-1, 110-111	A, G										R		C															R
66.1-4-3, 25-27	A, G										C																	F
66.1-4-5, 25-27	A, G										C		R															
66.0-1-3, Top	A, G										C																	
66.1-4-CC	A, G										C																	
66.1-5-1, 25-27	A, G										C																	
66.0-1-6, Top	A, G										C		R	-														
66.1-5-3, 30-32	A, G									-	A	-	-	-							C			-				F
66.0-1-CC	A, G										C		F	-														
66.1-5-5, 25-27	A, G										C			R									-	-				
66.1-5-CC	A, G										C																	
66.1-6-2, 25-27	A, G									-	C	-		R										-				
66.1-6-4, 25-27	A, G									+	A	-	-	R							F	-	-	+	-			R
66.1-6-6, 25-27	A, G										C			R								-	-	R	-			
66.1-6-CC	A, G										C			F														
66.1-7-1, 25-27	A, G										C											+	-	F	R			

Samples	Podocyrtis ampla	P. chalara	P. diamesa	P. goetheana	P. mitra	P. papalis	P. sinuosa	P. trachodes	Theocyrtis annosa	T. tuberosa	Artostrobium auritum group	A. doliolum	A. miralestense	Carpocanarium spp.	Lithomitra lineata group	Phormostichoartus corona	Siphocampe corbula	Spirocyrtis scalaris	Theocampe armadillo group	T. mongolfieri	T. pirum	Acrobotrys tritubus	Acrobotrys	Botryocyrtis spp.	Botryopyle dictyocephalus group	Botryopyle	Centrobotrys thermophila	Centrobotrys
66.1-1-CC											C	-	F	R	R	-	F	R	-	-	-		+	F	R	-	R	-
66.1-2-1, 25-27											F	+	F		-	-	R	+	-	-	-		+	F	+	-	+	-
66.1-2-3, 25-27																						-						
66.1-2-5, 25-27											C	-	C		R	-	F	R				-						
66.1-2-CC																												
66.1-3-1, 55-57											C	C	F		R	F	F	+				R						
66.1-3-3, 25-27											R	C	R		R	C	F	+				R		R				
66.1-3-5, 25-27											F	F	F	R	R	F	R	+				+	R	R	F	-	F	-
66.1-3-CC																												
66.1-4-1, 110-111														R				-				R		R				
66.1-4-3, 25-27																						+						
66.1-4-5, 25-27																						R		R				
66.0-1-3, Top																												
66.1-4-CC																												
66.1-5-1, 25-27																						-		R				
66.0-1-6, Top																												
66.1-5-3, 30-32											F	F	F	R	R	F	R	-	-	-	-	-	R	R	-	-	R	-
66.0-1-CC																						-						
66.1-5-5, 25-27											F	F	R		F	F	R	-				-		R				
66.1-5-CC																												
66.1-6-2, 25-27											C	R	F		F	F	R	-										
66.1-6-4, 25-27											F	-	R	+	R	F	R	-					+	R	+	-	+	-
66.1-6-6, 25-27												-																
66.1-6-CC												-																
66.1-7-1, 25-27																						-		F				

66.1-7-3, 70-72	A, G										C	-		F								+	-	R	R	-	-																		R											
66.1-7-5, 25-27	A, G										C											-			-	-	-																													
66.1-7-CC	A, G										C																																													
66.1-8-1, 25-27	A, G									F	C	-		R								R	-	F	-	-	?												+																	
66.1-8-3, 25-27	A, G									F	A	-	-	R							C	F	-	R	-	R	R	C											R	-	R	R	R	R	-	-	-	-	-		+	R	R	-	R	-
66.0-2-1, 25-27	A, G									R	C	+																																												
66.1-8-6, 25-27	A, G	-	-	-	-					R	C	-		R	-				-	-						F	R	C														R														
66.0-2-3, 25-27	A, G	-	-	-	-					F	C	-		R	-				-	-		F	-	R	-	R	F										-					R		F										-		
66.1-8-CC	A, G	-	-	-	-					F	C				-											R	R															R		F										-		
66.0-2-CC	A, G	-	-	-	-					F	C			R	-				-	-			-	R	-	R	F										-																			
66.0-3-1, 25-27	A, G				C					-	-	-		-								-	R	-	+	-	R	-									F					-		-										R		
66.0-3-1, 125-127	A, G																																																							
66.0-3-2, 25-27	A, G			-	C	-								-	+				+	R																																				
66.0-3-2, 125-127	A, G																										+		R								F																			
66.0-3-3, 25-27	A, G			-	C	-					-			-	-					+						-	+										F																			
66.0-3-3, 125-127	A, G																																																							
66.0-3-4, 25-27	A, G																										-										F																			
66.0-3-4, 125-127	A, M																																																							
66.0-3-5, 25-27	A, M									-				-							F	+	R	-	+	-	-										F					-		-						-	R	+	F	R	R	-
66.0-3-5, 125-127	A, M																																					-																		
66.0-3-6, 25-27	A, M	-	-	-	C	-		-							-	-	-	-	+	R							-										F	+																		
66.0-3-6, 125-127	A, M																																					R																		
66.0-3-CC	A, M																					-		-													F	R																		

TABLE 6
Radiolarian Events at Sites 62-66 (for explanation, see text Section 5)

Events at Sites 62, 63, 64, 66	Site 62	Site 63	Site 64	Site 66	Site 65	Events at Site 65 (all m)
T *Stichocorys peregrina* e	1-9-2 0-1-2 M (83-93)	1-2-CC 1-3-1 M (22-23)	0-1-3 0-2-1 G (4-100)	1-2-3 1-2-5 P (24-27)		
Spongaster pentas → *S. tetras*	1-9-4 0-1-2 M (86-93)	?	0-2-3 0-2-CC M (103-108)	1-2-5 1-3-1 M (27-30)	0-2-1 0-2-3 M (11-14)	B *Spongaster tetras*
T *Pterocanium prismatium* e	0-1-3 0-1-4 P (95-96)	1-1-1 1-2-CC P (4-22)	0-2-1 0-2-3 M (100-103)	1-2-1 1-2-3 G (21-24)		
B *Pterocanium prismatium* m	1-13-3 1-13-5 P (123-126)	2-3-1 2-3-4 M (31-35)	0-2-CC 0-3-1 M (108-203)	1-2-CC 1-3-1 M (29-30)	0-2-CC 0-3-1 P (19-20)	B *Pterocanium prismatium*
Ommatartus avitus → *O. tetrathalamus*	1-13-3 1-13-5 P (123-126)	1-3-1 2-3-4 M (23-35)	0-2-CC 0-3-1 M (108-203)	1-2-5 1-3-1 G (27-30)	0-4-2 0-5-2 P (30-39)	B *Ommatartus tetrathalamus*
Spongaster klingi → *S. pentas*	1-14-5 1-18-CC P (136-174)	?	0-2-CC 0-3-1 P (108-203)	1-2-CC 1-3-1 M (29-30)	0-5-2 0-5-4 P (39-42)	B *Spongaster pentas*
Ommatartus penultimus → *O. avitus*	1-13-3 1-13-5 P (123-126)	1-3-1 2-3-4 M (23-35)	0-2-CC 0-3-1 M (108-203)	1-3-1 1-3-3 G (30-33)	?	B *Ommatartus avitus*
T *Solenosphaera omnitubus* m	1-16-5 1-17-2 P (154-158)	2-3-CC 0-2-2 G (39-63)	0-2-CC 0-3-1 G (108-203)	1-2-5 1-3-1 G (27-30)		
T *Acrobotrys tritubus* m	1-18-2 1-18-5 P (167-172)	2-3-CC 0-2-2 M (39-63)	0-2-CC 0-3-1 P (108-203)	1-2-5 1-3-1 M (27-30)		
T *Artostrobium doliolum* m	1-20-2 1-22-2 M (188-209)	1-3-CC 0-2-2 G (31-63)	0-2-1 0-2-3 P (100-103)	1-1-CC 1-3-1 M (24-30)		
T *Phormostichoartus corona* m	1-18-5 1-22-2 P (172-209)	1-3-1 0-2-4 M (23-66)	0-2-3 0-3-1 P (103-203)	1-2-5 1-3-1 M (27-30)		

B *Spirocyrtis scalaris* m	?	?	0-1-3 0-2-3 (4-103) P	1-3-5 1-4-1 (36-39) P	?	B *Spirocyrtis scalaris*
Stichocorys delmontensis → *S. peregrina*	1-21-5 1-21-CC (202-204) M	2-3-CC 0-2-2 (39-63) G	0-2-CC 0-3-1 (108-203) G	1-4-1 1-4-3 (39-42) G	0-5-4 0-5-CC (42-46) M	B *Stichocorys peregrina*
T *Calocycletta* sp. m	?	2-3-CC 0-2-2 (39-63) M	0-3-3 0-3-CC (206-211) P	1-3-5 1-4-1 (36-39) M		
Ommatartus antepenultimus → *O. penultimus*	1-23-CC 1-24-2 (225-227) G	0-2-4 0-2-6 (66-69) G	0-2-CC 0-3-1 (108-203) M	1-3-5 1-4-1 (36-39) G	0-5-6 0-7-2 (45-57) M	B *Ommatartus penultimus*
B *Solenosphaera omnitubus* m	1-23-5 1-24-2 (223-227) G	0-2-4 0-2-6 (66-69) G	0-3-CC 0-4-1 (211-305) G	0-1-3 1-4-5 (45-45) M	0-5-6 0-5-CC (45-46) M	B *Solenosphaera omnitubus*
T *Ommatartus hughesi* e	1-24-5 1-24-CC (232-234) G	0-2-CC 1-5-1 (70-102) P	0-3-CC 0-4-1 (211-305) M	1-3-5 1-4-5 (36-45) M		
Cyclampterium brachythorax → *C. neatum*	1-25-2 1-26-2 (236-247) M	0-2-CC 1-5-1 (70-102) M	0-3-CC 0-4-1 (211-305) M	1-4-5 1-5-1 (45-48) M	0-7-2 0-7-4 (57-60) M	B *Cyclampterium neatum*
B *Acrobotrys tritubus* m	1-27-2 1-27-4 (256-259) P	0-2-CC 1-5-1 (70-102) M	0-3-3 0-3-CC (206-211) P	1-4-5 1-5-1 (45-48) M	0-6-CC 0-7-2 (55-57) P	B *Acrobotrys tritubus*
T *Dictyocoryne ontongensis* m	1-27-4 1-28-2 (259-265) P	0-2-CC 1-5-1 (70-102) P	0-3-3 0-3-CC (206-211) P	1-4-5 1-5-1 (45-48) P		
B *Spongaster klingi* m	1-28-5 1-29-5 (270-278) M	1-5-1 1-5-3 (102-105) P	0-3-CC 0-4-1 (211-305) P	1-5-3 1-5-5 (51-54) M	0-6-2 0-7-2 (48-57) P	B *Spongaster klingi*
Cannartus petterssoni → *Ommatartus hughesi*	1-29-CC 1-30-2 (280-283) G	2-3-CC 1-5-1 (39-102) P	0-3-CC 0-4-1 (211-305) M	1-5-3 1-5-CC (51-56) G	0-7-2 0-7-4 (57-60) M	B *Ommatartus hughesi*
T *Liriospyris elevata* m	1-30-2 1-30-5 (283-288) M	0-2-CC 1-5-1 (70-102) G	0-3-CC 0-4-1 (211-305) M	1-5-5 1-5-CC (54-56) M		
B *Carpocanarium* spp. m	1-32-2 0-3-6 (303-307) P	0-2-6 1-5-1 (69-102) P	0-2-3 0-3-1 (103-203) M	0-2-3 0-3-1 (83-118) M	0-6-2 0-7-2 (48-57) P	B *Carpocanarium* spp.

TABLE 6 – *Continued*

Events at Sites 62, 63, 64, 66		Site 62		Site 63		Site 64		Site 66		Site 65		Events at Site 65 (all m)
B *Dictyocoryne ontongensis*	m	1-30-5 1-31-2 (288-293)	M	1-5-1 1-5-3 (102-105)	P	0-3-CC 0-4-1 (211-305)	P	1-6-6 1-7-1 (64-68)	M	0-7-4 0-8-1 (60-65)	P	B *Dictyocoryne ontongensis*
Cannartus laticonus → *Ommatartus antepenultimus*		1-30-CC 1-31-5 (290-298)	G	1-5-1 1-5-3 (102-105)	G	0-3-CC 0-4-1 (211-305)	M	1-5-CC 1-6-4 (56-61)	G	0-7-2 0-7-4 (57-60)	M	B *Ommatartus antepenultimus*
Lithopera neotera → *L. bacca*		1-32-2 1-34-3 (303-324)	M	1-5-1 1-5-3 (102-105)	M	0-4-1 0-4-CC (305-313)	M	1-5-3 1-5-5 (51-54)	G	0-6-2 0-7-2 (48-57)	M	B *Lithopera bacca*
T *Carpocanopsis cristatum*	m	1-31-5 1-33-2 (298-312)	M	1-5-3 1-7-4 (105-124)	P	0-4-3 0-4-CC (308-313)	G	1-6-2 1-6-4 (58-61)	P			
T *Lithopera thornburgi*	m	1-35-2 1-35-5 (329-334)	P	0-2-4 1-5-1 (66-102)	P	0-4-CC 0-5-1 (313-410)	P	1-5-5 1-6-2 (54-58)	M			
T *Lithopera baueri*	m	1-32-5 1-33-2 (308-312)	P	1-5-3 1-6-1 (105-111)	P	0-4-CC 0-5-1 (313-410)	P	1-6-2 1-6-4 (58-61)	P			
Cyclampterium tanythorax → *C. brachythorax*		1-33-2 1-34-3 (312-324)	M	1-6-5 1-6-CC (117-119)	M	0-4-3 0-5-1 (308-410)	G	1-6-6 1-7-1 (64-68)	M	0-7-4 0-8-3 (60-68)	G	B *Cyclampterium brachythorax*
T *Stichocorys armata*	m	?		1-8-4 0-3-1 (134-138)	M	0-4-3 0-5-1 (308-410)	P	1-6-2 1-6-4 (58-61)	P			
T *Dorcadospyris alata*	e	1-33-CC 1-34-3 (319-324)	M	1-6-5 1-6-CC (117-119)	P	0-4-CC 0-5-1 (313-410)	M	1-6-6 1-6-CC (64-65)	M			
T *Cyrtocapsella cornuta*	m	1-34-5 1-34-CC (327-328)	G	1-6-5 1-6-CC (117-119)	M	0-4-CC 0-5-1 (313-410)	M	1-6-2 1-6-4 (58-61)	P			
T *Stichocorys wolffii*	m	1-37-2 0-4-1 (346-396)	G	1-6-3 1-6-CC (114-119)	P	0-4-3 0-4-CC (308-313)	M	0-1-CC 1-5-5 (50-54)	M			

B	*Artostrobium doliolum*	m	1-37-CC 0-4-3 (350-399)	M	1-6-3 1-7-4 (114-124)	P	0-4-3 0-4-CC (308-313)	M	1-6-2 1-6-4 (58-61)	M	0-7-4 0-7-CC (60-64)	M	B	*Artostrobium doliolum*
B	*Cannartus pettersoni*	m	1-35-2 1-35-5 (329-334)	P	1-8-2 1-8-4 (131-134)	M	0-4-CC 0-5-1 (313-410)	G	1-6-CC 1-7-1 (65-68)	G	0-7-4 0-8-3 (60-68)	M	B	*Cannartus pettersoni*
T	*Carpocanopsis bramlettei*	m	1-35-5 1-36-4 (334-341)	P	1-7-4 1-8-6 (124-137)	P	0-4-3 0-5-1 (308-410)	M	1-6-6 1-8-1 (64-77)	P				
B	*Liriospyris elevata*	m	1-37-2 1-37-CC (346-350)	M	1-8-2 1-8-3 (131-133)	P	0-4-CC 0-5-1 (313-410)	M	1-6-CC 1-7-1 (65-68)	M	0-7-CC 0-8-1 (64-65)	M	B	*Liriospyris elevata*
	Lithopera renzae → *L. neotera*		1-37-2 1-37-CC (346-350)	M	1-8-2 1-9-2 (131-140)	M	0-4-CC 0-5-4 (313-414)	P	1-6-6 1-7-1 (64-68)	G	0-7-4 0-8-1 (60-65)	M	B	*Lithopera neotera*
	Cannartus mammiferus → *C. laticonus*		1-38-CC 0-4-1 (358-396)	G	1-7-CC 1-8-6 (128-137)	M	0-4-CC 0-5-1 (313-410)	M	1-6-CC 1-7-1 (65-68)	G	0-7-CC 0-8-1 (64-65)	M	B	*Cannartus laticonus*
T	*Cyrtocapsella tetrapera*	m	1-37-CC 0-4-CC (350-404)	P	1-8-4 1-8-6 (134-137)	M	0-5-1 1-2-CC (410-451)	P	1-6-6 1-7-1 (64-68)	M				
B	*Lithopera thornburgi*	m	1-36-CC 1-37-2 (344-346)	P	1-9-1 1-9-2 (139-140)	P	0-4-CC 0-5-1 (313-410)	P	1-7-5 1-8-1 (74-77)	M	?		B	*Lithopera thornburgi*
B	*Lithopera baueri*	m	1-35-2 1-35-5 (329-334)	P	1-9-1 1-9-2 (139-140)	P	0-4-CC 0-5-1 (313-410)	P	1-7-5 1-8-6 (74-84)	M	?		B	*Lithopera baueri*
T	*Liriospyris parkerae*	m	?		1-9-2 1-9-3 (140-142)	M	0-4-CC 0-5-1 (313-410)	M	1-7-CC 1-8-1 (76-77)	G				
B	*Siphocampe corbula*	m	?		?		?		1-7-3 1-8-3 (71-80)	P	0-7-4 0-8-3 (60-68)	P	B	*Siphocampe corbula*
	Cyclampterium leptetrum → *C. tanythorax*		1-37-CC 0-4-1 (350-396)	M	1-9-1 1-9-2 (139-140)	M	0-4-3 0-5-1 (308-410)	G	1-8-1 1-8-6 (77-84)	M	0-8-3 0-8-CC (68-73)	P	B	*Cyclampterium tanythorax*
T	*Calocycletta virginis*	m	1-37-CC 0-4-1 (350-396)	M	1-9-2 1-9-3 (140-142)	M	0-5-CC 1-1-1 (418-434)	M	1-7-5 1-8-3 (74-80)	M				

TABLE 6 – *Continued*

Events at Sites 62, 63, 64, 66	Site 62	Site 63	Site 64	Site 66	Site 65	Events at Site 65 (all m)
T *Psychospyris grandis* e	?	?	?	1-8-1 1-8-3 P (77-80)		
T *Calocycletta costata* m	1-37-CC 0-4-1 G (350-396)	1-9-2 1-9-3 P (140-142)	0-5-CC 1-1-1 G (418-434)	1-8-1 1-8-3 M (77-80)		
T *Dorcadospyris dentata* m	1-37-CC 0-4-1 G (350-396)	1-10-1 1-10-3 G (149-152)	0-5-CC 1-1-1 P (418-434)	1-8-3 1-8-6 M (80-84)		
B *Dorcadospyris alata* m	1-37-CC 0-4-1 M (350-396)	1-10-1 1-10-3 M (149-152)	1-1-3 1-1-4 M (437-438)	1-8-CC 0-2-CC M (85-88)	0-7-CC 0-8-1 P (64-65)	B *Dorcadospyris alata*
Psychospyris intermedia → *P. grandis*	?	?	?	1-8-CC 0-2-CC G (85-88)	?	B *Psychospyris grandis*
Liriospyris stauropora → *L. parkerae*	1-38-CC 0-4-1 G (358-396)	1-10-1 1-10-3 G (149-152)	1-1-4 1-1-5 G (438-440)	1-8-CC 0-2-CC G (85-88)	0-7-CC 0-8-1 M (64-65)	B *Liriospyris parkerae*
Cannartus violina → *C. mammiferus*	1-38-CC 0-4-1 G (358-396)	1-9-5 1-10-1 G (145-149)	1-1-3 1-1-5 M (437-440)	1-8-CC 0-3-1 G (85-118)	0-8-3 0-9-1 M (68-75)	B *Cannartus mammiferus*
B *Lithopera renzae* m	1-37-CC 0-4-1 M (350-396)	1-10-1 1-10-3 M (149-152)	0-5-4 1-1-1 P (414-434)	0-2-3 0-3-1 M (83-118)	0-7-4 0-8-3 P (60-68)	B *Lithopera renzae*
T *Dorcadospyris forcipata* m	0-4-2 0-4-3 P (397-399)	1-10-1 1-10-3 M (149-152)	1-1-3 1-1-4 P (437-438)	0-2-CC 0-3-1 M (88-118)		
T *Carpocanopsis favosum* m	1-37-CC 0-4-1 P (350-396)	1-13-5 1-14-1 P (181-185)	1-1-3 1-1-5 P (437-440)	0-2-3 0-3-1 P (83-118)		
T *Cannartus prismaticus* m	1-37-CC 0-4-1 P (350-396)	1-13-1 1-14-1 P (175-185)	1-3-1 1-3-3 M (452-455)	1-8-6 0-3-1 G (84-118)		
T *Stichocorys diploconus* m	1-37-CC 0-4-1 M (350-396)	1-11-3 1-11-CC P (159-164)	1-3-CC 1-4-1 G (460-462)	1-8-3 0-2-1 P (80-80)		

B *Phormostichoartus corona*	m	0-4-1 0-4-2 (396-397) P	1-14-1 0-4-2 (185-232) P	1-3-CC 1-4-1 (460-462) P	0-2-3 0-3-1 (83-118) M	?	B *Phormostichoartus corona*
T *Carpocanopsis cingulatum*	m	1-37-2 0-4-3 (346-399) G	1-12-CC 1-13-1 (174-175) G	1-3-3 1-4-3 (455-465) G	0-2-CC 0-3-1 (88-118) M		
B *Carpocanopsis cristatum*	m	1-37-2 0-4-3 (346-399) M	1-13-3 1-14-1 (178-185) P	1-4-3 1-5-1 (465-471) P	0-2-CC 0-3-1 (88-118) M	0-8-5 0-10-3 (71-87) M	B *Carpocanopsis cristatum*
B *Calocycletta costata*	m	0-4-CC 0-5-2 (404-492) G	1-13-CC 1-14-1 (183-185) G	1-5-CC 0-6-1 (479-506) M	0-2-CC 0-3-1 (88-118) M	0-8-5 0-9-1 (71-75) G	B *Calocycletta costata*
T *Lychnocanium bipes*	m	0-4-6 0-5-2 (403-492) M	1-14-1 1-14-3 (185-188) M	1-5-1 1-5-3 (471-474) M	0-2-CC 0-3-1 (88-118) G		
B *Stichocorys diploconus*	m	0-4-CC 0-5-2 (404-492) M	1-14-CC 0-4-2 (193-232) M	1-4-CC 1-5-1 (470-471) M	0-2-1 1-8-6 (80-84) P	0-9-1 0-9-3 (75-78) M	B *Stichocorys diploconus*
B *Dorcadospyris dentata*	m	0-4-CC 0-5-2 (404-492) G	1-14-CC 0-4-1 (193-231) M	1-5-CC 0-6-1 (479-506) G	0-2-CC 0-3-1 (88-118) G	0-8-CC 0-9-1 (73-75) M	B *Dorcadospyris dentata*
Cannartus tubarius → *C. violina*		0-4-CC 0-5-2 (404-492) G	1-13-5 1-14-5 (181-191) M	1-5-1 1-5-CC (471-479) M	1-8-CC 0-3-1 (85-118) M	0-10-3 0-11-2 (87-94) M	B *Cannartus violina*
T *Theocorys spongoconum*	m	0-4-6 0-5-2 (403-492) M	1-13-5 1-14-3 (181-188) P	0-6-1 0-6-4 (506-510) P	?		
B *Liriospyris stauropora*	m	0-4-CC 0-5-2 (404-492) G	1-14-CC 0-4-1 (193-231) M	1-5-CC 0-6-1 (479-506) G	0-2-CC 0-3-1 (88-118) G	0-8-CC 0-9-1 (73-75) M	B *Liriospyris stauropora*
T *Botryopyle* sp. A	m	0-4-CC 0-5-2 (404-492) M	1-14-CC 0-4-2 (193-232) G	1-5-3 0-6-1 (474-506) M	0-2-3 0-3-1 (83-118) M		
B *Stichocorys wolffii*	m	0-4-CC 0-5-2 (404-492) G	1-14-CC 0-4-1 (193-231) G	0-6-CC 1-6-1 (514-566) G	0-2-CC 0-3-1 (88-118) M	0-9-CC 0-10-1 (83-84) M	B *Stichocorys wolffii*
Cyclampterium pegetrum → *C. leptetrum*		0-4-CC 0-5-2 (404-492) M	1-14-CC 0-4-1 (193-231) M	0-6-CC 1-6-1 (514-566) G	0-2-3 0-3-1 (83-118) M	0-9-CC 0-10-3 (83-87) M	B *Cyclampterium leptetrum*

TABLE 6 – *Continued*

Events at Sites 62, 63, 64, 66	Site 62	Site 63	Site 64	Site 66	Site 65	Events at Site 65 (all m)
B *Carpocanopsis bramlettei* m	0-4-6 0-5-4 G (403-495)	1-14-1 0-4-1 M (185-231)	1-6-3 0-7-1 P (569-611)	?	0-8-5 0-10-3 P (71-87)	B *Carpocanopsis bramlettei*
B *Cannartus tubarius* m	0-4-6 0-5-2 P (403-492)	0-4-1 0-4-2 M (231-232)	0-6-CC 1-6-1 G (514-566)	0-3-5 0-3-CC P (124-126)	0-10-CC 0-11-2 P (92-94)	B *Cannartus tubarius*
B *Stichocorys armata* m	?	0-4-2 0-5-2 M (232-354)	0-6-1 1-6-1 P (506-566)	0-2-3 0-3-1 G (83-118)	0-10-1 0-10-3 M (84-87)	B *Stichocorys armata*
T *Theocyrtis annosa* m	0-4-CC 0-5-2 M (404-492)	0-4-CC 0-5-1 G (239-353)	1-6-3 0-7-1 G (569-611)	0-2-CC 0-3-1 G (88-118)		
B *Stichocorys delmontensis* m	Below 0-5-CC M (499)	0-4-CC 0-5-1 G (239-353)	1-6-CC 0-7-1 G (574-611)	0-2-CC 0-3-1 G (88-118)	0-10-3 0-11-2 M (87-94)	B *Stichocorys delmontensis*
T *Dorcadospyris ateuchus* m	0-5-2 0-5-3 P (492-494)	0-4-1 0-4-2 M (231-232)	0-7-CC 1-7-1 P (619-662)	0-3-3 0-3-4 M (121-122)		
B *Carpocanopsis favosum* m	0-4-6 0-5-2 P (403-492)	0-4-2 0-5-2 P (232-354)	0-7-3 1-7-3 M (614-665)	0-3-5 0-3-CC P (124-126)	0-11-4 0-12-5 P (97-108)	B *Carpocanopsis favosum*
B *Botryocyrtis* spp. m	Below 0-5-4 M (495)	0-4-2 0-4-CC P (232-239)	1-6-1 1-6-3 P (566-569)	Below 0-3-5 (124)	0-12-1 0-12-3 P (102-105)	B *Botryocyrtis* spp.
T *Dorcadospyris papilio* m	Below 0-5-CC (499)	0-5-2 0-5-CC P (354-361)	0-7-CC 1-7-1 P (619-662)	Within 0-3-1 P (118)		
B *Cyrtocapsella cornuta* m	Below 0-5-CC (499)	0-4-CC 0-5-2 M (239-354)	0-7-CC 1-7-1 G (619-662)	0-3-1 0-3-5 M (118-124)	0-11-4 0-12-1 G (97-102)	B *Cyrtocapsella cornuta*
B *Calocycletta virginis* m	Below 0-5-CC (499)	0-4-CC 0-5-1 G (239-353)	0-7-CC 1-7-1 M (619-662)	0-3-3 0-3-4 P (121-122)	0-11-CC 0-12-1 M (101-102)	B *Calocycletta virginis*

Psychospyris parva → *P. intermedia*	?	?	?	0-3-4 0-3-5 G (122-124)	?	B *Psychospyris intermedia*
B *Cyrtocapsella tetrapera* m	Below 0-5-CC (499)	0-4-CC 0-5-2 G (239-354)	0-7-CC 1-7-1 G (619-662)	0-3-3 0-3-5 M (121-124)	0-11-CC 0-12-1 G (101-102)	B *Cyrtocapsella tetrapera*
B *Carpocanopsis cingulatum* m	0-5-2 0-5-3 P (492-494)	0-4-2 0-5-2 G (232-354)	1-7-3 0-8-2 G (665-707)	0-3-5 0-3-CC P (124-126)	0-11-2 0-11-4 M (94-97)	B *Carpocanopsis cingulatum*
T *Artophormis gracilis* m	Below 0-5-CC (499)	0-4-CC 0-5-1 G (239-353)	1-7-1 1-8-1 P (662-747)	0-3-3 0-3-5 M (121-124)		
B *Psychospyris parva* m	?	?	?	0-3-6 0-3-CC M (125-126)	?	B *Psychospyris parva*
T *Centrobotrys* sp. A m	Below 0-5-4 (495)	Below 0-5-2 (354)	0-7-1 0-7-3 P (611-614)	Below 0-3-5 (124)		
T *Lychnocanium trifolium* m	?	0-4-2 0-5-1 P (232-353)	1-7-CC 0-8-1 M (670-706)	?		
T *Lithocyclia angustum* m	Below 0-5-CC (499)	Below 0-5-2 (354)	1-7-CC 0-8-1 P (670-706)	Below 0-3-CC (126)		
B *Lychnocanium bipes* m	Below 0-5-CC (499)	0-4-CC 0-5-1 M (239-353)	1-7-CC 0-8-1 G (670-706)	Below 0-3-CC (126)	Within 0-12-4 M (106)	B *Lychnocanium bipes*
B *Lychnocanium trifolium* m	?	Below 0-5-CC (361)	0-8-CC 1-8-1 G (714-747)	?	?	B *Lychnocanium trifolium*
B *Botryopyle* sp. A m	Below 0-5-4 (495)	Below 0-5-2 (354)	0-8-2 1-8-1 G (707-747)	Below 0-3-5 (124)	0-12-3 0-12-5 P (105-108)	B *Botryopyle* sp. A
Cyclampterium milowi → *C. pegetrum*	Below 0-5-CC (499)	Below 0-5-CC (361)	1-8-1 1-8-2 M (747-748)	Below 0-3-CC (126)	0-13-3 0-13-CC M (114-119)	B *Cyclampterium pegetrum*
B *Dorcadospyris papilio* m	Below 0-5-CC (499)	Below 0-5-CC (361)	0-8-CC 1-8-1 M (714-747)	0-3-6 0-3-CC P (125-126)	0-14-CC 0-15-CC M (128-136)	B *Dorcadospyris papilio*

TABLE 6 – *Continued*

Events at Sites 62, 63, 64, 66		Site 62	Site 63	Site 64		Site 66	Site 65		Events at Site 65 (all m)
B *Cannartus prismaticus*	m	Below 0-5-CC (499)	Below 0-5-CC (361)	0-9-CC 0-10-1 (781-849)	P	Below 0-3-CC (126)	0-13-3 0-13-5 (114-117)	P	B *Cannartus prismaticus*
B *Dorcadospyris forcipata*	m	Below 0-5-CC (499)	Below 0-5-CC (361)	1-8-CC 0-10-1 (749-849)	P	Below 0-3-CC (126)	0-14-CC 0-15-CC (128-136)	P	B *Dorcadospyris forcipata*
B *Dorcadospyris ateuchus*	m	Below 0-5-CC (499)	Below 0-5-CC (361)	0-9-CC 0-10-1 (781-849)	G	Below 0-3-CC (126)	0-13-2 0-13-3 (112-114)	M	B *Dorcadospyris ateuchus*
T *Tristylospyris triceros*	m	Below 0-5-CC (499)	Below 0-5-CC (361)	0-9-CC 0-10-1 (781-849)	M	Below 0-3-CC (126)			
Theocyrtis tuberosa → *T. annosa*			Below 0-5-CC (361)	0-9-CC 0-10-1 (781-849)	G	Below 0-3-CC (126)	0-13-5 0-14-1 (117-120)	G	B *Theocyrtis annosa*
T *Theocampe pirum*	m			0-10-1 0-10-2 (849-850)	M				
B *Centrobotrys* sp. A	m		Below 0-5-2 (354)	Within 0-10-2 (850)	M		0-14-CC 0-15-CC (128-136)	M	B *Centrobotrys* sp. A
B *Lithocyclia angustum*	e			Within 0-10-2 (850)	M		0-14-5 0-14-CC (126-128)	P	B *Lithocyclia angustum*
T *Lithocyclia aristotelis* group	m			Within 0-10-2 (850)	P				
Artophormis barbadensis → *A. gracilis*			Below 0-5-CC (361)	Within 0-10-2 (850)	M		0-14-CC 0-15-CC (128-136)	M	B *Artophormis gracilis*
T *Theocampe armadillo* group	m			0-10-2 1-9-1 (850-912)	G				

B *Theocyrtis tuberosa* m			0-10-2 1-9-1 (850-912) G		0-14-CC 0-15-CC (128-136) G	B *Theocyrtis tuberosa*
T *Lychnocanium* aff. *L. bellum* m		Below 0-5-CC (361)	0-10-2 1-9-1 (850-912) G			
B *Theocorys spongoconum* m	Below 0-5-CC (499)	0-4-2 0-5-1 (232-353) P	0-10-2 1-9-1 (850-912) M		?	B *Theocorys spongoconum*
T *Sethochytris babylonis* group m			0-10-2 1-9-1 (850-912) G			
T *Lophocyrtis jacchia* m		Below 0-5-CC (361)	0-10-2 1-9-1 (850-912) G			
B *Cyclampterium milowi* m			0-10-2 1-9-1 (850-912) M		0-14-5 0-15-CC (126-136) G	B *Cyclampterium milowi*
T *Lithocyclia ocellus* group m			1-9-CC 1-10-1 (916-970) M			
T *Thyrsocyrtis tetracantha* m		Below 0-5-CC (361)	1-9-CC 1-10-1 (916-970) M			
T *Thyrsocyrtis bromia* m			1-9-CC 1-10-1 (916-970) M			
T *Artophormis dominasinensis* m			1-9-CC 1-10-1 (916-970) M			
B *Theocampe pirum* m			1-9-2 1-10-1 (913-970) G		0-16-6 1-2-1 (145-145) M	B *Theocampe pirum*
T *Theocampe mongolfieri* m			1-9-2 1-10-2 (913-971) G			
T *Cycladophora hispida* m			1-9-CC 1-10-1 (916-970) G			

TABLE 6 – *Continued*

Events at Sites 62, 63, 64, 66	Site 62	Site 63	Site 64	Site 66	Site 65	Events at Site 65 (all m)
T *Cycladophora turris* m			1-9-CC 1-10-1 (916-970) M			
T *Thyrsocyrtis rhizodon* m			1-9-CC 1-10-1 (916-970) G			
T *Calocycloma ampulla* m			1-9-CC 1-10-1 (916-970) M			
B *Lychnocanium* aff. *L. bellum* m			1-9-CC 1-10-1 (916-970) M		0-16-CC 1-2-1 (146-145) M	B *Lychnocanium* aff. *L. bellum*
T *Podocyrtis papalis* m			1-9-CC 1-10-1 (916-970) G			
B *Thyrsocyrtis bromia* m			1-9-CC 1-10-1 (916-970) G		0-16-CC 1-2-1 (146-145) G	B *Thyrsocyrtis bromia*
B *Lophocyrtis jacchia* m			1-9-CC 1-10-2 (916-971) G		0-16-6 1-2-1 (145-145) M	B *Lophocyrtis jacchia*
B *Tristylospyris triceros* m			1-9-CC 1-10-1 (916-970) M		1-2-CC 1-4-1 (154-155) M	B *Tristylospyris triceros*
T *Eusyringium fistuligerum* m			1-9-CC 1-10-1 (916-970) G			
T *Thyrsocyrtis triacantha* m			1-9-CC 1-10-1 (916-970) G			
B *Artophormis barbadensis* m			1-9-CC 1-10-1 (916-970) G		1-5-1 1-5-CC (163-168) P	B *Artophormis barbadensis*

B *Lithocyclia* *aristotelis* group m			1-9-CC 1-10-1 M (916-970)		1-5-1 1-5-3 P (163-166)	B *Lithocyclia* *aristotelis* group
T *Theocotyle ficus* m			1-9-CC 1-10-1 M (916-970)			
B *Thyrsocyrtis* *tetracantha* m			1-9-CC 1-10-1 M (916-970)		1-2-1 1-2-CC M (145-154)	B *Thyrsocyrtis* *tetracantha*
B *Cycladophora turris* m			1-9-CC 1-10-1 M (916-970)		1-2-CC 1-4-1 P (154-155)	B *Cycladophora turris*
T *Podocyrtis chalara* m			1-9-CC 1-10-1 M (916-970)			
T *Sethochytris* *triconiscus* m			1-9-CC 1-10-1 M (916-970)			
Podocyrtis mitra → *P. chalara*			1-9-CC 1-10-1 M (916-970)		Below 1-5-CC (168)	B *Podocyrtis chalara*
B *Sethochytris* *triconiscus* m			1-9-CC 1-10-1 M (916-970)		Below 1-5-CC (168)	B *Sethochytris* *triconiscus*
T *Lychnocanium bellum* m			Below 1-10-CC (972)			
B *Theocampe* *armadillo* group m			Below 1-10-2 (971)		Below 1-5-CC (168)	B *Theocampe* *armadillo* group
T *Lithochytris* *vespertilio* m			Below 1-10-CC (972)			
Podocyrtis sinuosa → *P. mitra* e			Below 1-10-CC (972)		Below 1-5-CC (168)	B *Podocyrtis mitra*

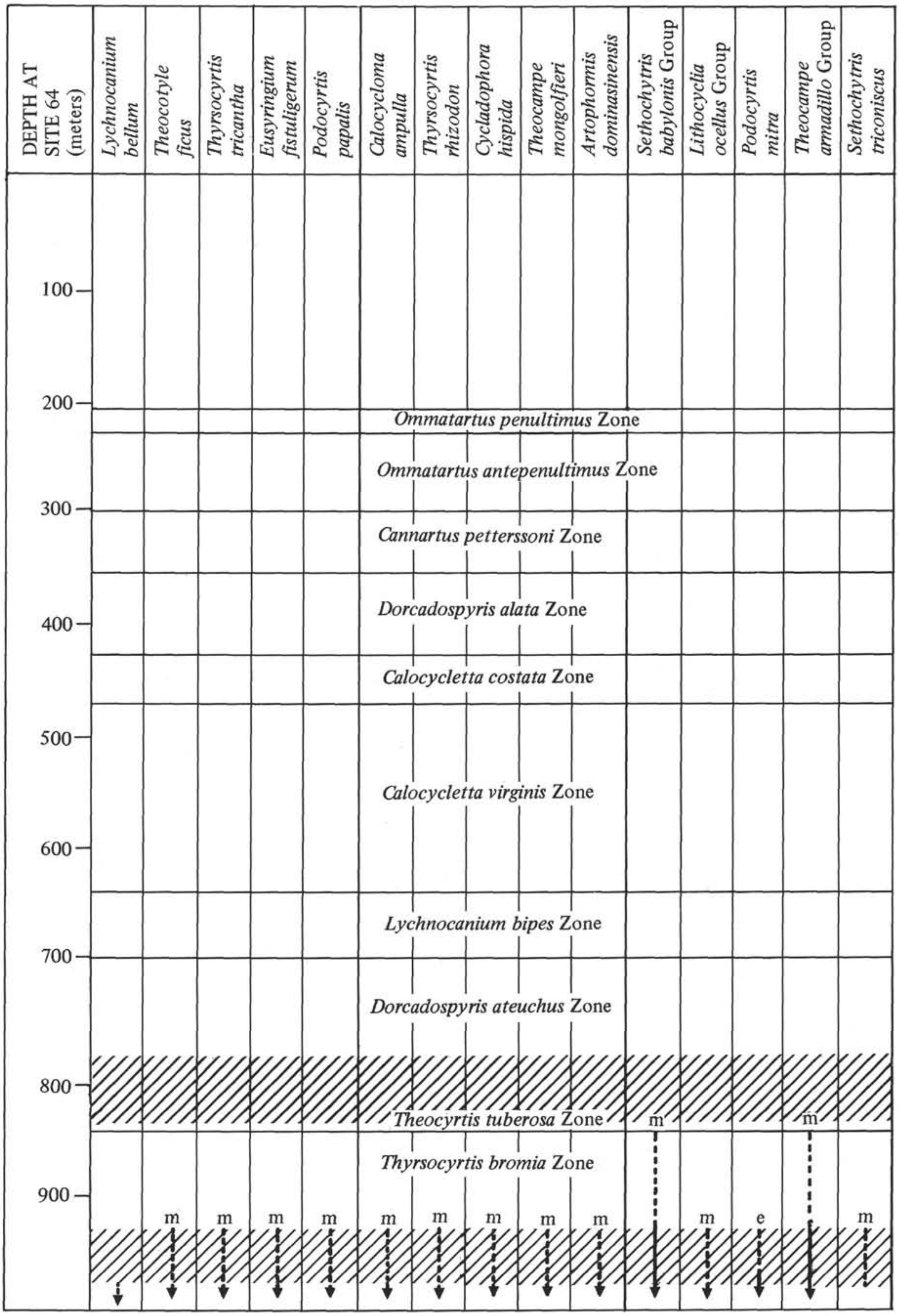

Figure 2. *Radiolarian Ranges and Zones.*

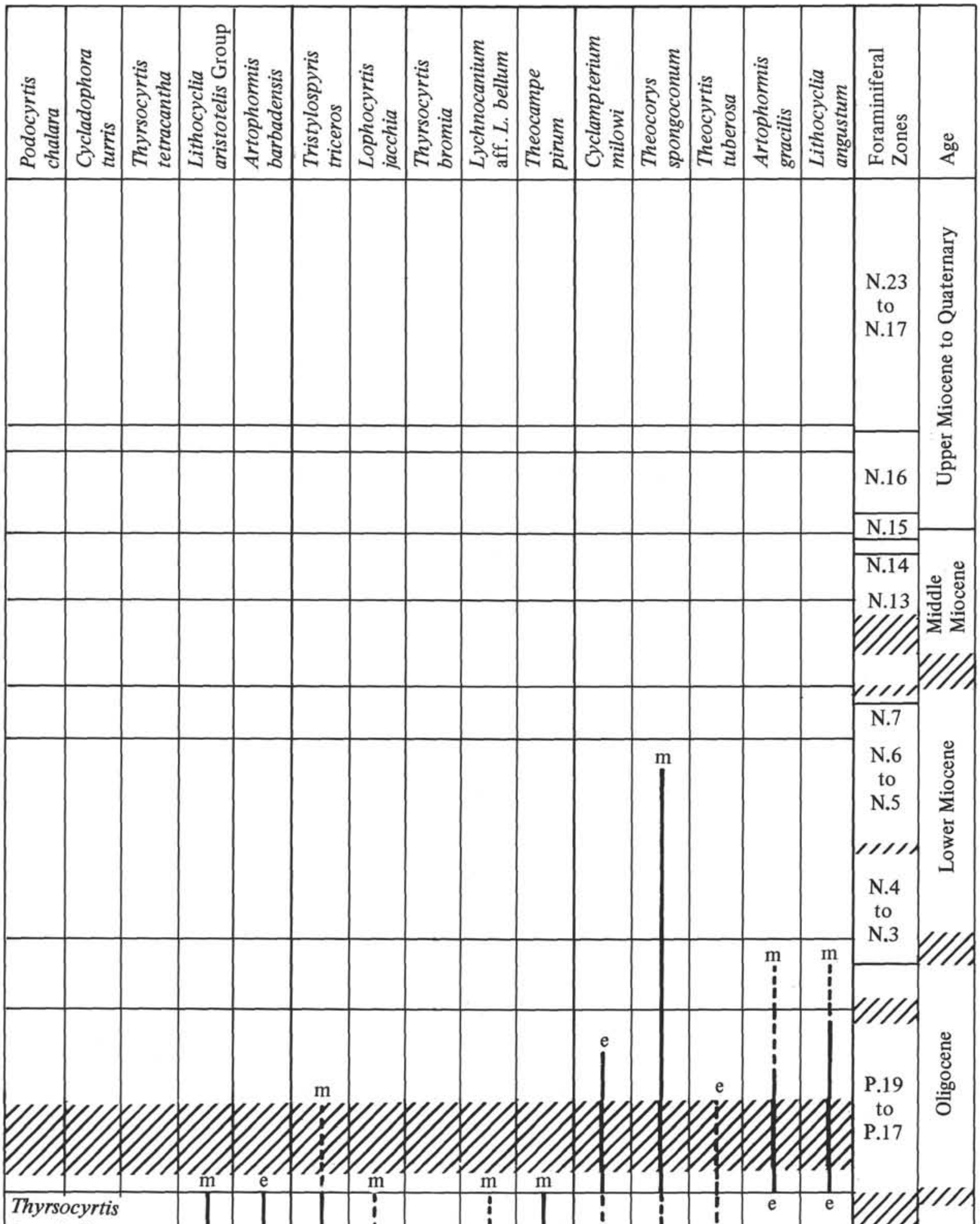

Figure 2. *Continued.*

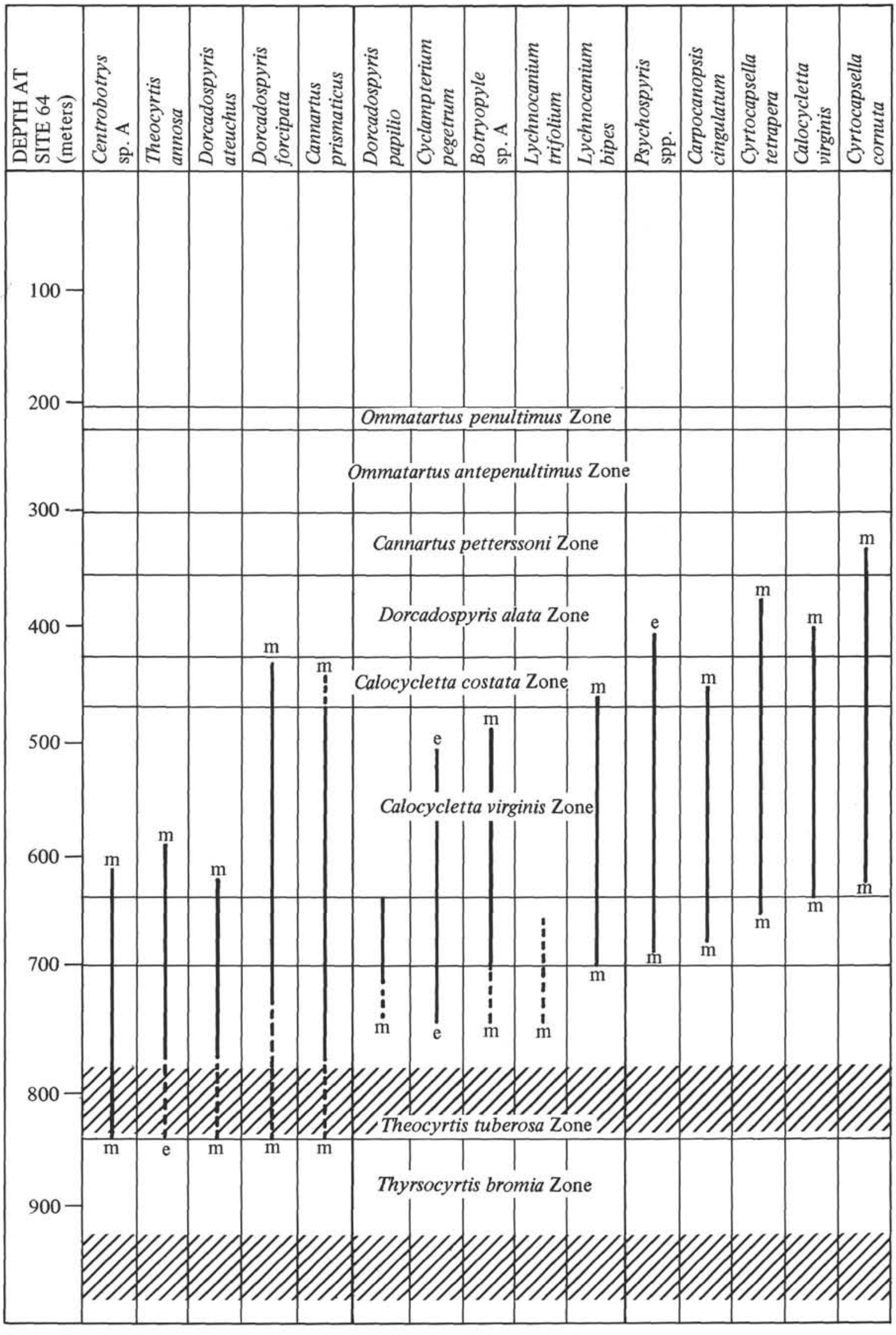

Figure 2. *Continued.*

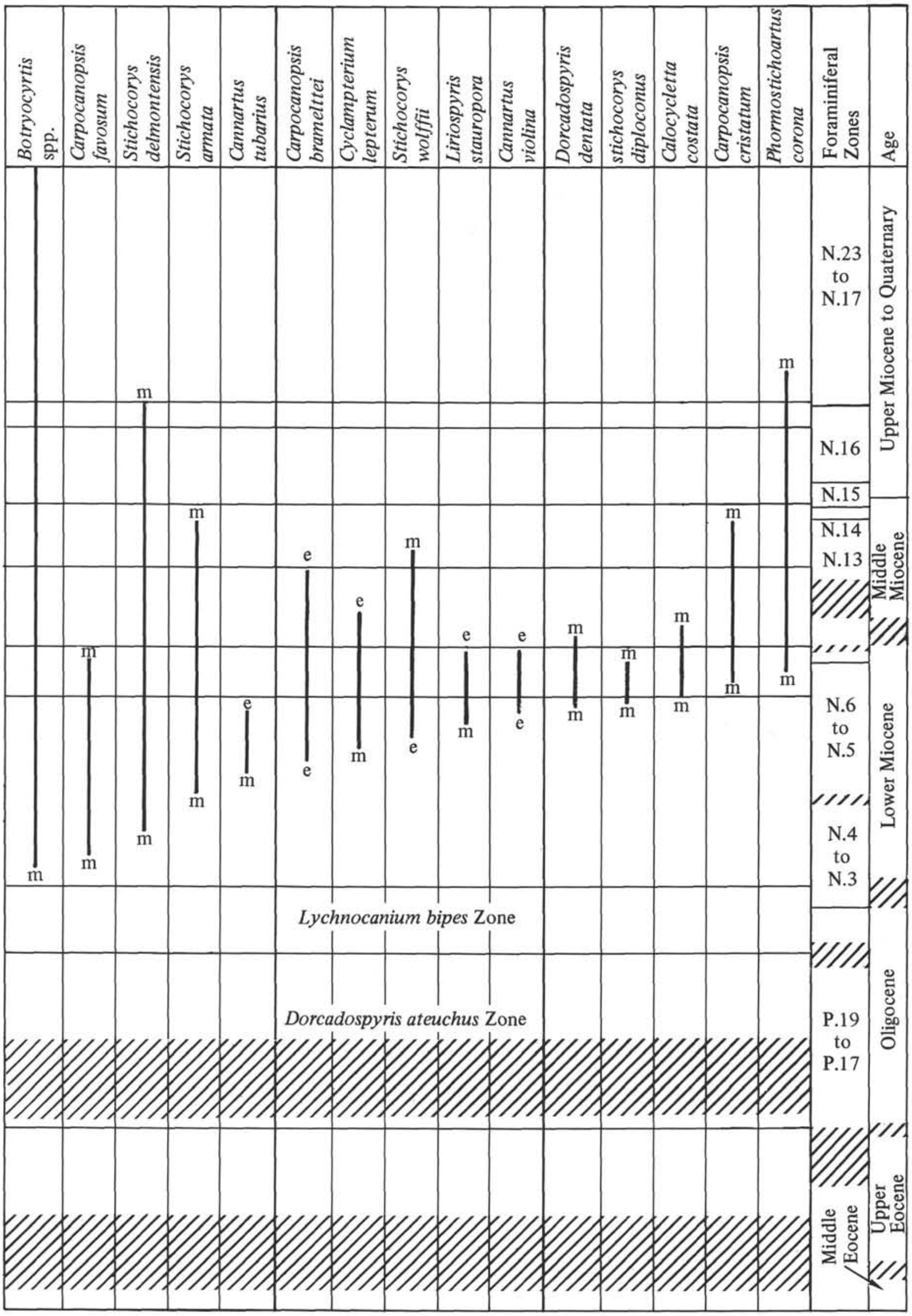

Figure 2. *Continued.*

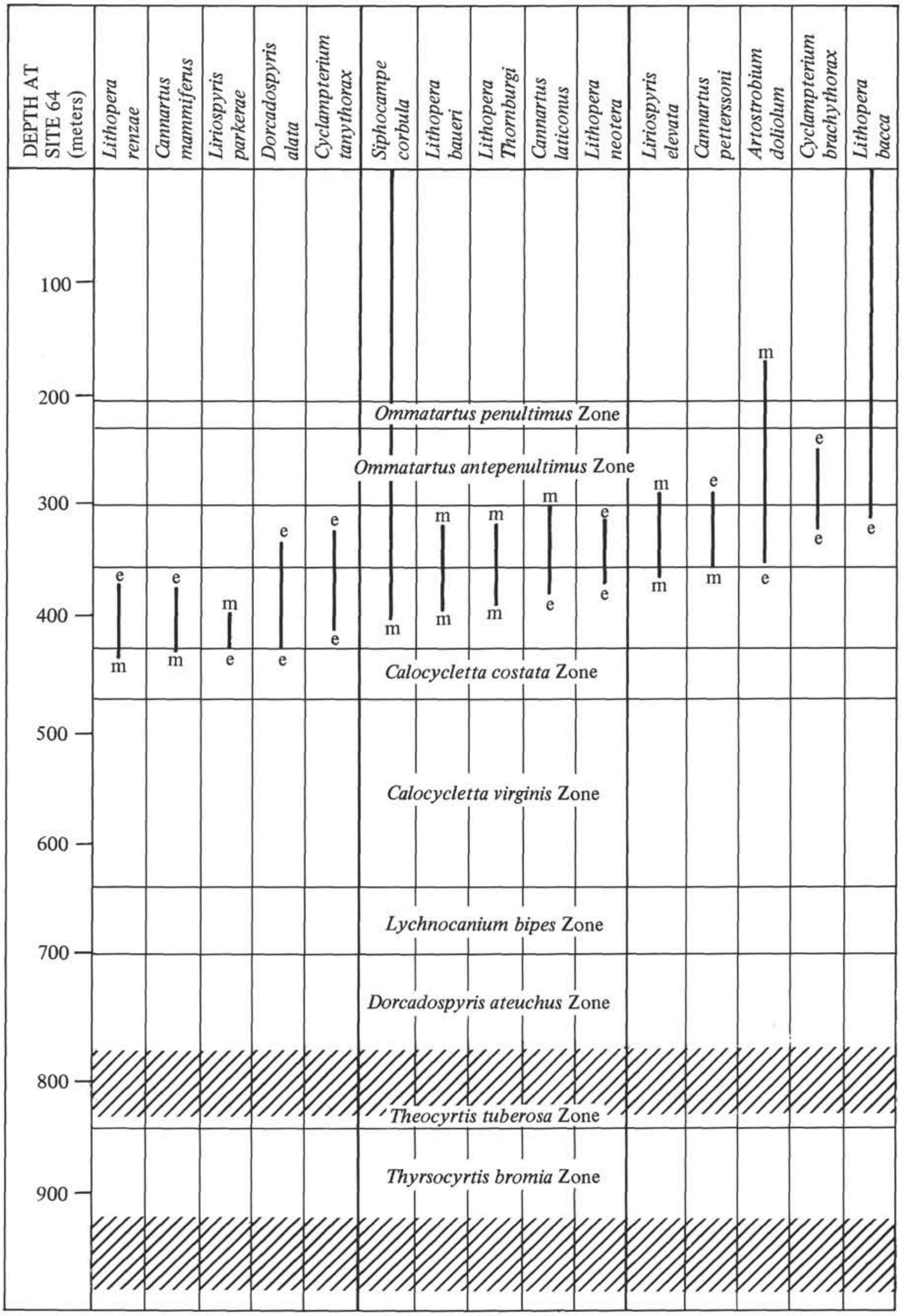

Figure 2. *Continued.*

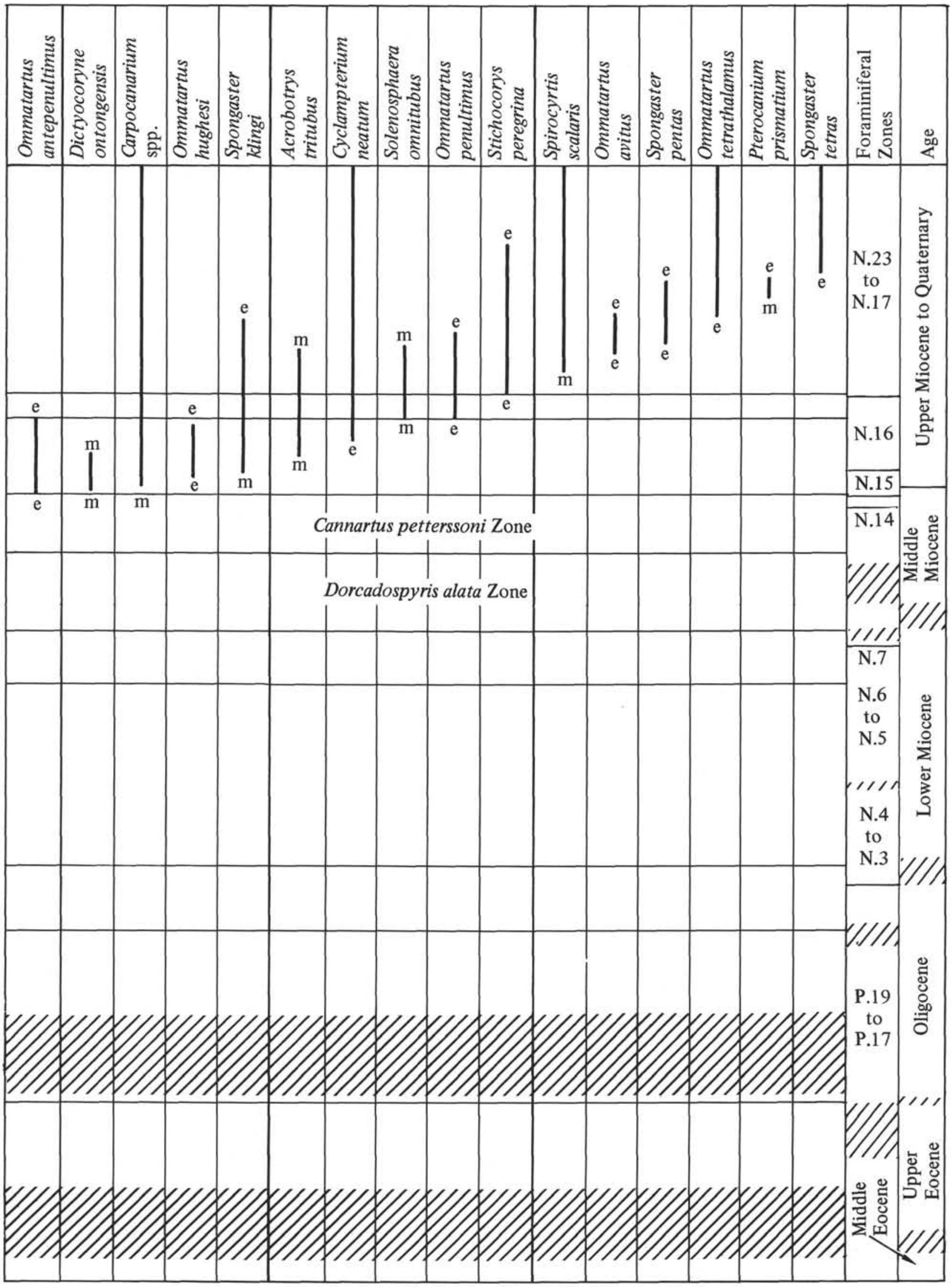

Figure 2. *Continued.*

The transitions from *Cannartus mammiferus* to *C. laticonus* and from *Lithopera renzae* to *L. neotera.*

The earliest morphotypic appearance of *Liriospyris elevata.*

Cannartus (?) *petterssoni* **Zone:**

Base defined by the earliest evolutionary appearance of *Cannartus* (?) *petterssoni,* which is approximately synchronous with the latest occurrence of *Carpocanopsis bramlettei.* Events within this zone include:

The earliest morphotypic appearance of *Artostrobium doliolum.*

The latest occurrences of *Stichocorys wolffii, Cyrtocapsella cornuta, Dorcadospyris alata* and *Stichocorys armata.*

The transition from *Cyclampterium tanythorax* to *C. brachythorax.*

The latest occurrences of *Lithopera baueri, L. thornburgi* and *Carpocanopsis cristatum.*

The transition from *Lithopera neotera* to *L. bacca.*

Ommatartus antepenultimus **Zone:**

Base defined by the earliest evolutionary appearance of *Ommatartus antepenultimus,* which is approximately synchronous with the earliest morphotypic appearance of *Dictyocoryne ontongensis.* Events within this zone include:

The earliest morphotypic appearance of *Carpocanarium* spp.

The latest occurrence of *Liriospyris elevata.*

The transition from *Cannartus* (?) *petterssoni* to *Ommatartus hughesi.*

The earliest morphotypic appearances of *Spongaster klingi* and *Acrobotrys tritubus.*

The latest occurrence of *Dictyocoryne ontongensis.*

The transition from *Cyclampterium brachythorax* to *C. neatum.*

The latest occurrence of *Ommatartus hughesi.*

Ommatartus penultimus **Zone:**

Base defined by the earliest evolutionary appearance of *Ommatartus penultimus,* which is approximately synchronous with the earliest morphotypic appearance of *Solenosphaera omnitubus.* The top of this zone (coincident with the base of the *Stichocorys peregrina* Zone) is defined by the evolutionary transition from *Stichocorys delmontensis* to *S. peregrina.* The order of radiolarian events above this level cannot be described with confidence on the basis of the Leg 7 material.

6. CORRELATIONS WITH EUROPE AND THE CARIBBEAN

It is of practical interest to attempt to correlate European and Caribbean radiolarian assemblages with the sequence found in the western tropical Pacific, partly because the ages of some of those land-based localities are not well established by calcareous microfossils, and partly as a test of the geographic extent of the applicability of the biostratigraphic zonation developed above. Because the western Pacific sequences provide better representation of the Miocene and Oligocene than they do of the Eocene, we concentrate in this section on land-based localities of the former ages, and treat Eocene occurrences only briefly.

Results of these comparisons are summarized in Figure 3, in which horizontal lines are omitted from the left- and right-hand columns because the correlations are only approximate.

6a. European Neogene

European Neogene samples suitable for this study are all from the Mediterranean region, and most were collected by the senior author with the help of R. Selli, G. Colom, G. Ruggieri and L. Montanari. Additional samples were provided by I. Premoli Silva. The localities of samples with radiolarian assemblages sufficiently diverse to permit an attempt at correlation with the western Pacific sequence are listed below, together with ages (in quotation marks) indicated by local geologists or the older literature.

WRE 67-76 to WRE 67-78. Three outcrops in very low road-banks near the church at Monte Calvo (44.418°N, 11.384°E), near Bologna, Italy. No. 76 is approximately 200 meters WSW of the church, no. 77 approximately 400 meters WSW of the church, and no. 78 approximately 450 meters W of the church. "Aquitanian or lowermost Langhian".

WRE 67-95 and WRE 67-96. Outcrops near the roadside chapel at il Monticciolo (44.511°N, 10.773°E), near Montegibbio, S of Sassuolo, Italy. No. 95 is approximately 20 meters S of the chapel, and no. 96 approximately 10 meters S of the chapel.

WRE 67-99 and WRE 67-100. Near the farm-house Bergonzano (44.619°N, 10.469°E), S of Quattro Castella, Italy. No. 99 is from a small pit about 30 meters E of the farm-house, and no. 100 from a roadcut approximately 350 meters further ENE. "Langhian".

WRE 67-106. Near Ca' de Rossi, approximately 2 kilometers ESE of Salsomaggiore, Italy. In a roadcut, at fork (44.811°N, 10.000°E) of the roads that lead to Ca'Lombasini and to Tabiano. "Upper Langhian to Lower Elveziano".

European Localities	Middle Eocene to Pliocene Radiolarian Zones	Caribbean Localities
	Pterocanium prismatium	
	Spongaster pentas	
Tabianian, N. Italy	*Stichocorys peregrina*	
	Ommatartus penultimus	
	Ommartartus antepenultimus	
	Cannartus petterssoni	
Muro, Mallorca	*Dorcadospyris alata*	St. Mark's Church, Barbados Hermitage Quar. and Philippine Rd., Trinidad
Casalino and Monte Calvo, N. Italy	*Calocycletta costata*	Golconda Rwy. Stn., Trinidad
Montegibbio, Bergonzano, Marmorita and Salsomaggiore, N. Italy	*Calocycletta virginis*	
Salsomaggiore, N. Italy	*Lychnocanium bipes*	
	Dorcadospyris ateuchus	
	Theocyrtis tuberosa	Bath, Barbados
	Thyrsocyrtis bromia	Bath, Barbados
	Thyrsocyrtis tetracantha	Bath, Barbados
	Unzoned interval with *Podocyrtis goetheana*	Bath (S.781, S.888) and Gay's Cove, Barbados
	Podocyrtis chalara	Bath, Barbados (S.893) Quarry E of Bissex Hill, Barbados
	Podocyrtis mitra	Quarry at Springfield, Barbados
Tel Hesi and Beit Jibrin, Israel	*Podocyrtis ampla*	Hopefield, Barbados Road E of Bissex Hill, Barbados
	Thyrsocyrtis triacantha	Friendship Quarry, Trinidad
	Theocampe mongolfieri	Cantera San Francisco and Cantera Central Toledo, Cuba

Figure 3. *European and Caribbean correlations.*

WRE 67-107. Roadcut at Ca' Lombasini (44.810°N, 10.004°E), near Salsomaggiore, Italy. "Upper Langhian to Lower Elveziano".

WRE 67-112. Roadcut at Marmorito (45.069°N, 8.020° E), NE of Castelnuovo Don Bosco, Italy. "Elveziano".

Three samples from the low cliff "La Mirada" at Muro, Mallorca. Samples Nos. 1-3 of WRR 1963. "Aquitanian-Burdigalian" of Colom (1952).

Premoli Silva sample C.9 from the Casalino section, Vercelli, Nth. Italy. "Foraminiferal zone N5/6".

AGIP locality no. 6509, between Bagni di Tabiano and C. dei Bassi, approximately 450 meters SE of the point of origin of the road that leads from the Salsomaggiore-Fidenza-Parma road to Bagni di Tabiano, Nth. Italy. Tabianian sample from Maria Chierici via F. L. Parker.

Table 7 shows the species identified in the Mediterranean Neogene samples, and the radiolarian evidence is used as a basis for arranging the samples in five groups which are believed to be progressively younger upward in the table. The oldest sample is apparently in the *Lychnocanium bipes* Zone, the next group of six in approximately the early *Calocycletta virginis* Zone, the following four in the late *C. virginis* or *C. costata* Zone, the three Mallorcan samples in the early *Dorcadospyris alata* Zone, and the youngest one apparently in the *Stichocorys peregrina* Zone. Comparison of Table 7 with the middle part of Figure 2 shows that a surprisingly high proportion of the radiolarians which are stratigraphically useful in the tropical Pacific occur also in the Mediterranean region. However, the Mediterranean occurrences are sparse and sporadic, so that it is generally difficult to make correlations to within one radiolarian zone.

For some species, the Mediterranean specimens are identical with those from the Pacific, but within other species there are morphological differences as indicated in the following comments:

Cannartus sp. of the type illustrated to the synchronopticon, Plate 2B, Figures 9 and 10, is rather common in many of the Italian samples.

Doryphacus sp. In Italian samples at the upper limit of the range of *Lithocyclia angustum,* we have found specimens of *Doryphacus* sp. with the spin latticed (Plate 4, Figure 4), which may be related to the *Dorydruppa* sp. or *Doryprunum* sp. of Hole 62.0, Core 5 (Plate 4, Figure 3), as described in the discussion of the subfamily Artiscinae. That core is near the boundary between the *Calocycletta virginis* and *Lychnocanium bipes* Zones, and thus of about the same age as the Italian samples with *Doryphacus* sp.

Dorcadospyris sp. aff. *D. dentata.* Specimens in the Mallorcan assemblages (Plate 5, Figure 3) lack an apical horn, and have a small cephalis and feet approaching the wide divergence characteristic of *D. alata.*

Dorcadospyris simplex. Specimens in the Italian assemblages commonly have several smaller feet in addition to the two larger ones (Plate 5, Figure 2).

Artophormis gracilis. The upper three segments and apical horn of the Italian specimens (Plate 6, Figure 7) are similar to those of tropical Pacific and Caribbean specimens, but the fourth segment is different. In many specimens, downwardly-directed spines arise from the distal part of the third segment, and subsequently join the fourth segment which has rather small pores and an inconstant shape.

Cyclampterium (?) *pegetrum.* Specimens in the older Italian assemblages commonly have short cylindro-conical feet which are slightly latticed proximally. They thus resemble early representatives of the species, close to *C.* (?) *milowi.*

Lithopera renzae. Specimens in the Mallorcan material are somewhat larger than usual. They are accompanied by a form (Plate 7, Figure 15) in which an additional internal constriction subdivides the large segment, so that the skeleton resembles a *Stichocorys diploconus* with a closed, obtusely-rounded base.

Stichocorys peregrina. The third segment of the Italian specimens (Plate 8, Figure 5) is not quite as neatly conical as in Pacific specimens, but in other respects they are typical.

Carpocanopsis cingulatum. The third segment of the Italian specimens is generally somewhat smaller and not as robust as that of Pacific specimens.

Calocycletta. In the Mediterranean assemblages, the few observed specimens of *C. costata* are not very pronouncedly costate, and the feet of *C. virginis* tend to be short and triangular rather than long and truncate.

6b. European Eocene

European samples containing Eocene radiolarian assemblages comparable with those of the tropics include two samples from Israel provided by Zeev Reiss, and one collected in Italy by M. N. Bramlette, listed below.

Geological Institute of Israel sample no. 1273-D32, from Tel Hesi, Israel, contains *Phormocyrtis striata, Sethochytris babylonis* group, *Podocyrtis ampla, P. sinuosa* and *Theocampe mongolfieri,* and thus belongs in the *Podocyrtis ampla* Zone.

Geological Institute of Israel sample no. 2329-At, from Beit Jibrin, Israel, contains *Lithapium* (?) *anoectum, Lithocyclia ocellus* group, *Cycladophora hispida, Eusyringium lagena* (?), *Theocorys anapographa, Thyrsocyrtis triacantha, Podocyrtis ampla, P. diamesa, P. papalis* and *P. sinuosa,* and thus also belongs in the *Podocyrtis ampla* Zone.

A sample collected by M. N. Bramlette from the highest exposure N (approximately 0.5 kilometer N) of Ponte dell' Olio on Torrente Nure, about 20 kilometers S of Piacenza, Italy, contains members of the *Lithocyclia ocellus* group, *Lithocampium* sp. with quincuncially arranged pores on the third segment and *Phormocyrtis striata,* and is apparently Lower Eocene in age.

6c. Caribbean Neogene

Caribbean Neogene radiolarian assemblages are known to have much in common with those of the tropical Pacific (Riedel, 1959b; Riedel and Sanfilippo, in press, footnotes to Figure 3), and Table 8 presents detailed information which permits rather precise correlations with the western Pacific sequence. Most of the samples (listed below) on which the tabulation is based were collected during the Fourth Caribbean Geological Congress in 1965 (Saunders and Cater, 1968; Saunders, 1968), but much of our earlier work on Caribbean Neogene radiolarians was based on samples generously provided by H. H. Renz, Paul Brönnimann, J. B. Saunders and H. M. Bolli.

TTOC 178888. Near Retrench trigonometrical station, Golconda Estate, Trinidad. Co-locality of the *Globigerinatella insueta* Zone (Bolli, 1957a, p. 101; Bramlette and Wilcoxon, 1967).

WRTR 10. Philippine Road, Trinidad. Radiolarian-rich facies of the *Globorotalia fohsi barisanensis* Zone (Stop 6 of Saunders and Cater, 1968). Approximately Bolli locality no. 200.

WRTR 11, High and Low, Hermitage Quarry, on the W side of the road leading from Hermitage Village to Ally's Creek about 1200 feet NW from the road junction in the village, south Trinidad. Type locality of the *Globorotalia fohsi barisanensis* Zone. Locality no. 202 of Bolli (1957 a, p. 101). WRTR 11 High is from approximately 1 meter higher in the quarry than WRTR 11 Low.

WRTR 23. Very near Golconda Railway Station, across the hill from the Retrench trigonometrical station. Kugler locality no. 9391 (Stop 19 of Saunders and Cater, 1968).

WRTR 36, 37 and 38. Exposures of Conset Marl near St. Mark's Church, Barbados (Stop 8 of Saunders, 1968). WRTR 36 is equivalent to Saunders' locality JS 1646, and WRTR 37 and 38 approximately equivalent to JS 1647.

The three samples from the Conset Marl contain a few reworked Eocene forms, but this contamination does not prevent assignment of the assemblages to radiolarian zones. In Table 8 the samples are arranged as nearly as possible in stratigraphic order, and the two oldest samples (from the *Globigerinatella insueta* foraminiferal zone) are seen to belong in the *Calocycletta costata* Zone, while the six younger ones (from the *Globorotalia fohsi barisanensis* foraminiferal zone) belong in *Dorcadospyris alata* Zone.

6d. Caribbean Eocene

Of the Caribbean Eocene samples presently available, many from the Oceanic Formation of Barbados and the Universidad Formation of Cuba contain well-preserved radiolarian assemblages, and several from the Navet Formation of Trinidad contain poorly preserved radiolarians (often calcitized).

In our chapter on the radiolarians collected during Leg 4 of the DSDP, we implied that the Eocene radiolarian-bearing sediments of the Oceanic Formation at Bath, Barbados, were all included in the *Thyrsocyrtis tetracantha* and *T. bromia* Zones. The range-chart (Riedel and Sanfilippo, in press, text-figure 3) was based on a series of samples kindly provided to M. N. Bramlette by W. F.-Auer in 1953. However, examination of additional samples indicates that, although many of the radiolarian localities of the Oceanic Formation belong in these tow zones, there are other localities that extend well down into the Middle Eocene (*Podocyrtis ampla* Zone at least).

Three of Senn's samples (S.781, 888 and 893) collected at Bath and reported on by Beckmann (1953) contain radiolarian assemblages older than the *Thyrsocyrtis tetracantha* Zone. The assemblages in S.781 and S.888 include members of the *Lithocyclia aristotelis* group, *Eusyringium fistuligerum, Podocyrtis chalara, P. goetheana* and *P. mitra,* and lack *Thyrsocyrtis tetracantha,* and are thus assignable to the *Podocyrtis chalara* Zone or to the unzoned interval with *P. goetheana.* S.898 contains most of the species listed in the two samples above, but lacks *Podocyrtis goetheana* and members of the *Lithocyclia aristotelis* group, and is thus in the *Podocyrtis chalara* Zone.

A number of samples older than the *Thyrsocyrtis tetracantha* Zone were collected by the senior author during the Barbados field trip conducted by J. B. Saunders in connection with the Fourth Caribbean Geological Conference (Saunders, 1968). The oldest of several samples collected at Gay's Cove (sample WRTR 53, approximately the same as Saunders' locality JS

TABLE 7
Radiolarians in Mediterranean Neogene
(*indicates samples in which *Doryphacus* sp. Accompanies *Lithocyclia angustum*)

Samples	*Artophormis barbadensis*	*A. gracilis*	*Lithocyclia angustum*	*Centrobotrys* sp. A	*Theocyrtis annosa*	*Dorcadospyris ateuchus*	*Cannartus prismaticus*	*Dorcadospyris simplex*	*Botryopyle dictyocephalus*	*Cyclampterium pegetrum*	*Botryopyle* sp. A	*Lychnocanium bipes*	*Carpocanopsis cingulatum*	*Cyrtocapsella tetrapera*	*Calocycletta virginis*	*Cyrtocapsella cornuta*	*Botryocyrtis* spp.	*Carpocanopsis favosum*	*Acrobotrys* spp.	*Centrobotrys thermophila*	*Stichocorys delmontensis*	*Cyrtocapsella japonica*	*Stichocorys armata*	*Cannartus tubarius*	*Carpocanopsis bramlettei*	*Cyclampterium lepterum*	*Cannartus violina*	*Dorcadospyris dentata*	*Calocycletta costata*	*Phormostichoartus corona*	*Lithopera renzae*	*Cannartus mammiferus*	*Dorcadospyris alata*	*Stichocorys peregrina*	*Spirocyrtis scalaris*	*Ommatartus avitus*
Tabianian 6509																																		F	+	R
Mallorca 1								+				–	+	F	+	R	R					R	F			+	+	R	–		R	R	?			
Mallorca 2								–			+	+		C	R	R						+	F			+	+	R	+	R	R	R	+			
Mallorca 3								+	+			+		F	+	R	R					+	R			+	+	R	–	R	R	R	+			
Casalino, Silva C.9										+				F			R						?				R			R						
Monte Calvo, WRE 67-76		–	–	–			–	–	R	+	–	–	R	C	–	R	–		–	–	F	R	R	+	+	+	R									
Monte Calvo, WRE 67-77		–	–	–			–	–	+	+	+	–	+	C	–	–	–		–	–	–	F	–	–	–	+	+									
Monte Calvo, WRE 67-78		–	–	+			–	–	R	–	–	–	R	C	–	–	–		–	–	–	F	–	+	–	–	–									
Montegibbio, WRE 67-95			–				–	R	R	+	+	R	–	R		F																				
Montegibbio, WRE 67-96			*				+	R	R	–	–	R	+	F		R																				
Bergonzano, WRE 67-99		+	*	–		–	–	+	R	+	–	+	+	R	–	+	+		+	R	–	–	–	–	–	+	–									
Bergonzano, WRE 67-100			*				–	–	R	–	R	R	–	C		F																				
Marmorito, WRE 67-112		–	*		–	–	+	+	+	+	+	R	+	+	–	R																				
Salsomaggiore, WRE 67-107	–	+	*	–	–	+	+	+	R	+	–	+	+	F		–	–	–		–																
Salsomaggiore, WRE 67-106	–	–	+		F	+	?	–	R	+	R	R	R	F				+																		

TABLE 8
Radiolarians in Neogene of Trinidad and Barbados

Samples	*Lychnocanium bipes*	*Dorcadospyris forcipata*	*Carpocanopsis cingulatum*	*Cyrtocapsella tetrapera*	*Calocycletta virginis*	*Cyrtocapsella cornuta*	*Botryocyrtis* spp.	*Carpocanopsis favosum*	*Stichocorys delmontensis*	*S. armata*	*Cannartus tubarius*	*Carpocanopsis bramlettei*	*Cyclampterium leptetrum*	*Stichocorys wolffii*	*Liriospyris stauropora*	*Cannartus violina*	*Dorcadospyris dentata*	*Stichocorys diploconus*	*Calocycletta costata*	*Carpocanopsis cristatum*	*Phormostichoartus corona*	*Lithopera renzae*	*Cannartus mammiferus*	*Liriospyris parkerae*	*Dorcadospyris alata*	*Cyclampterium tanythorax*	*Siphocampe corbula*	*Lithopera baueri*	*L. thornburgi*	*Cannartus laticonus*	*Lithopera neotera*	*Liriospyris elevata*	*Cannartus petterssoni*
St. Mark's, WRTR 36			–	–	–	F	R	–	A	R	–	R	F	–	–	–		–	–	+	F	F	+	–	R	+	–	R	–	R	+	–	
St. Mark's, WRTR 38					–		R	–	F		–		+	–	–	–	–	–	–	–	R	+		R		–	–				+		
Hermitage, WRTR 11 High	–		–	–	R	R	R	+	C	F		R	+	–	–	+	+	–	F	R	R	R		R	R	R	–	–	–	R		+	–
Hermitage, WRTR 11, Low	–		–		R	F	R	–	A	F	–	R	R	R	–	+	+	–	F	R	R	R	R	R	R	+	–	+	–	F	+	+	
St. Mark's, WRTR 37				–	–	F		+	C	R	–		+	R	+	+	–	–	–	–	+	+		+	+	–	–	–	–		R		
Philippine Rd., WRTR 10	–				R		F		R	F	–			R					R		F	R	+	R	R					–			
Golconda, WRTR 23	–	+	+	–	F	–	R		C	F	+	R	+	R	R	R	R	–	+		R		+		–	–							
Golconda, TTOC 178888	R	R	F	+	C	R		R	R	R	–	+	+	A	F	R	R	–	–	–	–	–	+	–	–								

1598) contains *Eusyringium fistuligerum, Sethochytris triconiscus* (?), *Podocyrtis chalara* and *P. mitra,* but lacks the *Lithocyclia aristotelis* group, *Thyrsocyrtis tetracantha* and *Podocyrtis goetheana,* and thus belongs in the *Podocyrtis chalara* Zone or in the unzoned interval characterized by *P. goetheana.* Of two samples from the quarry east of Bissex Hill (Saunders, 1968, Stop 11; samples WRTR 41 and 42, from Saunders' localities JS 1629 and 1628, respectively), the former contains *Sethochytris triconiscus* (?) and evolutionarily advanced specimens of *Podocyrtis mitra,* and is therefore high in the *Podocyrtis mitra* Zone, while the latter contains in addition *Podocyrtis chalara* and thus belongs in the *P. chalara* Zone—the section here may be steeply dipping or overturned, since at the time of collection WRTR 41 was recorded as being from higher in the exposure than WRTR 42. Samples WRTR 44 and 45 (corresponding to Saunders' localities JS 1643 and 1644, respectively), from the quarry at Springfield, contain *Podocyrtis ampla* and primitive representatives of *P. mitra* and lack *Sethochytris triconiscus* (?), and may be assigned to the *Podocyrtis mitra* Zone. A sample collected at a road-side outcrop east of Bissex Hill (Saunders, 1968, Stop 12; WRTR 43, corresponding to JS 1630) contains *Eusyringium lagena* (?), *Theocotyle venezuelensis, Thyrsocyrtis triacantha* and *Podocyrtis sinuosa,* and thus belongs in the *Podocyrtis ampla* Zone or the *Thyrsocyrtis triacantha* Zone.

Finally, a sample from near Hopefield Plantation provided by W. F.—Auer contains *Eusyringium lagena* (?), *Thyrsocyrtis triacantha, Podocyrtis ampla* and *P. sinuosa,* and no *Eusyringium fistuligerum,* and thus belongs in the early part of the *Podocyrtis ampla* Zone.

The only non-calcitized radiolarian assemblage that we have seen from the Navet Formation of Trinidad is that in Renz sample 336 from Friendship Quarry, near milepost 5 of the Princes Town Road (Bolli, 1957b, p. 158), which contains members of the *Lithocyclia ocellus* group, *Lithochytris vespertilio, Thyrsocyrtis triacantha, Theocampe mongolfieri,* and doubtfully identifiable *Theocotyle venezuelensis* and *Podocyrtis sinuosa,* and is thus probably assignable to the *Thyrsocyrtis triacantha* Zone.

Two samples from the Toledo member of the Universidad Formation of Habana Province, Cuba (Bermudez sample nos. 310 from Cantera San Francisco, Puentes Grandes, and 351 from Cantera Central Toledo) contain well-preserved, diverse assemblages including *Theocotyle cryptocephala* (?) *nigriniae, Thyrsocyrtis hirsuta hirsuta, Podocyrtis aphorma, P. sinuosa* and rare specimens of *Theocampe mongolfieri,* and thus belong in the lower part of the *Theocampe mongolfieri* Zone. An older Cuban Eocene assemblage is discussed in connection with the radiolarians occurring at Site 67.

7. COMMENTS

7a. Preservation of Radiolarians

At the Leg 7 drilling sites, radiolarians are commonly well preserved through long sequences of cores, and most of the occurrences of poorly preserved radiolarians are readily explained as being the result of the normal difference between sediments deposited beneath the Equatorial Current System (highly radiolarian) and those deposited beneath the Central Water Masses (and containing few, poorly preserved siliceous microfossils) (Riedel, 1959a; Riedel and Funnell, 1964). In addition to the poorly preserved assemblages mentioned in the section on paleo-environmental interpretations, the scarcity or absence of siliceous microfossils in the following cores may well be due to accumulation outside the area of influence of the biologically productive Equatorial Current System—Cores 62.0-6 to 62.0-8, 63.0-6 to 63.0-9, 66.0-4 to 66.0-8, and 67.1-1.

In addition to these long sequences of poorly preserved assemblages, there is a shorter interval that merits special consideration. Radiolarians are poorly preserved to absent in Cores 62.1-38 and 62.1-39, and it is not immediately apparent why this is the case, nor why the same effect was not observed in sediments of the same age in the continuously cored section at the nearby Site 63.

7b. Paleoenvironmental Interpretations

All of the Cenozoic sequences cored at Sites 62 through 66 appear to have normal tropical radiolarian assemblages, with the exception of the uppermost Miocene and Pliocene at Sites 62 and 63 (from about 90 to 200 meters below the sediment surface at Site 62 and about 15 to 30 meters at Site 63). In those intervals, radiolarian assemblages are commonly poorly preserved, and less diverse than normal tropical assemblages, with many spongodiscids, few artiscins and collosphaerids, and occurrences of *Pterocanium prismatium* so sporadic that the definition of radiolarian zones is difficult. The scarcity and poor preservation of radiolarians, as well as the listed characteristics of the assemblages, are more characteristic of sediments beneath the North and South Central Pacific Water Masses than those beneath the Equatorial Current System.

7c. Hiatuses in Sedimentation

There are only two intervals in the cored Cenozoic sequences at which hiatuses in sedimentation or exceptional shortening of the column are indicated by the radiolarian evidence.

At Site 65, between the lower part of 65.0-7 and the top of 65.0-8, an interval representing the *Dorcadospyris alata* Zone (which occupies approximately 20 meters at some other sites) may be compressed or missing.

At Site 64 there appears to be a hiatus or condensed section between 915 and 970 meters (between Cores 64.1-9 and 64.1-10), but a complete radiolarian sequence corresponding to this interval was not cored at other sites and therefore the amount of shortening of the section is uncertain.

7d. New Information on Phylogeny

Our report on radiolarians from Leg 4 of the drilling expedition (Riedel and Sanfilippo, in press) includes a summary of what was then known of Cenozoic radiolarian phylogeny, and we here add only the advances made on the basis of the Leg 7 material.

Artiscinae. It now seems clear that this subfamily developed from *Lithocyclia angustum* by reduction of the number of spongy columns from three to two, and displacement of the axis of radial symmetry through 90°.

Spongaster. The development of this genus from a circular spongodiscid in the *Ommatartus antepenultimus* Zone is clearly demonstrated. The relationships of superficially similar earlier forms remain to be worked out.

Liriospyris parkerae. Intermediate forms, with reduced pores in the frontal ring, link this species with the ancestral *L. stauropora.*

Psychospyris. This remarkable genus, comprised of a lineage of the three species *Psychospyris parva, P. intermedia* and *P. grandis,* evidently evolved from *Dendrospyris anthocyrtoides.*

Dorcadospyris ateuchus. The Leg 7 material provides more convincing evidence than was previously available, for the development of this species from *Tristylospyris triceros.*

Cyclampterium (?). The phylogenetic sequence of species observed in the Leg 7 material corresponds to that described (Sanfilippo and Riedel, in press) on the basis of scattered piston cores, and the lineage is extended back in time by the recognition of *Cyclampterium* (?) *milowi* as the ancestor of *C.* (?) *pegetrum.* The ultimate origin of the lineage is still not known.

Lychnocanium sp. aff. *L. bellum.* This distinctive species evidently evolved directly from *L. bellum,* and appears to represent the termination of the lineage.

Artostrobium doliolum, Phormostichoartus corona, Siphocampe corbula and *Spirocyrtis scalaris.* The forms ancestral to these species have been determined and illustrated, but not named.

8. SYSTEMATIC SECTION

The taxonomy applied here is heavily dependent upon other papers which we have recently completed (Sanfilippo and Riedel, in press; Riedel and Sanfilippo, in press). In the synonymies of species that have previously been treated adequately, we here include only the reference to the original description and figure, the reference to the new combination if the generic name now used differs from that to which the species was originally assigned, and a reference to a paper defining the present concept of the species.

Genera are arranged alphabetically within families, and species alphabetically within genera.

Type specimens and some other figured specimens will be deposited in the U.S. National Museum, Washington, D. C.

8a. Family COLLOSPHAERIDAE Müller 1858

A preliminary survey was made to determine the earliest occurrence of members of this family, and to determine whether any species or genera could easily be used for correlation. The earliest occurrence observed in the drill-cores was a *Siphonosphaera*? in the *Calocycletta virginis* Zone, and in slightly younger assemblages the genera *Collosphaera, Polysolenia, Solenosphaera* and *Tribonosphaera* are also present. Thus, none of these genera in the sense of Hilmers (1906), is very restricted stratigraphically, and we describe only one species of *Solenosphaera* which appears to be useful for late Neogene correlations. In the synchronopticon, however, we illustrate a number of the more common forms (Plate 1A, Figures 1-24; Plate 1B, Figures 1-17; Plate 1C, Figures 1-4; Plate 2A, Figures 1-15; Plate 2B, Figures 1-8).

Genus **Solenosphaera** Haeckel 1887

Solenosphaera omnitubus Riedel and Sanfilippo, new species (Plate 1A, Figures 23, 24; Plate 4, Figures 1, 2).

Description: Shell small, approximately spherical, with 4 to 8 short, truncate, cylindrical tubes without differentiated termination, which occupy most of the surface of the sphere. Pores small, subcircular, not very variable in size, similar on the tubes and the sphere.

Measurements based on 30 specimens from 62.1-20-2, 84-86 cm and 66.1-4-3, 25-27 cm. Overall diameter (including tubes) 70 to 120μ.

Remarks: This species differs from other members of the genus in the small number of tubes which occupy a very large proportion of the surface of the sphere.

8b. Family ACTINOMMIDAE Haeckel 1862, emend. Riedel 1967b

Apart from a passing reference to *Lithapium* (?) *anoectum,* the only actinommids treated are the members of the subfamily Artiscinae. This is because we have no useful system for classifying the vast bulk of actinommids.

Genus **Lithapium** Haeckel, 1887

Lithapium (?) anoectum Riedel and Sanfilippo

Lithapium (?) *anoectum* Riedel and Sanfilippo, in press.

Subfamily ARTISCINAE Haeckel 1881, emend. Riedel 1967b

The Neogene sequences obtained in the Western Pacific confirm most of the details of the phylogenetic development of artiscins suggested previously (Riedel, 1959). The only significant point of difference concerns the origin of *Cannartus tubarius,* which was previously thought to have developed from *Cannartus prismaticus,* but which may actually have arisen more directly from a form closely related to *Lithocyclia angustum*—the form (Plate 4, Figure 3) mentioned below in the discussion of *Doryphacus, Dorydruppa* and *Doryprunum.*

The earliest specimens of *Cannartus prismaticus* provide rather convincing evidence that this species (the earliest representative of its family) developed from *Lithocyclia angustum,* by loss of one of the spongy arms of the latter, and the remaining two arms becoming the the spongy columns of the artiscin. Their cortical shell tends to be spherical, the two spongy columns tend not to be diametrically opposed, and the structure of the cortical shell of the two species is similar (Plate 4, Figure 5). The transition between these two species is very interesting, since it involves a fundamental change in the axis of rotational symmetry, which in the earlier form is through the short axis of a disc, and in the later form is along the long axis of an ellipsoid (homologous with a diameter of the earlier disc). This evident origin of the artiscins from a coccodiscid ancestor raises a question as to the appropriateness of the placement of the subfamily within the family Actinommidae.

At about the time that this transition was taking place, discoidal and ellipsoidal forms with latticed spines appeared, which may possibly have some connection with the *Lithocyclia-Cannartus* transition. In some of our Italian samples we have found a discoidal form with one latticed spine (Plate 4, Figure 4)—evidently belonging to *Doryphacus* Carnevale (1908)—which may have arisen from *Lithocyclia angustum.* And in some Pacific samples (62.0-5-2 to 62.0-5-4) of perhaps similar age there is a form with a rather irregularly ellipsoidal cortical shell, medullary shell(s?) connected to it by equatorially disposed bars, and a remarkably similar latticed spine (Plate 4, Figure 3). This form fits within the definition of *Dorydruppa* or *Doryprunum* of Vinassa (1898), and may bear a similar relationship to *Cannartus* as *Doryphacus* does to *Lithocyclia.*

In this report we take account of the short-lived species *Ommatartus avitus* (Riedel), which has been overlooked in some recent papers (Riedel and Funnell, 1964; Riedel and Sanfilippo, in press). Thus, all known artiscins are treated systematically, except for the following two.

In the sequences at the westernmost drilling sites, in some of the assemblages containing *Cannartus mammiferus* or *C. antepenultimus,* occur rare specimens of a form which we have illustrated as *Cannartus* sp. (Plate 1D, Figure 1). This form has somewhat thinner walls than *Cannartus prismaticus* and polar columns not well developed, and has been found in Cores 62.1-26 to 62.1-32, 63.0-2 to 63.1-10 and 64.0-3 to 64.0-5. It closely resembles *Cannartus prismaticus,* but is perhaps not closely related to it because there seems to be a gap between their ranges. It may have arisen from a form similar to *Cannartus mammiferus,* later becoming smooth and inflated, and ultimately losing the spongy columns.

Another form, also identified as *Cannartus* sp. (Plate 2B, Figures 9, 10), has not been treated in detail. This is a rather narrow, very thin-walled, elongated form with distinct equatorial constriction, which has been found rarely in Cores 63.1-11 to 63.1-13 and 64.1-6.

Division of the artiscins into the two genera *Cannartus* and *Ommatartus* in the sense used herein is not very satisfactory, since it divides the continuous lineage from *Cannartus tubarius* to *Ommatartus tetrathalamus* into two parts, and does not reflect the natural relationships of the short *Cannartus* (?) *petterssoni*–*Ommatartus hughesi* lineage. However, it seems undesirable to change the generic classification prior to publication of the paper (Riedel, in press) in which the system used here is established.

Genus **Cannartus** Haeckel 1881, emend. Riedel in press

The emended definition admits artiscins with spongy polar columns only, and no distinct polar caps.

Cannartus laticonus Riedel (Plate 1C, Figures 13, 14)

Cannartus laticonus Riedel, 1959b, p. 291, pl. 1, fig. 5.

Cannartus mammiferus (Haeckel)—(Plate 2C, Figures 1-3)

Cannartidium mammiferum Haeckel, 1887, p. 375, pl. 39, fig. 16.

Cannartus mammiferus (Haeckel), Riedel, 1959b, p. 291, pl. 1, fig. 4.

Cannartus (?) petterssoni Riedel and Sanfilippo (Plate 1C, Figures 19, 20)

Cannartus petterssoni, manuscript name proposed provisionally in Riedel and Funnell, 1964, p. 310.

Cannartus (?) *petterssoni* Riedel and Sanfilippo, in press.

Cannartus prismaticus (Haeckel)–(Plate 2C, Figures 11-13; Plate 4, Figure 5)

Pipettella prismatica Haeckel, 1887, p. 305, pl. 39, fig. 6; Riedel, 1959b, p. 287, pl. 1, fig. 1.

Cannartus prismaticus (Haeckel), Riedel and Sanfilippo, in press.

In some assemblages from the *Lychnocanium bipes* Zone, *Cannartus prismaticus* is accompanied by a form with rather similar cortical shell and two-bladed spines in place of the spongy columns (Plate 2C, Figure 14).

Cannartus tubarius (Haeckel) (Plate 2C, Figures 8-10)

Pipettaria tubaria Haeckel, 1887, p. 339, pl. 39, fig. 15; Riedel, 1959b, p. 289, pl. 1, fig. 2.

Cannartus tubarius (Haeckel), Riedel and Sanfilippo, in press.

Cannartus violina Haeckel (Plate 2C, Figures 4-7)

Cannartus violina Haeckel, 1887, p. 358, pl. 39, fig. 10; Riedel 1959b, p. 290, pl. 1, fig. 3.

Genus **Ommatartus** Haeckel 1881,
emend. Riedel in press

The emended definition includes artiscins with polar caps, and so sometimes spongy columns as well.

Ommatartus antepenultimus Riedel and Sanfilippo (Plate 1C, figures 11, 12)

Panarium antepenultimum, manuscript name proposed provisionally in Riedel and Funnell, 1964, p. 311.

Ommatartus antepenultimus Riedel and Sanfilippo, in press.

Ommatartus avitus (Riedel) (Plate 4, Figure 6)

Panartus avitus Riedel, 1953, p. 808, pl. 84, fig. 7.

This species, with tuberculate surface of the cortical shell and no spongy columns on the well developed polar caps, is intermediate between *Ommatartus antepenultimus* and *O. tetrathalamus.*

Ommatartus hughesi (Campbell and Clark) (Plate 1C, Figures 17, 18)

Ommatocampe hughesi Campbell and Clark, 1944, p. 23, pl. 3, fig. 12.

Ommatartus hughesi (Campbell and Clark), Riedel and Sanfilippo, in press.

Ommatartus penultimus (Riedel) sensu stricto (Plate 1C, Figures 8-10)

Panarium penultimum Riedel, 1957, p. 76, pl. 1, fig. 1; Riedel and Funnell, 1964, p. 311.

Ommatartus penultimus (Riedel), Riedel and Sanfilippo, in press.

Ommatartus tetrathalamus (Haeckel) (Plate 1C, Figures 5-7)

Panartus tetrathalamus Haeckel, 1887, p. 378, pl. 40, fig. 3; Nigrini, 1967, p. 30, pl. 2, figs. 4 a-d.

8c. Family COCCODISCIDAE Haeckel, 1862

By dividing this family very coarsely into three groups (one with narrow spongy arms, the second with broad spongy arms, and the third with a spongy zone not subdivided into arms), we accommodate all representatives present in the assemblages. The family terminated by evolving into the Artiscinae.

Genus **Lithocyclia** Ehrenberg,
sensu Riedel and Sanfilippo, in press

Lithocyclia angustum (Riedel) (Plate 3A, Figures 1, 2 (?), 3)

Trigonactura angusta Riedel, 1959b, p. 292, pl. 1, fig. 6.

Lithocyclia angustum (Riedel), Riedel and Sanfilippo, in press.

Lithocyclia aristotelis (Ehrenberg) group (Plate 3A, Figures 4, 5)

Astromma aristotelis Ehrenberg, 1847b, p. 55, fig. 10.

Lithocyclia aristotelis (Ehrenberg) group, Riedel and Sanfilippo, in press.

Lithocyclia ocellus Ehrenberg group (Plate 3A, Figure 6)

Lithocyclia ocellus Ehrenberg, 1854, pl. 36, fig. 30; 1873, p. 240.

Lithocyclia ocellus Ehrenberg group, Riedel and Sanfilippo, in press.

8d. Family SPONGODISCIDAE Haeckel, emend. Riedel 1967b

The only members of this family that we have treated are the genus *Spongaster* (of which the evolutionary development is presented), and a single species of *Dictyocoryne.*

Genus **Dictyocoryne** Ehrenberg 1860

Dictyocoryne ontongensis Riedel and Sanfilippo, new species (Plate 1E, Figures 1, 2; Plate 4, Figures 9, 10, 11)

Description: Central disc small, with usually 5 concentric rings. Three arms arranged usually in a Y-shape, with one angle smaller than the others, but in some early specimens at equal angles. Arms rarely with slight transverse zonation, parallel-sided or slightly expanding distally; one or more of them forked distally at a very obtuse angle, each branch being of approximately the same width as the distal part of the arm or wider, and with a bluntly rounded termination. Rarely, the terminations of the arms are doubly bifurcate (Plate 4, Figure 11). Some specimens have a patagium that occupies practically all of the space outlined by the arms and their bifurcations.

Measurements based on 30 specimens from 66.1-5-1, 25-27 cm; 66.1-5-5, 25-27 cm; and 66.1-6-2, 25-27 cm. Maximum radius 116 to 215μ.

Remarks: *D. ontongensis* differs from *Chitonastrum jugatum* Haeckel and *C. lyra* Haeckel in that the arms are more uniformly spongy, not pronouncedly transversely chambered, and from *C. dicranodes* Haeckel in that the three arms are approximately equal. It differs from *Trigonastrum regulare* Haeckel and *T. gegenbauri* (Haeckel) in that the angles of bifurcation are more obtuse, and from *Rhopalodictyum bifidum* Haeckel in that each branch of the bifurcation is as wide as the proximal part of the arm or wider.

In the absence of any satisfactory understanding of the relationships of this species, it could equally well be placed in the spongodiscid genera *Dictyocoryne* Ehrenberg or *Rhopalodictyum* Ehrenberg, or the "porodiscid" genera *Chitonastrum* Haeckel or *Trigonastrum* Haeckel. We have chosen to place it in *Dictyocoryne* because that genus is the earliest described, and is defined as having a "spongodiscid" rather than a "porodiscid" structure.

Genus **Spongaster** Ehrenberg 1860

Emended definition: This genus comprises the forms that appear to form a phylogenetic series from *Spongaster klingi* to *S. tetras* (the type species of the genus). The thickened marginal part of the skeleton is not uniform circular, but is differentiated into four or more (sometimes two) denser areas separated by less dense zones. None of the species is constantly three-armed as in the genera *Euchitonia* Ehrenberg, *Dictyastrum* Ehrenberg, *Chitonastrum* Haeckel, etc.

Remarks: In the earliest assemblages containing the genus *Spongaster,* there is a circular spongodiscid with thickened center and periphery and with a narrow cone ("pylome tube" of *Schizodiscus,* in Dogel and Reshetnyak, 1952) extending inward from the margin (Plate 1D, Figure 14). Specimens of *Spongaster klingi* often show a similar cone within one of the two diametrically opposed radial thickenings (Plate 1D, Figure 10; Plate 4, Figure 8), and early specimens of *S. pentas* also show such a structure within one of the thickened rays (Plate 1D, Figure 5; on the ray pointing downward). There seems to have been a strong tendency for the thickenings of the spongy disc to have become differentiated symmetrically with respect to this pylome-tube.

In addition to the species treated below, the genus may also include a semicylindrical form (Plate 1D, Figures 11, 12), perhaps homologous with the central area and two long radial thickenings of *S. klingi,* which occurs together with the latter species.

Well below the range of *Spongaster* as defined here, occurs a form (Plate 5, Figure 1), which fits the earlier concept of this genus but is evidently not related.

Spongaster klingi Riedel and Sanfilippo, new species (Plate 1D, Figures 8, 9, 10; Plate 4, Figures 7, 8)

"Elliptical spongodiscid", Kling, in press, pl. 1, fig. J.

Description: Finely spongy skeleton elliptical in outline. Especially thickened are the central area, two opposite radii (and especially their distal parts), and two bluntly crescentic zones near the periphery (one on either side of the thickened diameter). One of the thickened radii includes a narrow conical pylome-tube.

Measurements based on 30 specimens from 66.1-4-CC; 66.1-4-3, 25-27 cm; 66.1-4-1, 110-111 cm; and 66.1-3-CC. Major diameter 325 to 405 μ; minor diameter 255 to 355 μ.

Remarks: This species differs from the other members of the genus in having only two thickened radii, and two crescentic thickenings. It is named for Stanley A. Kling, who first illustrated the species and deduced its origin from a circular spongodiscid.

Spongaster pentas Riedel and Sanfilippo (Plate 1D, Figures 5, 6, 7)

Spongaster pentas Riedel and Sanfilippo, in press.

This species apparently developed from a circular spongodiscid ancestor at about the same time as, or slightly later than, the first *S. klingi.* The earlier description of this species did not note the narrow pylome-tube visible within the distal part of one arm of some specimens.

Spongaster tetras Ehrenberg (Plate 1D, Figures 2, 3, 4)

Spongaster tetras Ehrenberg, 1860, p. 833; 1861, p. 301; 1872b, pl. 6 (3), fig. 8; Nigrini, 1967, p. 41, pl. 5, figs. la-b, 2.

This species apparently developed from *S. pentas,* by reduction of the number of arms from five or six to four, and stabilization of the four-rayed symmetry. It seems that the pylome-tube characteristic of other members of the genus has been lost at this stage of phylogenetic development. Nigrini (1967, p. 43, pl. 5, fig. 2) has described an irregularly rectangular subspecies *S. tetras irregularis* characteristic of middle latitudes, which also occurs in some of our sequences at the westernmost drilling sites. In sequences in which *S. tetras* is represented by the subspecies *irregularis,* it is difficult to recognize the zone of transition from *S. pentas.*

8e. Family ACANTHODESMIIDAE Haeckel 1862, emend. Riedel 1967b

Only a small number of the many species of this family (=Trissocyclidae of Goll, 1968, 1969) are treated here.

Genus **Dendrospyris** Haeckel 1881, emend. Goll 1968

Dendrospyris anthocyrtoides (Bütschli) (Plate 5, Figures 5-7)

Petalospyris anthocyrtoides Bütschli, 1882b, p. 532, figs. 19a-b.

Dendrospyris anthocyrtoides (Bütschli), Goll, 1968, p. 1419, pl. 174, figs. 9, 11-14; text-fig. 8.

Some late specimens of this species (e.g., Plate 5, Figure 7) tend to have the anterior and posterior faces of the cephalic lattice-shell more delicate than usual, and with smaller pores, and a rather robust thorny zone in the frontal plane—they thus approach *Psychospyris parva.*

Genus **Dorcadospyris** Haeckel, 1881

This generic name is here used in a much more restricted sense than applied by Goll (1969). We include in *Dorcadospyris* only those forms in which two feet are especially strongly developed, and exclude *Tristylospyris triceros* (the immediate ancestor of *Dorcadospyris ateuchus),* in which three feet are strongly developed.

Dorcadospyris alata (Riedel) (Plate 2D, Figure 1)

Brachiospyris alata Riedel, 1959b, p. 293, pl. 1, figs. 11, 12.

Dorcadospyris alata (Riedel), Riedel and Sanfilippo, in press.

Dorcadospyris ateuchus (Ehrenberg) (Plate 2D, Figure 6; Plate 3A, Figures 9, 10)

Ceratospyris ateuchus Ehrenberg, 1873, p. 218; 1875, pl. 21, fig. 4.

Cantharospyris ateuchus (Ehrenberg), Haeckel, 1887, p. 1051; Riedel, 1959b, p. 294, pl. 22, figs. 3, 4.

Dorcadospyris ateuchus (Ehrenberg), Riedel and Sanfilippo, in press.

Evidence from the drilled sequences in the western Pacific confirms the suggestion by Riedel (1959) that this species evolved from *Tristylospyris triceros* by reduction of the number of strongly developed feet from three to two.

Dorcadospyris dentata Haeckel (Plate 2D, Figures 2, 3)

Dorcadospyris dentata Haeckel, 1887, p. 1040, pl. 85, fig. 6; Riedel, 1957, p. 79, pl. 1, fig. 4.

Dorcadospyris forcipata (Haeckel) (Plate 2C, Figures 20-23; Plate 3A, Figure 8)

Dipospyris forcipata Haeckel, 1887, p. 1037, pl. 85, fig. 1.

Dorcadospyris forcipata (Haeckel), Riedel and Sanfilippo, in press.

Dorcadospyris papilio (Riedel) (Plate 2D, Figures 4, 5; Plate 3A, Figure 7)

Hexaspyris papilio Riedel, 1959b, p. 294, pl. 2, figs. 1, 2.

Dorcadospyris papilio (Riedel), Riedel and Sanfilippo, in press.

Dorcadospyris simplex (Riedel)

Brachiospyris simplex Riedel, 1959b, p. 293, pl. 1, fig. 10.

Dorcadospyris simplex (Riedel), Riedel and Sanfilippo, in press.

Genus **Liriospyris** Haeckel 1881, emend. Goll 1968

Liriospyris elevata Goll (Plate 1E, Figure 3)

Liriospyris elevata Goll, 1968, p. 1426, pl. 175, figs. 4, 5, 8, 9; text-fig. 9.

Liriospyris parkerae Riedel and Sanfilippo, new species (Plate 2C, Figure 15; Plate 5, Figure 4)

Description: Sagittal ring D-shaped, with a furrow on the anterior and posterior sides. Four collar pores, separated by the median and sternal (in the sense of Goll) bars and the primary lateral spines, are enclosed within the basal ring. The remainder of the skeleton is a simple longitudinally furrowed frontal ring, except that it is divided apically to join the upper part of the sagittal ring at two points. There is no apical spine, and the vertical spine is represented by a short thorn. At the base of the apical bar of the sagittal ring is a single small pore, near which can be distinguished two very small secondary lateral bars, and near the base of the vertical bar is a pair of small pores and near them a sternal bar (in the sense of Goll, 1968).

Measurements based on 25 specimens from 63.1-9-4, 15-16 cm and 64.0-5-4, 84-86 cm. Height of sagittal ring 50 to 70 μ, total width of skeleton 95 to 125 μ.

Remarks: This species differs from *Liriospyris stauropora,* its immediate ancestor, in that the band-like lattice-shell of that species is here reduced to a poreless bar.

It is named for Frances L. Parker, whose investigations of Cenozoic foraminifera have contributed greatly to our understanding of the biostratigraphy of pelagic sediments.

Liriospyris stauropora (Haeckel) (Plate 2C, Figures 16-19)

Trissocyclus stauroporus Haeckel, 1887, p. 987, pl. 83, fig. 5.

Liriospyris stauropora (Haeckel), Goll, 1968, p. 1431, pl. 175, figs. 1-3, 7; text-fig. 9.

Goll's records of this species above the Lower Miocene are evidently due to the admixture of older forms into younger assemblages—a commonly occurring circumstance in deep-sea sediments of which his tabulation takes no account. Our evidence indicates that *Liriospyris stauropora* evolved into *L. parkerae* at about the boundary between the *Calocycletta costata* and *Dorcadospyris alata* Zones.

Genus **Psychospyris** Riedel and Sanfilippo, new genus

Type species: *Psychospyris intermedia* Riedel and Sanfilippo, new species.

Definition: This genus comprises the members of the lineage extending from *Psychospyris parva* through *P. intermedia* to *P. grandis.* There is a strong tendency for shell development to be concentrated in the frontal plane, and for the shells therefore to be discoidal in general form. The outer part of this disc usually consists of two lattice-plates joined by bars which give the appearance of a radially chambered structure, and the inner part (corresponding to the cephalic cavity or more) hollow. The primary and secondary lateral bars are well developed, and there is no basal ring in *P. parva,* though it may be present in the other species. Below the collar pores, and marked off from the remainder of the disc by the primary lateral bars and obliquely downwardly directed bars arising from them, is a type of "pocket". There are commonly two prominent bars arising from the top of the D-shaped sagittal ring (in the position denoted as "q" by Petrushevskaya, 1969), and extending obliquely upward to the spongy zone at the top of the skeleton.

Remarks: In the phylogenetic development of this lineage, the overall size increases and the originally kidney-shaped outline becomes almost circular. Also, the ring, which has the usual D-shaped proportions in *P. parva,* becomes markedly elongated vertically in late *P. intermedia* and especially in *P. grandis,* and the hollow cephalic cavity becomes correspondingly larger in diameter. We have been surprised to find such a range of size and form in the sagittal ring of this genus, but there appears to be no doubt that the forms included here are in fact closely related.

This genus is distinguished from some species of *Tholospyris* (in the sense of Goll, 1969), which have the skeleton developed principally in the frontal plane, in the lack of strongly developed sagittal ring bars. *Psychospyris* may well have developed from *Dendrospyris anthocyrtoides,* which immediately precedes it in the cored sequences, by degeneration of the lattice plates on the anterior and posterior faces, strong development of the shell (first as spines and later as lattice plates) in the frontal plane, and increase in size.

The name is derived from the Greek *psyche* (=butterfly) and *spyris* (=basket), and is feminine.

Psychospyris grandis Riedel and Sanfilippo, new species (Plate 6, Figures 3-5)

Description: Cephalic cavity, together with the "pocket" below the lateral bars, almost circular in outline, covered by very delicate lattice-plates with pores resembling an irregular network rather than circular. Chambered zone narrow, dense, peripherally thorny, and similar in structure around the entire periphery. Sagittal ring high and delicate, at its upper end connected to the inner margin of the spongy zone by paired sagittal ring bars which are generally shorter than in *P. intermedia.*

Measurements based on 6 specimens from 66.1-8-CC, 66.0-2-1, 25-27 cm, and 66.0-2-3, 25-27 cm. Width of cephalic cavity 265 to 365 μ; height of sagittal ring 110 to 145 μ; greatest diameter of total skeleton 375 to 475 μ.

Remarks: This species is distinguished from *Psychospyris intermedia* by its larger size, subcircular outline and constantly elongated and delicate sagittal ring. This species evidently represents the termination of its lineage.

Psychospyris intermedia Riedel and Sanfilippo, new species (Plate 5, Figure 11; Plate 6, Figures 1, 2)

Description: Cephalic cavity much larger than that of *P. parva,* in early specimens not bounded by a distinct frontal ring and in late specimens bounded by an apparently secondarily developed line at the inner margin of the chambered zone. Chambered zone in some specimens represented only by a zone of strongly developed thorns. Sagittal ring in early specimens similar to that of *P. parva,* and surmounted by a pair of long sagittal ring bars (in position "q" of Petrushevskaya, 1969), and in later specimens much more delicate and higher. Lattice shell on anterior and posterior faces of cephalic cavity very delicate, with small pores, and often broken.

Measurements based on 15 specimens from 66.0-2-CC, 66.0-3-1, 25-27 cm, and 66.0-3-3, 125-127 cm. Width of cephalic cavity 195 to 330 μ; height of sagittal ring 50 to 115 μ; greatest diameter of total skeleton (including spines) 245 to 435 μ.

Remarks: This species is phylogenetically intermediate between *Psychospyris parva* and *P. grandis,* and is usually kidney-shaped or elliptical in outline rather than subcircular.

Psychospyris parva Riedel and Sanfilippo, new species (Plate 5, Figures 8-10)

Description: Bilobed cephalis of the usual acanthodesmiid form, its outline marked by an almost complete frontal ring. Anterior and posterior faces of this cephalic shell very delicate, with small subcircular pores. In the frontal plane, surrounding the cephalic shell, is a more robustly developed zone of chambered structure, which may be kidney-shaped, elliptical or circular in outline. The cephalic cavity is generally about a third to a half as wide as the total width of the skeleton.

Measurements based on 9 specimens from 66.0-3-5, 25-27 cm and 125-127 cm. Width of cephalic cavity 130 to 170 μ; height of sagittal ring 65 to 80 μ; greatest diameter of total skeleton 205 to 365 μ.

Remarks: This species is distinguished from *Psychospyris intermedia* by the smaller cephalic cavity.

Genus **Tristylospyris** Haeckel 1881

The assignment of the following species to this genus is not based on any conviction that it is related to the type species of *Tristylospyris,* but is simply an application of Haeckel's binomen pending determination of its true relationships.

Tristylospyris triceros (Ehrenberg) (Plate 3A, Figures 11, 12)

Ceratospyris triceros Ehrenberg, 1873, p. 220; 1875, pl. 21, fig. 5.

Tristylospyris triceros (Ehrenberg), Haeckel, 1887, p. 1033.

8f. Family THEOPERIDAE Haeckel, emend. Riedel 1967b

We treat only a small proportion of the many forms in this large, probably polyphyletic family. The new genus *Bekoma* may differ sufficiently in its cephalic structure to warrant exclusion from this family, but it is retained here pending elucidation of its evolutionary origin.

Genus **Artophormis** Haeckel 1881

Artophormis barbadensis (Ehrenberg) (Plate 3B, Figures 8, 9)

Calocyclas barbadensis Ehrenberg, 1873, p. 217; 1875, pl. 18, fig. 8.

Artophormis barbadensis (Ehrenberg), Riedel and Sanfilippo, in press.

Artophormis dominasinensis (Ehrenberg) (Plate 6, Figure 6)

Podocyrtis dominasinensis Ehrenberg, 1873, p. 250; 1875, pl. 14, fig. 4.

Artophormis dominasinensis (Ehrenberg), Riedel and Sanfilippo, in press.

This species has a thin poreless rim with few to many small teeth. The cephalis is not regularly three-lobed as might be deduced from Ehrenberg's figure.

Artophormis gracilis Riedel (Plate 3B, Figures 5-7; Plate 6, Figure 7)

Artophormis gracilis Riedel, 1959b, p. 300, pl. 2, figs. 12, 13.

Genus **Bekoma** Riedel and Sanfilippo, new genus

Definition: Shell consisting of cephalis, thorax, three robust feet, and usually some lattice in the abdominal position. The cephalis contains a well developed spicular structure, and the collar stricture is not as distinct as in most cyrtoids. From each foot arises an inwardly or downwardly directed rod, and these rods are sometimes connected to those of the neighboring feet by additional bars.

Remarks: This genus differs from other superficially similar theoperid genera by the combination of characters–lack of distinct collar stricture and characteristically pronged feet.

The generic name is an arbitrary combination of letters, and is treated as feminine.

The peculiar structure of the cephalis, in particular, seems to necessitate the erection of a new genus for the species described below. The fundamental spicule, with median bar and apical, vertical, and probably primary and secondary lateral rays, is well developed and not reduced to form the small collar pores normally associated with a pronounced collar stricture.

An undescribed species of this genus occurring in an apparently older Paleocene assemblage from Belus (Plate 6, Figure 8) has almost straight feet each with an inwardly directed rod. In the species occurring at Site 67 and in the Upper Paleocene at Ibbaritz-Bidarf, this latter rod changes its orientation to become downwardly directed, and thus collinear with the proximal part of the foot, and the original distal part of the foot is reduced to a small, outwardly directed thorn.

In rare specimens from Ibbaritz-Bidarf, bars are developed to join the inwardly directed rods of neighboring feet, but this has not been observed in specimens from Site 67, which might therefore be interpreted as slightly younger–Plate 7, Figure 3 shows the manner of this joining in side view, and Plate 7, Figure 4 in plan view.

Bekoma bidarfensis Riedel and Sanfilippo, new species (Plate 7, Figures 1-7)

Description: Cephalis and thorax together campanulate, with three robust feet. Cephalis approximately hemispherical, with very thick wall, not marked off from the thorax externally. Cephalis seems generally poreless, but with numerous depressions resembling infilled pores. In some specimens the apical and vertical spines extend beyond the cephalic surface as two weak, oblique spines. Thorax campanulate, with somewhat rough surface, proximally narrow and forming a type of "neck" merging with the cephalis with no change in contour. Thoracic pores subcircular, smaller and sparser proximally. From (and slightly above) the distinct distal rim of the thorax arise three long, thick, subparallel cylindrical feet with an outwardly-directed thorn in the distal half (but see discussion of homologies below). In many specimens, the feet are irregularly hollow distally. Fragments of a latticed abdomen are commonly present.

Measurements based on 9 specimens from 67.1-2-CC. Length of cephalis plus thorax 145 to 165 μ; maximum breadth of thorax 130 to 170 μ.

Remarks: Specimens from Site 67, and some from the Upper Paleocene at Ibbaritz-Bidarf, have an outwardly directed thorn in the distal part of the robust rod which superficially resembles a foot. This thorn is evidently homologous with the terminal part of the straight foot of the form from Belus, and the structure distal from that is homologous with the inwardly-directed rod from which arise the bars that connect the three feet in some specimens.

Genus **Calocycloma** Haeckel 1887

Calocycloma (?) ampulla (Ehrenberg) (Plate 3B, Figure 4)

Eucyrtidium ampulla Ehrenberg, 1854, pl. 36, fig. 15; 1873, p. 225.

Calocycloma (?) *ampulla* (Ehrenberg), Riedel and Sanfilippo, in press.

Genus **Cycladophora** Ehrenberg 1847a

Cycladophora hispida (Ehrenberg) (Plate 3B, Figures 10,11)

Anthocyrtis hispida Ehrenberg, 1873, p. 216; 1875, pl. 8, fig. 2.

Cycladophora hispida (Ehrenberg), Riedel and Sanfilippo, in press.

Cycladophora turris (Ehrenberg)

Calocyclas turris Ehrenbèrg, 1873, p. 218; 1875, pl. 18, fig. 7.

Cycladophora turris Ehrenberg, Riedel and Sanfilippo, in press.

Genus **Cyclampterium** Haeckel 1887

Cyclampterium (?) brachythorax Sanfilippo and Riedel (Plate 1E, Figure 7)

Cyclampterium (?) *brachythorax* Sanfilippo and Riedel, in press.

Cyclampterium (?) leptetrum Sanfilippo and Riedel (Plate 2D, Figures 9-12)

Cyclampterium (?) *leptetrum* Sanfilippo and Riedel, in press.

Cyclampterium (?) milowi Riedel and Sanfilippo, new species (Plate 3B, Figure 3; Plate 7, Figures 8, 9)

Cyclampterium (?) sp., Sanfilippo and Riedel, in press, pl. 2, fig. 7.

Description: Shell robust, subcylindrical to campanulate, with the large abdomen bearing three latticed feet. Cephalis subspherical, with few small pores, bearing a short, broadly conical horn. Collar stricture usually pronounced, but less so when the wall of the cephalis is very thick. Thorax hemispherical, thick-walled, with subregular circular pores and surface smooth or slightly thorny. Abdomen subcylindrical or expanding distally, with robust bars separating large pores of variable size. The abdomen passes terminally into three irregular, coarsely latticed feet.

Measurements based on 30 specimens from 64.0-10-1, top, and 65.0-13-3, 25-27 cm. Total length 375 to 595 μ (usually approximately 475 μ). Maximum breadth 235 to 375 μ (usually approximately 275 μ). Length of the thorax 70 to 120 μ (usually approximately 90 μ).

Remarks: This species differs from all others of the genus in possessing latticed feet. *Dictyopodium eurylophos* Ehrenberg (1873, p. 223; 1875, pl. 19, fig. 4) and *D. oxylophos* Ehrenberg (1873, p. 223; 1875, pl. 19, fig. 5) have latticed feet, but their entire skeleton and the meshes of their abdomen and feet are much smaller.

This species is named for E. Dean Milow, who noticed this species during his investigation of radiolarians from Leg 3 of the Deep-Sea Drilling expedition.

The phylogenetic origin of *Cyclampterium* (?) *milowi* is obscure. *C.* (?) *pegetrum* is apparently its immediate descendant.

Cyclampterium (?) neatum Sanfilippo and Riedel (Plate 1E, Figures 4-6)

Cyclampterium (?) *neatum* Sanfilippo and Riedel, in press.

Cyclampterium (?) pegetrum Sanfilippo and Riedel (Plate 2D, Figures 13, 14; Plate 3B, Figures 1, 2)

Cyclampterium (?) *pegetrum* Sanfilippo and Riedel, in press.

Cyclampterium (?) tanythorax Sanfilippo and Riedel (Plate 1E, Figures 8-10; Plate 2D, Figures 7, 8)

Cyclampterium (?) *tanythorax* Sanfilippo and Riedel, in press.

Genus **Cyrtocapsella** Haeckel 1887

Cyrtocapsella cornuta Haeckel (Plate 2E, Figures 1-4)

Cyrtocapsa (Cyrtocapsella) cornuta Haeckel, 1887, p. 1513, pl. 78, fig. 9.

Cyrtocapsella cornuta Haeckel, Sanfilippo and Riedel, in press.

Cyrtocapsella japonica (Nakaseko) (Plate 1F, Figure 1; Plate 2E, Figure 12)

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

Cyrtocapsella japonica (Nakaseko), Sanfilippo and Riedel, in press.

Cyrtocapsella tetrapera Haeckel (Plate 2E, Figures 5-7)

Cyrtocapsa (Cyrtocapsella) tetrapera Haeckel, 1887, p. 1512, pl. 78, fig. 5.

Cyrtocapsella tetrapera Haeckel, Sanfilippo and Riedel, in press.

Genus **Eucyrtidium** Ehrenberg 1847a

Eucyrtidium cubense Riedel and Sanfilippo, new species (Plate 7, Figures 10, 11)

Description: Upper three segments form a conical section of the shell, and fourth segment (separated from third by slight if any internal ledge) approximately cylindrical. Cephalis subspherical, with few small pores, and bearing a short bladed apical spine. Collar stricture indistinct externally. Thorax campanulate and abdomen inflated annular, separated by pronounced internal and slight external lumbar stricture. Pores of both thorax and abdomen subcircular, larger and more closely spaced on the abdomen. In most specimens, longitudinal ridges on the surface of thorax and proximal part of abdomen separate longitudinal rows of pores. Fourth segment subcylindrical, of densely spongy material. Termination ragged or broken in all observed specimens.

Measurements based on 9 specimens from 67.1-2-CC and Palmer's Cuban Eocene sample no. 4131. Length of first three segments 120 to 150 μ, their maximum breadth 90 to 135 μ.

Remarks: This species differs from all other known members of the genus in the spongy nature of the fourth segment. The general form is reminiscent of *Stichocorys,* but that genus is believed to have originated as *S. delmontensis* from a *Eucyrtidium*-like ancestor during the early Miocene—much later than the range of this species.

Genus **Eusyringium** Haeckel 1881

Eusyringium fistuligerum (Ehrenberg) (Plate 3B, Figure 14)

Eucyrtidium fistuligerum Ehrenberg, 1873, p. 229; 1875, pl. 9, fig. 3.

Eusyringium fistuligerum (Ehrenberg), Haeckel, 1887, p. 1498.

Eusyringium fistuligerum (Ehrenberg), Riedel and Sanfilippo, in press.

Eusyringium lagena (Ehrenberg) (?)

[?] *Lithopera lagena* Ehrenberg, 1873, p. 241; 1875, pl. 3, fig. 4.

Eusyringium lagena (Ehrenberg) (?), Riedel and Sanfilippo, in press.

Genus **Lithocampium** Haeckel 1881

Lithocampium sp. A (Plate 7, Figure 12)

This species is evidently very closely related to that described from DSDP Leg 4 material as *Lithocampium* sp. (Riedel and Sanfilippo, in press). It is spindle-shaped, consisting of four segments not separated by external constrictions, and the third segment is the largest. In the Leg 4 specimens, the quincuncially arranged pores of the third segment give the general impression of being aligned obliquely, but in the specimens from Site 67 the pores of the segment are rectangularly arranged, aligned longitudinally and transversely, with ridges separating the longitudinal rows. The pores of the thinner-walled, tapering fourth segment are regularly arranged in transverse rows.

Genus **Lithochytris** Ehrenberg 1847a

Lithochytris archaea Riedel and Sanfilippo (Plate 7, Figure 13)

Lithochytris archaea Riedel and Sanfilippo, in press.

Lithochytris vespertilio Ehrenberg

Lithochytris vespertilio Ehrenberg, 1873, p. 239; 1875, pl. 4, fig. 10; Riedel and Sanfilippo, in press.

Genus **Lithopera** Ehrenberg 1847a

Lithopera (Lithopera) bacca Ehrenberg (Plate 1F, Figures 10-13)

Lithopera bacca Ehrenberg, 1872a, p. 314; 1872b, pl. 8, fig. 1; Nigrini, 1967, p. 54, pl. 6, fig. 2; Sanfilippo and Riedel, in press.

Lithopera (Glomaria) baueri Sanfilippo and Riedel (Plate 1F, Figure 9)

Lithopera baueri Sanfilippo and Riedel, in press.

Lithopera (Lithopera) neotera Sanfilippo and Riedel (Plate 1F, Figures 14, 15; Plate 2E, Figure 19)

Lithopera neotera Sanfilippo and Riedel, in press.

Lithopera (Lithopera) renzae Sanfilippo and Riedel (Plate 2E, Figures 17, 18; Plate 7, Figure 14)

Lithopera renzae Sanfilippo and Riedel, in press.

Lithopera (Glomaria) thornburgi Sanfilippo and Riedel (Plate 1F, Figure 8)

Lithopera thornburgi Sanfilippo and Riedel, in press.

Genus **Lophocyrtis** Haeckel 1887

Lophocyrtis (?) jacchia (Ehrenberg) (Plate 3C, Figures 4, 5; Plate 7, Figure 16)

Thyrsocyrtis jacchia Ehrenberg, 1873, p. 261; 1875, pl. 12, fig. 7.

Lophocyrtis (?) *jacchia* (Ehrenberg), Riedel and Sanfilippo, in press.

This species is characterized by the apical horn being supported by three (or possibly four) arches, abdomen subcylindrical or slightly expanded distally, with pores generally larger than those of the thorax, three (or four) terminal or subterminal feet usually divergent, and no differentiated peristome. Near the upper limit of this species the feet are lost (Plate 3C, Figure 5).

Genus **Lychnocanium** Ehrenberg 1847a

Lychnocanium bellum Clark and Campbell

Lychnocanium bellum Clark and Campbell, 1942, p. 72, pl. 9, figs. 35, 39; Riedel and Sanfilippo, in press.

Lychnocanium sp. aff. *L. bellum* Clark and Campbell (Plate 3C, Figures 1, 2)

We have used this designation for a form with shorter and thinner hollow feet and larger thorax than *L. bellum,* and often an inverted cap-shaped abdomen which incorporates the feet and in some individuals closes the shell aperture. The wall of the abdomen is spongy, and a spongy layer often covers the regular pores of the thorax. This form evidently developed from *L. bellum.*

Lychnocanium bipes Riedel (Plate 2F, Figures 1, 2)

Lychnocanium bipes Riedel, 1959b, p. 294, pl. 2, figs. 5, 6.

Lychnocanium trifolium Riedel and Sanfilippo, new species (Plate 3B, Figure 12; Plate 8, Figures 2, 3)

Description: Cephalis spherical, poreless, bearing a conical or three-bladed apical horn. Collar stricture pronounced. Thorax campanulate, with smooth surface and subcircular pores generally arranged in groups of three separated by wide poreless areas. Three feet three-bladed, approximately straight, longer than the thorax.

Measurements based on 20 specimens from 64.0-8-2, 84-86 cm. Length excluding horn and feet 75 to 90 μ. Maximum breadth of thorax 75 to 90 μ.

Remarks: This species differs from all other members of the genus in the characteristic grouping of thoracic pores in threes.

Genus **Phormocyrtis** Haeckel 1887

Phormocyrtis striata Brandt (Plate 8, Figure 4)

Phormocyrtis striata Brandt 1935, *in* Wetzel, 1935, p. 55, pl. 9, fig. 12; Riedel and Sanfilippo, in press.

Genus **Pterocanium** Ehrenberg 1847a

Pterocanium prismatium Riedel (Plate 8, Figure 1)

Pterocanium prismatium Riedel, 1957, p. 87, pl. 3, figs. 4-5; Riedel and Sanfilippo, in press.

Genus **Sethochytris** Haeckel 1881

Sethochytris babylonis (Clark and Campbell) group (Plate 3B, Figure 13)

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

Sethochytris babylonis (Clark and Campbell) group, Riedel and Sanfilippo, in press.

Sethochytris triconiscus Haeckel (?)

Sethochytris triconiscus Haeckel, 1887, p. 1239, pl. 57, fig. 13; (?) Riedel and Sanfilippo, in press.

Genus **Stichocorys** Haeckel 1881

Stichocorys armata (Haeckel) (Plate 2E, Figures 13-15)

Cyrtophormis armata Haeckel, 1887, p. 1460, pl. 78, fig. 17.

This species is evidently closely related to *Stichocorys diploconus,* and is therefore transferred to the same genus.

Stichocorys delmontensis (Campbell and Clark) (Plate 1F, Figures 5-7; Plate 2E, Figures 10, 11)

Eucyrtidium delmontense Campbell and Clark, 1944, p. 56, pl. 7, figs. 19, 20.

Stichocorys delmontensis (Campbell and Clark), Sanfilippo and Riedel, in press.

As in previous papers, we here define *Stichocorys delmontensis* very broadly, to include virtually all stichocyrtids (except for *Stichocorys wolffii*) in which a conical upper part of the shell formed of the first three segments is distinguished from a distal, narrower subcylindrical part comprised of the fourth and subsequent segments. At Sites 63 and 64, a form conforming to this definition appears commonly below the earliest occurrence of *S. wolffii,* becomes rare during the lower part of the range of *S. wolffii,* and then again common in younger samples.

Stichocorys diploconus (Haeckel) (Plate 2E, Figure 16)

Cyrtocapsa diploconus Haeckel, 1887, p. 1513, pl. 78, fig. 6.

Stichocorys diploconus (Haeckel), Sanfilippo and Riedel, in press.

Stichocorys peregrina (Riedel) (Plate 1F, Figures 2-4; Plate 8, Figure 5)

Eucyrtidium elongatum peregrinum Riedel, 1953, p. 812, pl. 85, fig. 2.

Stichocorys peregrina (Riedel), Riedel and Sanfilippo, in press.

Stichocorys wolffii Haeckel (Plate 2E, Figures 8, 9)

Stichocorys wolffii Haeckel, 1887, p. 1479, pl. 80, fig. 10; Riedel, 1957, p. 92, pl. 4, figs. 6, 7.

Genus **Theocorys** Haeckel 1881

Theocorys anapographa Riedel and Sanfilippo

Theocorys anapographa Riedel and Sanfilippo, in press.

Theocorys spongoconum Kling (Plate 2F, Figure 4; Plate 3C, Figure 3)

Theocorys spongoconum Kling, in press.

Genus **Theocotyle** Riedel and Sanfilippo, in press

Theocotyle cryptocephala (?) nigriniae Riedel and Sanfilippo

Theocotyle cryptocephala (?) *nigriniae,* Riedel and Sanfilippo, in press.

Theocotyle (?) ficus (Ehrenberg)

Eucyritidium ficus Ehrenberg, 1873, p. 228; 1875, pl. 11, fig. 19.

Theocotyle (?) *ficus* (Ehrenberg), Riedel and Sanfilippo, in press.

Theocotyle venezuelensis Riedel and Sanfilippo

Theocotyle venezuelensis Riedel and Sanfilippo, in press.

Genus **Thyrsocyrtis** Ehrenberg 1847b

Thyrsocyrtis bromia Ehrenberg (Plate 8, Figure 6)

Thyrsocyrtis bromia Ehrenberg, 1873, p. 260; 1875, pl. 12, fig. 2; Riedel and Sanfilippo, in press.

This species is characterized by the large, subcircular abdominal pores, often thorny surface, and very short feet (sometimes absent).

Thyrsocyrtis hirsuta hirsuta (Krasheninnikov)

Podocyrtis hirsutus Krasheninnikov, 1960, p. 300, pl. 3, fig. 16.

Thyrsocyrtis hirsuta hirsuta (Krasheninnikov), Riedel and Sanfilippo, in press.

Thyrsocyrtis rhizodon Ehrenberg (Plate 3C, Figure 6)

Thyrsocyrtis rhizodon Ehrenberg, 1873, p. 262; 1875, pl. 12, fig. 1; Riedel and Sanfilippo, in press.

Thyrsocyrtis tetracantha (Ehrenberg)

Podocyrtis tetracantha Ehrenberg, 1873, p. 254; 1875, pl. 13, fig. 2.

Thyrsocyrtis tetracantha (Ehrenberg), Riedel and Sanfilippo, in press.

Under this name we include specimens with up to five or six feet.

Thyrsocyrtis triacantha (Ehrenberg) (Plate 3C, Figure 7)

Podocyrtis triacantha Ehrenberg, 1873, p. 254; 1875, pl. 13, fig. 4.

Thyrsocyrtis triacantha (Ehrenberg), Riedel and Sanfilippo, in press.

8g. Family CARPOCANIIDAE Haeckel, emend. Riedel 1967b

We have included illustrations of all common members of this family in the synchronopticon, but have been unable to bring any satisfactory systematic order to the largest group of species, here lumped under the name *Carpocanistrum* spp.

The taxonomic position of the genus *Carpocanium* Ehrenberg (and therefore the appropriate name for the family) is somewhat uncertain, because its type species (*Lithocampe solitaria* Ehrenberg, 1838, p. 130; 1854, pl. 22, fig. 28) may, perhaps, be related to the artostrobiid genus *Carpocanarium.*

Genus **Carpocanistrum** Haeckel, 1887

Carpocanistrum spp. (Plate 1G, Figures 1-6, 8-13; Plate 2F, Figures 5-16; Plate 3D, Figures 1, 2, 6, 7, 9)

Included under this name are most of the forms commonly thought of as typical carpocaniids–with cephalis not markedly distinguished in contour from the ovate thorax, pores often longitudinally aligned, and a somewhat constricted peristome often bearing numerous teeth. Resolution of the question as to whether or not forms with a more distinct cephalis (Plate 1G, Figures 7, 14, 15; Plate 3D, Figures 3-5, 8) are appropriately included here must await more detailed morphological studies.

Campbell's (1954), p. D 119) action in synonymizing *Carpocanistrum* Haeckel with *Lithocarpium* Stöhr is unsatisfactory, because Haeckel (1887, p. 1172) assigned the type species of the latter genus (*Lithocarpium pyriforme* Stohr, 1880, p. 97, pl. 3, fig. 10) only doubtfully to his new genus *Carpocanistrum.* We therefore here designate, as type species of *Carpocanistrum* Haeckel, *Carpocanistrum evacuatum* Haeckel (1887, p. 1172, pl. fig. 11).

Genus **Carpocanopsis** Riedel and Sanfilippo, new genus

Type species: *Carpocanopsis cingulatum* Riedel and Sanfilippo, new species.

Definition: Robust Carpocaniidae with an abdomen separated from the thorax by a lumbar stricture that is well developed internally.

Remarks: Our object in erecting this genus is to provide a place, distinct from the genus *Carpocanistrum,* for a group of carpocaniids of heavy construction, with an abdomen, and a lumbar stricture that is pronounced internally. It might be suspected that they arose from a form resembling the late Eocene *Cryptoprora ornata* Ehrenberg (1873, p. 222; 1875, pl. 5, fig. 8) (Plate 3D, Figures 10, 11), but we have not found any connecting forms in the early and middle Oligocene parts of our sections.

It is not yet certain that this is a natural genus comprising closely related species, but the fact that the species assigned here have some structural similarities and occur together over a rather short period of time indicates that they may be phylogenetically related.

Carpocanopsis bramlettei Riedel and Sanfilippo, new species (Plate 2G, Figures 8-14; Plate 8, Figure 7)

Cycladophora favosa Haeckel, Riedel, 1954, pl. 1, fig. 3 (*non* 2).

Description: Cephalis externally obtusely cap-shaped, generally separated from the thorax by a slight change in contour. Thorax barrel-shaped, with smooth surface and circular pores longitudinally aligned. Lumbar stricture expressed externally by a distinct change in contour. Abdomen subcylindrical, hyaline, usually with one row of pores proximally and a row of teeth terminally.

Measurements based on 25 specimens from 63.1-14-1, 10-12 cm; 66.0-2-3, 25-27 cm; and 66.1-8-3, 25-27 cm. Total length 115 to 190 μ. Maximum breadth 80 to 105 μ.

Remarks: This species is distinguished from *C. favosum* by the more pronounced longitudinal alignment of the thoracic pores, and by the abdomen being always subcylindrical.

It is named for M. N. Bramlette, who in addition to developing the stratigraphic applicability of calcareous nannofossils has taken every opportunity to assist the development of research on fossil radiolarians.

Carpocanopsis cingulatum Riedel and Sanfilippo, new species (Plate 2G, Figures 17-21; Plate 8, Figure 8)

Description: Cephalis obtusely cap-shaped, not separated from the thorax by an external collar structure. Thorax barrel-shaped, thick-walled (smaller and somewhat thinner-walled in early specimens), with smooth surface and circular pores longitudinally aligned. Abdomen inverted truncate-conical, not distinguished in external contour from distal part of thorax, with rounded pores irregular in shape and arrangement. The termination of the abdomen is corroded in most specimens, but in a few is observed to consist of short, irregular, lamellar teeth.

Measurements based on 25 specimens from 63.1-14-1, 10-12 cm, 64.1-6-3, 30-32 cm, and 64.1-7-3, 30-32 cm. Length of cephalis plus thorax 95 to 115 μ. Maximum breadth 85 to 115 μ.

Remarks: This species differs from *C. bramlettei* and *C. favosum* in the abdomen being porous rather than hyaline, and from *C. cristatum* (Carnevale)? in the thorax having a greater number of pores, longitudinally aligned, and smoother surface.

Carpocanopsis cristatum (Carnevale)? (Plate 1G, Figure 16; Plate 2G, Figures 1-7)

? *Sethocorys cristata* Carnevale, 1908, p. 31, pl. 4, fig. 18.

? *Sethocorys cristata* var. Carnevale, 1908, p. 32, pl. 4, fig. 19.

Description: Cephalis hemispherical, in rare specimens bearing a short apical spine, usually separated from the thorax by a change in external contour. Thorax inflated barrel-shaped, with very thick wall and rough surface, and with fewer pores than *C. cingulatum* and *C. bramlettei*, not longitudinally aligned. Abdomen usually represented by only a few corroded protuberances on the distal part of the thorax, but to judge from portions preserved on rare specimens it appears not to be separated from the thorax by an externally expressed stricture, and to have irregular pores similar to those of *C. cingulatum*.

Remarks: This species is distinguished from *C. favosum* by the abdomen being porous rather than hyaline, and evidently inverted truncate-conical (narrowing distally). It differs from *C. cingulatum* as indicated in the discussion of that species.

Dimensions and other features are generally similar to those given by Carnevale for specimens from the Italian Miocene, but we cannot be confident of the identity of our species with his until there is an opportunity to examine additional Italian material.

Carpocanopsis favosum (Haeckel) (Plate 2G, 15, 16; Plate 8, Figures 9-11)

Cycladophora favosa Haeckel, 1887, p. 1380, pl. 62, figs. 5, 6; Riedel, 1954, p. 172, pl. 1, fig. 2 (*non* 3).

Description: Cephalis obtusely cap-like, commonly marked off externally from the thorax by a slight change in contour. Thorax barrel-shaped, with smooth or slightly rough surface and circular pores usually not showing marked longitudinal alignment. Lumbar stricture usually pronounced externally; in rare specimens the shell wall is very thick, even to the extent of filling the external lumbar stricture (Plate 8, Figure 10). Abdomen usually truncate-conical, widening distally, hyaline and commonly longitudinally ribbed, terminating in a row of irregular teeth; but in rare specimens similar to that of *C. bramlettei*.

Measurements based on 15 specimens from 63.1-14-1, 10-12 cm; 64.1-4-3, 84-86 cm; 64.1-5-1, 20-22 cm; and 64.1-6-3, 30-32 cm. Total length 105 to 155 μ. Maximum breadth of thorax 70 to 95 μ.

8h. Family PTEROCORYIDAE Haeckel 1881, emend. Riedel 1967b

In the synchronopticon and in this systematic section we have been able to treat only a few genera of this family, namely *Calocycletta, Podocyrtis* with its two subgenera *Podocyrtis* and *Lampterium,* and *Theocyrtis.* Lack of time has prevented our treating the genera *Anthocyrtidium, Lamprocyclas, Theoconus* and *Theocorythium,* and their relatives.

Genus **Calocycletta** Haeckel 1887

Calocycletta costata (Riedel) (Plate 2H, Figures 12-14)

Calocyclas costata Riedel, 1959b, p. 296, pl. 2, fig. 9.
Calocycletta costata (Riedel), Riedel and Sanfilippo, in press.

Calocycletta virginis Haeckel (Plate 2H, Figures 5-11)

Calocyclas (Calocycletta) virginis Haeckel, 1887, p. 1381, pl. 74, fig. 4.
Calocycletta virginis Haeckel, Riedel and Sanfilippo, in press.

Near the lower limit of occurrence of *Calocycletta virginis* occurs a related form (Plate 8, Figure 12) with feet broad and shovel-shaped rather than narrowly lamellar. A similar form was recorded in the material from DSDP Leg 4 (Riedel and Sanfilippo, in press).

Calocycletta sp. (Plate 1G, Figures 17, 18; Plate 2H, Figures 1-3)

Under this name we have included forms rather similar to *C. virginis,* but lacking the elongated, parallel-sided feet. Early specimens are difficult to distinguish from *C. virginis* because the assemblages are corroded (and the abdomen therefore tends to be dissolved), but in late specimens it can often be seen that the abdominal pores lose their longitudinal alignment distally. Some specimens have short, triangular feet terminally. The shape of the thorax is inflated-hemispherical in the early forms and campanulate (so that the cephalis and thorax together are onion-shaped) in late forms. It is possible that more than one species is included under this name, and only the latest occurrence of the late form has been used as a datum for correlation in this report.

Genus **Podocyrtis** Ehrenberg 1847a

Podocyrtis (Podocyrtis) ampla Ehrenberg

Podocyrtis (?) *ampla* Ehrenberg, 1873, p. 248; 1875, pl. 16, fig. 7.
Podocyrtis (Podocyrtis) ampla Ehrenberg, Riedel and Sanfilippo, in press.

Podocyrtis (Podocyrtis) diamesa Riedel and Sanfilippo

Podocyrtis (Podocyrtis) diamesa Riedel and Sanfilippo, in press.

Podocyrtis (Podocyrtis) papalis Ehrenberg (Plate 3E, Figure 1)

Podocyrtis papalis Ehrenberg, 1847b, fig. 2; 1873, p. 251.

Podocyrtis (Podocyrtis) papalis Ehrenberg, Riedel and Sanfilippo, in press.

Podocyrtis (Lampterium) aphorma Riedel and Sanfilippo

Podocyrtis (Lampterium) aphorma Riedel and Sanfilippo, in press.

Podocyrtis (Lampterium) chalara Riedel and Sanfilippo

Podocyrtis (Lampterium) chalara Riedel and Sanfilippo, in press.

Podocyrtis (Lampterium) goetheana (Haeckel) (Plate 8, Figure 13)

Cycladophora goetheana Haeckel, 1887, p. 1376, pl. 65, fig. 5.

Podocyrtis (Lampterium) goetheana (Haeckel), Riedel and Sanfilippo, in press.

Podocyrtis (Lampterium) mitra Ehrenberg (Plate 3D, Figure 19)

Podocyrtis mitra Ehrenberg, 1854, pl. 36, fig. B20; 1873, p. 251.

Podocyrtis (Lampterium) mitra Ehrenberg, Riedel and Sanfilippo, in press.

Podocyrtis (Lampterium) sinuosa Ehrenberg (?)

[?] *Podocyrtis sinuosa* Ehrenberg, 1873, p. 253; 1875, pl. 15, fig. 5.

Podocyrtis (Lampterium) sinuosa Ehrenberg (?), Riedel and Sanfilippo, in press.

Genus **Theocyrtis** Haeckel 1887

Theocyrtis annosa (Riedel) (Plate 2H, Figure 4; Plate 3D, Figures 12, 13)

Phormocyrtis annosa Riedel, 1959b, p. 295, pl. 2, fig. 7.

Theocyrtis annosa (Riedel), Riedel and Sanfilippo, in press.

Theocyrtis tuberosa Riedel (Plate 3D, Figures 14, 15)

Theocyrtis tuberosa Riedel, 1959b, p. 298, pl. 2, figs. 10, 11.

Remarks: This species is preceded by an ancestral form in which the thoracic wall is smooth or plicate (and occasionally slightly tuberose). The evolutionary lower limit of the species is defined as that level at which tuberose specimens predominate over those that are not tuberose.

8i. Family ARTOSTROBIIDAE Riedel, 1967a

All common members of this family are included in the synchronopticon, but some are not understood sufficiently to permit their inclusion in the tables of occurrences or the summary range-chart. We have not been able to trace long evolutionary lineages within this family, and are therefore unable at this time to suggest any substantial revision of the generic classification—before this can be done, it will probably be necessary to investigate cephalic structures in detail. We have, however, found forms ancestral to some of the late Cenozoic species, and the times of transition between ancestors and descendants will probably prove useful as biostratigraphic datum-levels.

Genus **Artostrobium** Haeckel, 1887

Artostrobium auritum (Ehrenberg) group (Plate 1H, Figures 5-8)

Lithocampe aurita Ehrenberg, 1844, p. 84; 1854, pl. 22, fig. 25.

Lithocampe lineata Ehrenberg, 1838, p. 130 (partim); 1854, pl. 19, fig. 54.

[?] *Lithostrobus seriatus* Haeckel, 1887, p. 1474, pl. 79, fig. 15.

[?] *Lithostrobus lithobotrys* Haeckel, 1887, p. 1475, pl. 79, fig. 17.

[?] *Lithostrobus botryocyrtis* Haeckel, 1887, p. 1475, pl. 79, figs. 18, 19.

[?] *Dictyomitra ferminensis* Campbell and Clark, 1944, p. 51, pl. 7, fig. 7.

[?] *Dictyomitra montereyana* Campbell and Clark, 1944, p. 52, pl. 7, fig. 8.

[?] *Lithomitra bramlettei* Campbell and Clark, 1944, p. 53, pl. 7, figs. 10-14.

Included here are all artostrobiids with more than four segments separated by rounded constrictions, and having numerous rows of pores on each segment. The only other species that might be confused with this group is a possible ancestor of *Spirocyrtis scalaris* (Plate 1G, Figures 19, 20, 22) which has sharper intersegmental constrictions, usually more prominent lateral tubule and apical horn (the latter replaced by a tube in some specimens), and a greater number of segments which continue to become wider distally rather than attaining a constant width or becoming narrower.

Artostrobium doliolum Riedel and Sanfilippo, new species (Plate 1H, Figures 1-3; Plate 8, Figures 14, 15)

Description: Spindle-shaped, four-segmented artostrobiids in which the intersegmental strictures are not strongly pronounced externally. Cephalis very small, spherical, bearing a lateral tubule that lies along the thoracic wall and is thus directed obliquely downward. Thorax and third segment truncate-conical; fourth segment the widest, tapering distally, in some specimens with a poreless peristome. All post-cephalic segments with pores in closely-spaced transverse rows.

Measurements based on 30 specimens from 62.1-24-6, 63.0-2-4, 66.1-3-3 and 66.1-4-3. Total length 95 to 150 μ. Maximum breadth 75 to 100 μ (usually about 85 μ).

Remarks: This species differs from all described members of the family in the broadly spindle-shaped form of the four-segmented shell, without very pronounced external strictures.

It apparently developed from a form with less developed third segment, more widely separated rows of pores and somewhat more pronounced intesegmental strictures (Plate 1H, Figure 4; Plate 2I, Figures 1-8; Plate 3E, Figures 7-9) as we are not yet sure of the phylogenetic development of this form, its assignment to the genus *Artostrobium* is arbitrary.

Artostrobium miralestense (Campbell and Clark) (Plate 1H, Figures 9-17; Plate 2I, Figures 9, 10; Plate 3E, Figure 12)

Dictyocephalus miralestensis Campbell and Clark, 1944, p. 45, pl. 6, figs. 12-14.

[?] *Siphocampe erucosa* Haeckel, 1887, p. 1500, pl. 79, fig. 11.

[?] *Eucyrtidium tumidulum* Bailey, 1856, p. 5, pl. 1, fig. 11; Hays, 1965, p. 181, pl. 3, fig. 7.

We have used this name for forms in which the shell wall is thick, and intersegmental constrictions (other than the collar and lumbar strictures) are unevenly spaced and in some specimens obscure. The lateral cephalic tubule is usually directed obliquely upward (commonly at about 45°). A distinct peristome is rarely present.

Campbell and Clark did not observe the lumbar stricture in this species, and therefore regarded it as dicyrtid. The species is here assigned to *Artostrobium* because it is evidently closely related to the type species of that genus (*Lithocampe aurita* Ehrenberg 1844, p. 84; 1854, pl. 22, fig. 25).

Genus **Carpocanarium** Haeckel, 1887

Carpocanarium spp. (Plate 1I, Figures 17-25; Plate 2J, Figures 8, 9)

Eucyrtidium papillosum Ehrenberg, 1872a, p. 310; 1872b, pl. 7, fig. 10.

Dictyocephalus papillosus (Ehrenberg), Haeckel, 1887, p. 1307; Riedel, 1958, p. 236, pl. 3, fig. 10, text-fig. 8.

Dictyocryphalus papillosus (Ehrenberg), Nigrini, 1967, p. 63, pl. 6, fig. 6.

Carpocanium calycothes Stöhr, 1880, p. 96, pl. 3, fig. 8.

Dictyocephalus bergontianus Carnevale, 1908, p. 32, pl. 4, fig. 20.

The designation "*Carpocanarium* spp." is here used for forms with hemispherical cephalis, distinct collar stricture, ovate thorax with rather few, rather large pores and occasionally three short spine-like wings in its proximal half, and a poreless subcylindrical peristome which in some specimens is irregularly terminated to give the impression of a corona of teeth. These forms include the type species of *Carpocanarium* Haeckel (*Carpocanium calycothes* Stöhr), and are not closely related to the type species of *Dictyocryphalus* (*Cornutella obtusa* Ehrenberg, 1844; p. 77; 1854, pl. 22, fig. 40), to which genus the best-known member of this group of species (*Eucyrtidium papillosum* Ehrenberg) has recently been assigned.

The phylogenetic origin of this group of species remains obscure. An inconspicuous lateral cephalic tubule is present in at least some specimens from the Sicilian Miocene, and from the lower part of the range of this group in the Western Pacific. Therefore they are assigned to the Artostrobiidae, although they do not have the transversely aligned pores characteristic of most members of the family.

Genus **Lithomitra** Bütschli, 1882b

Lithomitra lineata (Ehrenberg) group (Plate 11, Figures 1-11; Plate 2I, Figures 14-16; Plate 3E, Figure 14)

Lithocampe lineata Ehrenberg, 1838, p. 130 (partim); 1854, pl. 22, fig. 26; pl. 36, fig. 16.

Lithomitra lineata (Ehrenberg), Haeckel, 1887, p. 1484.

Eucyrtidium lineatum arachneum Ehrenberg, 1861, p. 299.

Tricolocampe cylindrica Haeckel, 1887, p. 1412, pl. 66, fig. 21; aff., Nakaseko, 1963, p. 182, pl. 2, fig. 7.

Lithomitra nodosaria Haeckel, 1887, p. 1484, pl. 79, fig. 1.

Lithomitra eruca Haeckel, 1887, p. 1485, pl. 79, fig. 3.

Siphocampe annulosa Haeckel, 1887, p. 1500, pl. 79, fig. 10; cf., Nakaseko, 1963, p. 195, pl. 4, fig. 8.

Tricolocampe sanpedroana Campbell and Clark, 1944, p. 50, pl. 7, fig. 5.

Lithomitra altamiraensis Campbell and Clark, 1944, p. 53, pl. 7, fig. 9.

Siphocampium sp. Bachmann *et al.*, 1963, p. 133, pl. 8, fig. 40.

Members of the species-group are illustrated in the synchronopticon, and some occurrences are tabulated, but the limits of its range are not yet known. We include in this group three-segmented forms with cylindrical or subcylindrical abdomen perforated by regular, rather widely spaced transverse rows of pores (e.g., Plate 1I, Figures 2, 5) and also forms in which the abdomen has the appearance of being segmented as a result of the development of rounded constrictions alternating with the rows of pores (e.g., Plate 1I, Figures 9, 10). Not included in this group, but also illustrated, are forms which are rather similar but with somewhat inflated abdomen (Plate 1I, Figure 12; Plate 2I, Figure 17; Plate 3E, Figures 15-19).

Assignment to the genus *Lithomitra* is based partly on the possibility that the constituent species may be related to its type species (*Eucyrtidium pachyderma* Ehrenberg 1873, p. 231; 1875, pl. 11, fig. 21), and partly on the desirability of separating members of this species-group from more inflated forms with a well-differentiated peristome (genus *Theocampe*).

Genus **Phormostichoartus** Campbell, 1951

Phormostichoartus corona Haeckel (Plate 1I, Figures 13-15; Plate 2J, Figures 1-5)

Cyrtophormis (Acanthocyrtis) corona Haeckel, 1887, p. 1462, pl. 77, fig. 15.

Lithostrobus cf. *botryocyrtis* Haeckel, Nakaseko, 1963, p. 185, pl. 3, figs. 11a, b.

Although Haeckel's illustration of this species shows a very different termination to the shell than do our photographs, there is little doubt that the two are identical. Haeckel's specimen was from *Challenger* Station 225 (a Miocene locality, see Riedel, 1954), and on searching through a large number of radiolarians from that sample we have found no specimen with large triangular "teeth" or lobes terminally, but many specimens corresponding to ours. Some specimens are terminated by being broken along a line of pores, and in this sense might be described as having very small terminal "teeth" which were perhaps exaggerated by Haeckel's illustrator.

In *Phormostichoartus corona* the third segment has more than two transverse rows of pores. The species is characterized by having four segments (the last segment considerably larger than the others, skirt-like, contracting distally and without a differentiated peristome), intersegmental strictures curved, not pronounced internally, a well-developed apical horn and a prominent, duck-billed lateral tubule.

This species appears to have developed from a form (Plate 2J, Figure 6; Plate 3F, Figures 1-6) in which the third segment has only two transverse rows of pores, and the apical horn and lateral tubule are generally not so prominent. Also closely related seems to be a form (Plate 2J, Figure 7) with only three segments, the last segment having a narrow "neck" proximally which tends to be limited distally by an incipient stricture.

Phormostichoartus (name proposed for the junior homonym *Acanthocyrtis* Haeckel, 1887, p. 1461, by Campbell, 1951, p. 530) is here used as the generic name because this species is evidently more closely related to the type species of that taxon (*Cyrtophormis cylindrica* Haeckel, 1887, p. 1461, pl. 77, fig. 17) than it is to the type species of *Cyrtophormis* (*C. armata* Haeckel, 1887, p. 1460, pl. 78, fig. 17).

Genus **Siphocampe** Haeckel, 1881

Siphocampe corbula (Harting) (Plate 1H, Figures 18-25)

Lithocampe corbula Harting, 1863, p. 12, pl. 1, fig. 21.

Siphocampe corbula (Harting) Nigrini, 1967, p. 85, pl. 8, fig. 5; pl. 9, fig. 3.

Tricolocampe polyzona Haeckel, 1887, p. 1412, pl. 66, fig. 19.

Tricolocampe stenozona Haeckel, 1887, p. 1413, pl. 66, fig. 20.

Lithomitra schencki Campbell and Clark, 1944, p. 54, pl. 7, fig. 16.

This species, originally poorly described and illustrated by Harting from Quaternary sediment, and evidently excessively subdivided by later authors (Haeckel, Campbell and Clark) has been adequately redescribed by Nigrini. In the Leg 7 material, it is preceded by a form (Plate 2I, Figure 13) which is generally similar but which has only three segments and a thicker wall, and is preceded and for a time accompanied by an apparently related form with larger pores (Plate 1H, Figures 26-28; Plate 2I, Figures 11-13). The cephalic tubule in *Siphocampe corbula* lies on the surface of the upper part of the thorax and is therefore directed downward, and a distinctly differentiated peristome is present. The cephalis appears to be large and cap-shaped, but this is merely due to the small spherical cephalis and the collar stricture being obscured by thickening of the wall of the proximal part of the thorax.

Genus **Spirocyrtis** Haeckel, 1881

Spirocyrtis scalaris Haeckel (Plate 1G, Figures 25-27)

Spirocyrtis scalaris Haeckel, 1887, p. 1509, pl. 76, fig. 14; Nigrini, 1967, p. 88, pl. 8, fig. 7; pl. 9, fig. 4.

This species apparently arose from a form (Plate 1G, Figures 19-24; Plate 2H, Figures 15-18) in which the outlines of the segments are not angular but rounded. This ancestral form has sharp rather than rounded intersegmental constrictions, and usually has a prominent, duck-billed lateral cephalic tubule and apical horn (the latter in some specimens replaced by a tube).

Genus **Theocampe** Haeckel, 1887

Theocampe armadillo (Ehrenberg) group (plate 3E, Figures 3-6)

Eucyrtidium armadillo Ehrenberg, 1873, p. 225; 1875, pl. 9, fig. 10.

[?] *Theocorys ovata* Haeckel, 1887, p. 1416, pl. 69, fig. 16.

In this group we include relatively large, three-segmented artostrobiids with a distinct peristome and commonly with a large apical horn and prominent lateral cephalic tubule. One of the forms included here (Plate 3E, Figures 3, 5) resembles *Eucyrtidium armadillo* Ehrenberg from the Eocene of Barbados, and another (Plate 3E, Figure 4) may be related to *Theocorys ovata* Haeckel.

We assign this species-group to the genus *Theocampe* because of the possibility that its constituent species are related to *Theocampe mongolfieri.*

Theocampe mongolfieri (Ehrenberg) (plate 3E, Figure 13)

Eycyrtidium mongolfieri Ehrenberg, 1854, pl. 36, fig. 18B; 1873, p. 230; 1875, pl. 10, fig. 3.

Theocampe mongolfieri (Ehrenberg), Burma, 1959, p. 239; Riedel and Sanfilippo, in press.

Theocampe pirum (Ehrenberg) (Plate 3E, Figures 10, 11)

Eucyrtidium pirum Ehrenberg, 1873, p. 232; 1875, pl. 10, fig. 14.

Theocampe pirum (Ehrenberg), Haeckel, 1887, p. 1423.

This three-segmented form has the last segment wide in normal view but compressed in the sagittal plane, and with a differentiated peristome. We have found similar, laterally compressed specimens in the *Thyrsocyrtis bromia* Zone of the Oceanic Formation of Barbados, and therefore use Ehrenberg's specific name.

8j. Family CANNOBOTRYIDAE Haeckel, emend. Riedel 1967b

In our report on radiolarians from Leg 4 of the Deep-Sea Drilling Project, the only cannobotryid in the Middle Eocene sequence at Site 29 is illustrated (Riedel and Sanfilippo, in press, Plate 12, Figure 10). It has a relatively large cephalic chamber, a small antecephalic chamber, no very distinct postcephalic chamber, and a subcylindrical thorax. This form may be closely related to that illustrated as *Lithobotrys geminata* by Ehrenberg (1875, pl. 3, fig. 19) and Bütschli (1882a, pl. 30, figs. 3a-c; 1882b, pl. 33, figs. 27a-c), from the Oceanic Formation of Barbados. The considerable diversity of Neogene cannobotryids evidently arose subsequent to the Middle Eocene.

In this preliminary investigation of the Leg 7 radiolarians, we report on all of the more common cannobotryids in the Eocene and younger cores, but without attempting fine taxonomic distinctions. Thus we have not investigated their skeletal structure in sufficient detail to permit comparison with the results of Petrushevskaya (1965, 1968), and group our forms into broad genera resembling those of Haeckel rather than into Petrushevskaya's better-defined ones. Even at this gross level of discrimination, however, the various general forms of cannobotryids seem to be stratigraphically restricted.

Genus **Acrobotrys** Haeckel, 1881

Acrobotrys spp. (Plate 1J, Figures 12-16; Plate 2J, Figures 13-15; Plate 3F, Figure 8)

Under this name we have tabulated occurrences of all cannobotryids with two prominent cephalic tubules forming approximately a right angle. Thus we apply the generic name in a sense closer to that of Haeckel (1887) than to that of Petrushevskaya (1965). Bachmann *et al.* (1963, p. 128, pl. 5, fig. 22) have reported a member of this genus from the Miocene of Austria.

Acrobotrys tritubus Riedel (Plate 1J, Figures 19, 20)

Acrobotrys tritubus Riedel, 1957, p. 80, pl. 1, fig. 5.

Genus **Botryocyrtis** Ehrenberg, 1860

Botryocyrtis spp. (Plate 1J, Figures 1-11; Plate 2J, Figures 10-12; Plate 3F, Figure 7)

We have used this name to include forms both with and without a "lumbar" stricture subdividing the conical or subcylindrical part of the shell distal from the cephalis, though Petrushevskaya (1965) would separate those without such a stricture into the genus *Monotubus.* Specimens without a "lumbar" stricture predominate in our older samples, and those with such a stricture predominate in younger samples.

Genus **Botryopyle** Haeckel, 1881

Botryopyle dictyocephalus Haeckel group (Plate 1J, Figures 21-26; Plate 2J, Figures 16-18; Plate 3F, Figures 9-12)

Botryopyle dictyocephalus Haeckel, 1887, p. 1113, pl. 96, fig. 6.

Botryocella multicellaris Haeckel, 1887, p. 1117, pl. 96, fig. 12.

In this species-group we have included all forms with a large antecephalic chamber, small postcephalic chamber, and a subcylindrical thorax, and without prominent cephalic tubes. This group apparently includes forms that Petrushevskaya (1965) assigned to the genera *Botryopyle, Bisphaerocephalina, Acrobotrys* and *Botryocella.* The most obvious variable among the skeletons included here is the degree of porosity of the shell wall—some are densely porous and others only very sparsely porous, hyaline.

The form that we have tabulated as *Botryopyle* sp. A (Plate 2J, Figures 20, 21; Plate 3F, Figure 13) appears to be closely related to this species-group. It has a small tubule arising proximally from both the ante- and post-cephalic chambers, and lying close to the thoracic wall.

Genus **Centrobotrys** Petrushevskaya, 1965

Centrobotrys thermophila Petrushevskaya (Plate 1J, Figures 27-31; Plate 2J, Figure 19; Plate 3F, Figure 14)

Centrobotrys thermophila Petrushevskaya, 1965, p. 115, text-fig. 20; Nigrini, 1967, p. 49, text-fig. 26, pl. 5, fig. 7.

Centrobotrys (?) sp. A (Plate 3F, Figures 15, 16)

This form resembles Petrushevskaya's (1965) *Centrobotrys* at least superficially, in that the cephalis is surrounded by a large chamber that is not subdivided into ante- and post-cephalic parts. The apex of the cephalis is more rounded and the entire shell wall more porous than in *C. thermophila.*

REFERENCES

Bachmann, Alfred, Papp, Adolf and Stradner, Herbert, 1963. Mikropaläontologische Studien im "Badener Tegel" von Frättingsdorf, N. Ö. *Geol. Ges. Wien, Mitt.* **56**, (1), 117-210, pl. 1-24.

Bailey, J. W., 1856. Notice of microscopic forms found in the soundings of the Sea of Kamtschatka–with a plate. *Am. J. Sci.*, Ser. 2, **22**, 1-6, pl. 1.

Beckmann, J. P., 1953. Die Foraminiferen der Oceanic Formation (Eocaen-Oligocaen) von Barbados, Kl. Antillen. *Eclogae Geol. Helv.* **46** (2), 301-412, pl. 16-30.

Bolli, H. M., 1957a. Planktonic foraminifera from the Oligocene-Miocene Cipero and Lengua Formations of Trinidad, B.W.I. *Bull. U.S. Nat. Museum.* **215**, 97-123, pl. 22-29.

______, 1957b. Planktonic foraminifera from the Eocene Navet and San Fernando Formations of Trinidad, B.W.I. *Bull. U.S. Nat. Museum.* **215**, 155-172, pl. 35-39.

Bramlette, M. N., and Wilcoxon, J. A., 1967. Middle Tertiary calcareous nannoplankton of the Cipero section, Trinidad, W. I. *Tulane Stud. Geol.* **5** (3), 93-131.

Burma, B. H., 1959. On the status of *Theocampe* Haeckel, and certain similar genera. *Micropaleontology.* **5** (3), 325-330.

Bütschli, O. 1882a. Radiolaria. **In** *Klassen und Ordnungen des Thier-Reichs.* H. G. Bronn (Ed.) Vol. 1, pt. 1, 332-478, pl. 17-32.

______, 1882b. Beiträge zur Kenntnis der Radiolarienskelette, insbesondere der Cyrtida. *Z. Wiss. Zool.* **36**, 485-540, pl. 31-33.

Campbell, A. S., 1951. New genera and subgenera of Radiolarida. *J. Paleontolog.* **25** (4), 527-530.

______, 1954. Radiolaria. **In** *Treatise on Invertebrate Paleontology.* R. C. Moore (Ed.). (Univ. Kansas Press and Geol. Soc. Am.), Pt. D. Protista 3, 11-163.

______and Clark, B. L., 1944. Miocene radiolarian faunas from Southern California. *Geol. Soc. Am. Spec. Paper 51.* vii + 76 p., 7 pl.

Carnevale, P., 1908. Radiolarie e silicoflagellati di Bergonzano (Reggio Emilia). *R. Ist. Veneto Sci. Lett. Arti, Mem.* **28** (3), 1-46, pl. 1-4.

Cita, M. B., Nigrini, Catherine, and Gartner, Stefan, 1970. Biostratigraphy. **In** Peterson, M.N.A. *et al.*, 1970. *Initial Reports of the Deep Sea Drilling Project, Volume II.* Washington (U.S. Government Printing Office) 391-411.

Clark, B. L. and Campbell, A. S., 1942. Eocene radiolarian faunas from the Mt. Diablo area, California. *Geol. Soc. Am. Spec. Paper 39.* vii + 112 p., 9 pl.

Dogel, V. A., and Reshetnyak, V. V., 1952. Materialy po radiolyariyam severo-zapadnoi chasti Tikhogo Okeana. *Issled. Dalnevost. Morei SSSR.* (3), 5-36.

Ehrenberg, C. G. 1838. Über die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen. *Kgl. Akad. Wiss. Berlin, Abhandl.* Jahre 1838, 59-147, pl. 1-4, 3 tables.

______, 1844. Über 2 neue Lager von Gebirgsmassen aus Infusorien als Meeres-Absatz in Nord-Amerika und eine Vergleichung derselben mit den organischen Kreide-Gebilden in Europa und Afrika. *Kgl. Preuss. Akad. Wiss. Berlin, Ber.* Jahre 1844, 57-97.

______, 1847a. Über eine halibiolithische, von Herrn R. Schomburgk entdeckte, vorherrschend aus mikroskopischen Polycystinen gebildete, Gebirgsmasse von Barbados. *Kgl. Preuss. Akad. Wiss. Berlin, Ber.* Jahre 1846, 382-385, chart to p. 385.

______, 1847b. Über 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, 40-60, table opposite p. 54, 1 pl.

______, 1854. *Mikrogeologie.* Leipzig, (Voss) xxviii + 374 p., Atlas, 31 p., 41 pl., Fortsetzung (1856) 88 p. + 1 p. errata.

______, 1860. Über den Tiefgrund des stillen Oceans zweischen Californien und den Sandwich-Inseln aus bis 15600' Tiefe nach Lieut. Brooke. *Kgl. Preuss. Akad. Wiss. Berlin, Monatsber.* Jahre 1860, 819-833.

______, 1861. Über die Tiefgründ-Verhältnisse des Oceans am Eingange der Davisstrasse und bei Island. *Kgl. Preuss. Akad. Wiss. Berlin, Monatsber.* Jahre 1861, 275-315, chart opposite p. 276.

______, 1872a. Mikrogeologischen Studien als Zusammenfassung der Beobachtungen des kleinsten Lebens der Meeres Tiefgründe aller Zonen und dessen geologischen Einfluss. *Kgl. Preuss. Akad. Wiss. Berlin, Monatsber.* Jahre 1872, 265-322.

______, 1872b. Mikrogeologische Studien über das kleinste Leben der Meeres-Tiefgründe aller Zonen und dessen geologischen Einfluss. *Kgl. Akad. Wiss. Berlin, Abhandl.* Jahre 1872, 131-399, 1 chart, pl. 1-12.

______, 1873. Grossere Felsproben des Polycystinen-Mergels von Barbados mit weiteren Erläuterungen. *Kgl. Preuss. Akad. Wiss. Berlin, Ber.* Jahre 1873, 213-263.

______, 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, Abhandl.* Jahre 1875, 1-225 + 1 p. errata, pl. 1-30.

Goll, R. M., 1968. Classification and phylogeny of Cenozoic Trissocyclidae (Radiolaria) in the Pacific and Caribbean Basins. Part I. *J. Paleontol.* **42** (6), 1409-1432, pl. 173-176.

______, 1969. Classification and phylogeny of Cenozoic Trissocyclidae (Radiolaria) in the Pacific and Caribbean Basins. Part II. *J. Paleontol.* **43** (2), 322-339, pl. 55-60.

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

______, 1881. Entwurf eines Radiolarien-Systems auf Grund von Studien der Challenger-Radiolarien. *Jena. Z. Med. Naturwiss.* **15** (new ser., vol. 8), (3), 418-472.

______, 1887. Report on the Radiolaria collected by H.M.S. *Challenger* during the years 1873-76. *Rept. Voyage* Challenger, Zool. **18**, clxxxviii + 1803 p., 140 pl., 1 map.

Harting, P., 1863. Bijdrage tot de kennis der mikroskopische faune en flora van de Banda-Zee. *Koninkl. Akad. Wetenschap. Amsterdam, Verh.* **10**, 1-34, pls. 1-3.

Hays, J. D., 1965. Radiolaria and late Tertiary and Quaternary history of Antarctic Seas. Biology of *Antarctic Seas II, Antarctic Research Ser.* 5 (Am. Geophys. Union), 124-184.

Hilmers, Carl, 1906. Zur Kenntnis der Collosphaeriden. *(Doctoral Diss., Kgl. Christian-Albrecht Univ. Kiel.)* 1-95, pl. 1.

Kling, S. A., In press. Radiolaria. **In** Heezen, B. C. *et al.*, 1970. *Initial Reports of the Deep Sea Drilling Project, Volume VI.* Washington (U. S. Government Printing Office).

Krasheninnikov, V. A., 1960. Nekotorye Radiolyarii Nizhnego i Srednego Eotsena Zapadnogo Predkavkazya. *Min. Geol. i Okhr. Nedr SSSR Vses. Nauch.-Issled, Geol. Neft. Inst.* (16), 271-301, pl. 1.

Müller, Johannes, 1855. Über die im Hafen von Messina beobachteten Polycystinen. *Kgl. Preuss. Akad. Wiss. Berlin, Ber.* Jahre 1855, 671-674.

Nakaseko, Kojiro, 1963. Neogene Cyrtoidea (Radiolaria) from the Isozaki Formation in Ibaraki Prefecture, Japan. *Sci. Rept. Osaka Univ.* **12** (2), 165-198, pl. 1-4.

Nigrini, Catherine, 1967. Radiolaria in pelagic sediments from the Indian and Atlantic Oceans. *Bull. Scripps Inst. Oceanog. Univ. Calif.* **11**, 125 p., 9 pl.

Petrushevskaya, M. G., 1965. Osobennosti konstruktsii skeleta radiolyarii Botryoidae (otr. Nassellaria). *Tr. Zool. Inst. Leningrad* **35**, 79-118.

______1968. Gomologii v skeletakh radiolyarii Nassellaria. 2. Osnovnye skeletnye dugi slozhnoustroennykh tsefalisov Cyrtoidae i Botryoidae. *Zool. Zh.* **47** (12), 1766-1776.

______1969. Gomologii v skeletakh radiolyarii Nassellaria. 3. Sagittalno koltso i perifericheskii skelet semeistv Stephoidae i Spyroidae. *Zool Zh.* **48** (5), 642-657.

Riedel, W. R., 1953. Mesozoic and Late Tertiary Radiolaria of Rotti. *J. Paleontol.* **27** (6), 805-813, pl. 84-85.

______1954. The age of the sediment collected at *Challenger* (1875) Station 225 and the distribution of *Ethmodiscus rex* (Rattray). *Deep-Sea Res.* **1**, 170-175.

______1957. Radiolaria: a preliminary stratigraphy. *Rept. Swed. Deep-Sea Exped.* **6** (3), 59-96, pl. 1-4.

______1958. Radiolaria in Antarctic sediments. *Rept. B.A.N.Z. Antarct. Res. Exped., ser. B.* **6**, pt. 10, 217-255.

______1959a. Siliceous organic remains in pelagic sediments. **In** *Silica in Sediments.* (Soc. Econ. Paleontol. Mineral., Spec. Publ. 7), 80-91.

Riedel, W. R., 1959b. Oligocene and Lower Miocene Radiolaria in tropical Pacific sediments. *Micropaleontology.* **5** (3), 285-302.

______1967a. Some new families of Radiolaria. *Proc. Geol. Soc. London.* (1640), 148-149.

______1967b. Subclass Radiolaria. **In** *The Fossil Record.* W. B. Harland *et al.* (Eds.) London (Geol. Soc. London), 291-298.

______In press. Systematic classification of polycystine Radiolaria. **In** *The Micropalaeontology of Oceans.* B. M. Funnell and W. R. Riedel (Eds.) Cambridge (Cambridge Univ. Press).

______and Funnell, B. M., 1964. Tertiary sediment cores and microfossils from the Pacific Ocean floor. *Quart. J. Geol. Soc. London.* **120**, 305-368, pl. 14-32.

______and Sanfilippo, Annika. In press. Radiolaria. **In** Bader, R.G. *et al.* 1970. *Initial Reports of the Deep Sea Drilling Project, Volume IV.* Washington (U.S. Government Printing Office).

Sanfilippo, Annika and Riedel, W. R. In press. Post-Eocene "closed" theoperid radiolarians. *Micropaleontology.*

Saunders, J. B., 1968. Field trip guide. Barbados. *Trans. Fourth Caribbean Geol. Conf.* 443-449.

______and Cater, M. C., 1968. Excursion No. 3. Paleontological collecting trip. *Trans. Fourth Caribbean Geol. Conf.* 433-434.

Stöhr, Emil, 1880. Die Radiolarienfauna der Tripoli von Grotte Provinz Girgenti in Sicilien. *Palaeontographica.* **26**, (Ser. 3, vol. 2). 71-124, pl. 17-23 (1-7).

Vinassa de Regny, P. E., 1898. Nuovi generi di radiolaire del miocene di Arcevia. *Boll. Soc. Geol. Ital.* **17**, 197-198.

Wetzel, O., 1935. Die Mikropalaeontologie des Heiligenhafener Kieseltones (Ober-Eozän). *Niedersaechs. Geol. Ver. Jahr.* **27**, 41-81, pl. 8-10.

10. ACKNOWLEDGEMENTS

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11. PLATES

Plates 1A-3F constitute a synchronopticon, with figures arranged in such a way that each horizontal row contains the prominent forms in an assemblage of one age, and vertical rows show changes in a group through time. The youngest assemblage is illustrated in the top row of Plate 1, and the oldest at the bottom of Plate 3. The fifteen samples from which the illustrated specimens were obtained are the following:

Plate 1

- 66.1-1-CC
- 66.1-2-1, 25-27 cm
- 66.1-3-5, 25-27 cm
- 66.1-5-3, 30-32 cm
- 66.1-6-4, 25-27 cm

Plate 2

- 66.1-8-3, 25-27 cm
- 63.1-11-3, 84-86 cm
- 63.1-14-1, 10-12 cm
- 64.1-6-3, 30-32 cm
- 64.1-7-3, 30-32 cm

Plate 3

- 64.0-8-2, 84-86 cm
- 64.1-8-2, 84-86 cm
- 64.0-10-2, 11-13 cm
- 64.1-9-1, 30-32 cm
- 64.1-10-2, 84-86 cm

Because each horizontal row generally illustrates forms from a single sample, it has not been necessary to specify the sample in the explanation of each figure. However, in the rare cases in which it has not been possible to find a specimen suitable for illustration in one of the fifteen samples on which the synchronopticon is based, a specimen has been chosen from a sample of approximately the same age as a synchronopticon sample, and its source is specified in the figure explanation.

In the figure explanations, numbers preceded by Ph., Sl. or Cse. or in the form "Cl.456½" indicate slides in the collection at Scripps Institution of Oceanography, and designations in the form "U35/1" indicate England Finder positions of the illustrated specimens on the slides.

Evolutionary limits (see Section 2) have been applied, where possible, for the species names used in the explanations to synchronopticon plates. Thus, for example, on Plate 3B both figures 8 and 9 are labelled *Artophormis barbadensis* (though figure 8 alone might be identified as *A. gracilis*), since the morphotype of *A. barbadensis* predominates in this assemblage. The abundance of each morphotype in an assemblage is indicated by "a" (abundant), and "c" (common), "f" (few), "r" (rare) or "+" (very rare) near the top of each figure.

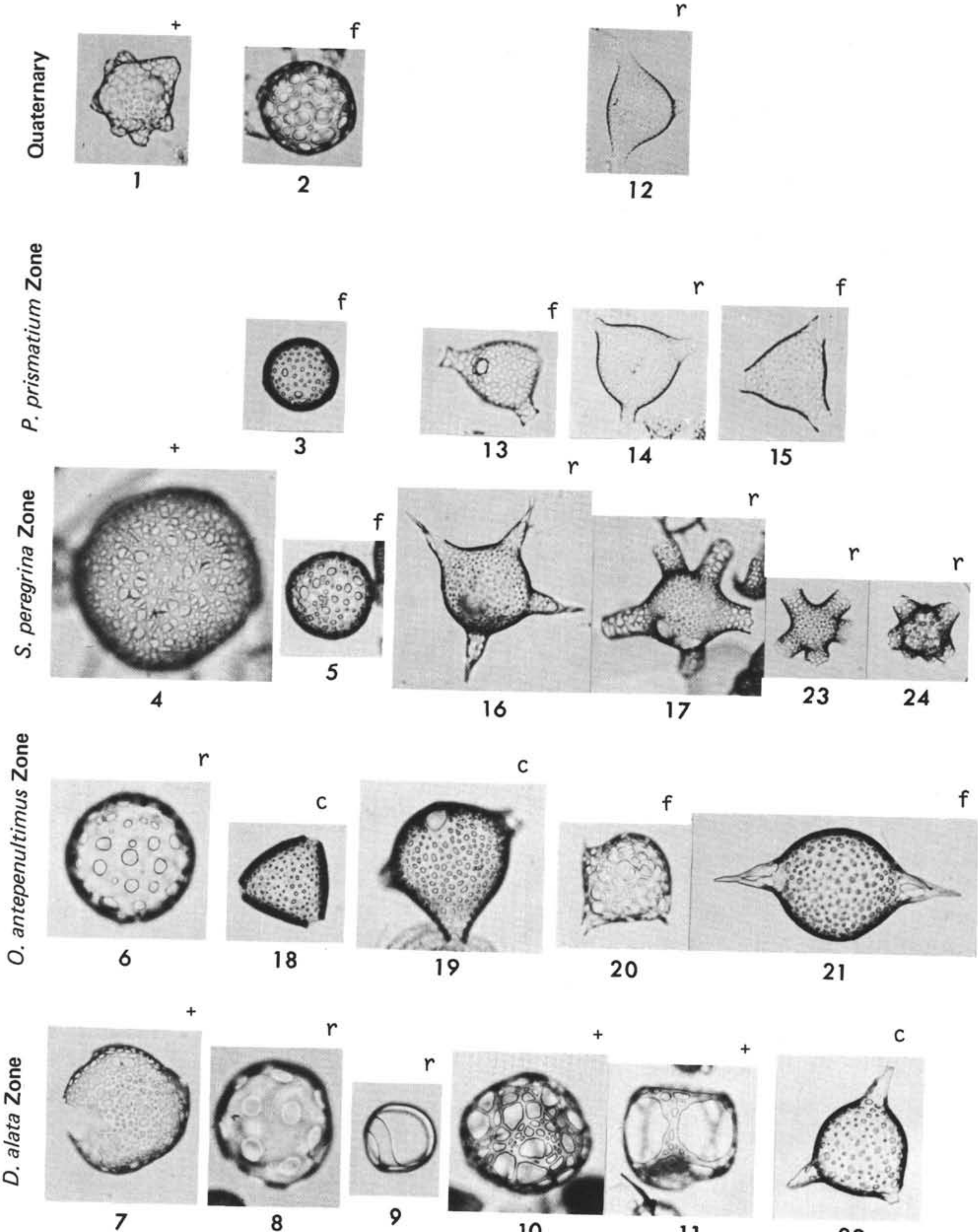
Plates 4-8 illustrate taxonomically important specimens, most of which will be deposited in the U. S. National Museum.

PLATE 1A

(Magnification 150×)

Figure 1	*Collosphaera* (?) Ph. 1, K28/4.
Figures 2-11	*Collosphaera* spp. 2: Ph. 1, B46/3. 3: Ph. 1, N17/2. 4: Ph. 1, P39/0. 5: Ph. 1, V14/2. 6: Ph. 1, G53/4. 7: Ph. 1, D19/1. 8: Ph. 1, Y53/2. 9: Ph. 1, B32/0. 10: Ph. 1, H26/4. 11: Ph. 1, M28/0.
Figures 12-22	*Solenosphaera* spp. 12: Ph. 1, M37/0. 13: Ph. 1, L51/4. 14: Ph. 1, U40/0. 15: Ph. 1, M24/2. 16: Ph. 1, K51/0. 17: Ph. 1, Y46/0. 18: Ph. 1, Q43/4. 19: Ph. 1, Y50/0. 20: Ph. 1, G26/0. 21: Ph. 1, N53/0. 22: Ph. 1, Y52/2.
Figures 23, 24	*Solenosphaera omnitubus* Riedel and Sanfilippo, n. sp. 23: Ph. 1, N20/3. 24: Ph. 1, Q51/4.

PLATE 1A


Quaternary
P. prismatium Zone
S. peregrina Zone
O. antepenultimus Zone
D. alata Zone
+ f r
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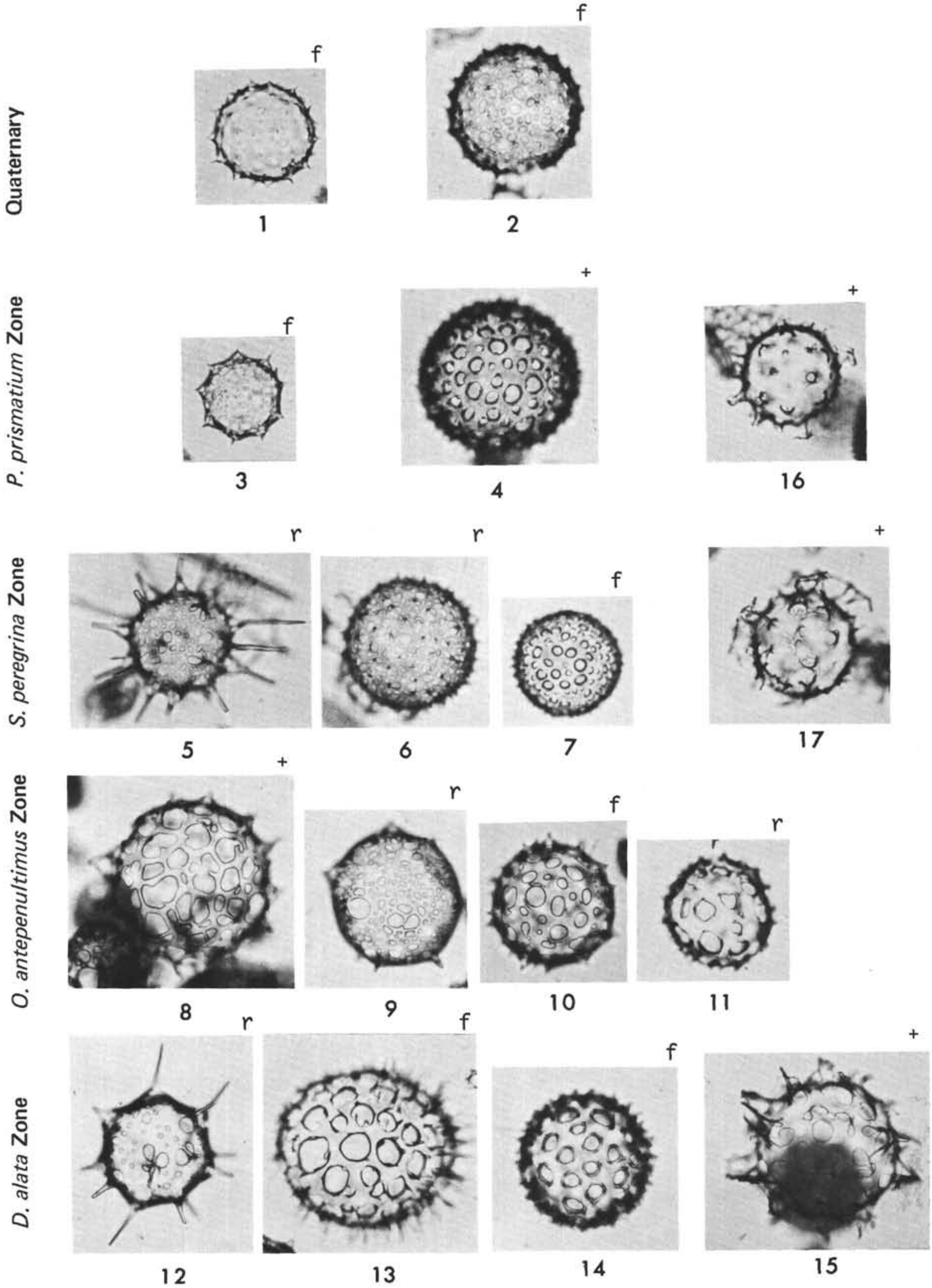
f f r f
3 13 14 15
+ f r r r r
4 5 16 17 23 24
r c c f f
6 18 19 20 21
+ r r + + c
7 8 9 10 11 22

PLATE 1B

(Magnification 150X)

Figures 1-15	*Polysolenia* spp.	
	1:	Ph. 1, U35/1.
	2:	Ph. 1, T38/2.
	3:	Ph. 1, Q33/0.
	4:	Ph. 1, N15/3.
	5:	Ph. 1, J28/2.
	6:	Ph. 1, U32/3.
	7:	Ph. 1, V41/4.
	8:	Ph. 1, Y14/0.
	9:	Ph. 1, Y36/1.
	10:	Ph. 1, T52/1.
	11:	Ph. 1, D23/2.
	12:	Ph. 1, R34/0.
	13:	Ph. 1, V24/0.
	14:	Ph. 1, V42/4.
	15:	Ph. 1, H24/0.
Figures 16, 17	*Polysolenia* (?)	
	16:	Ph. 1, R15/2.
	17:	Ph. 1, V13/0.

PLATE 1B

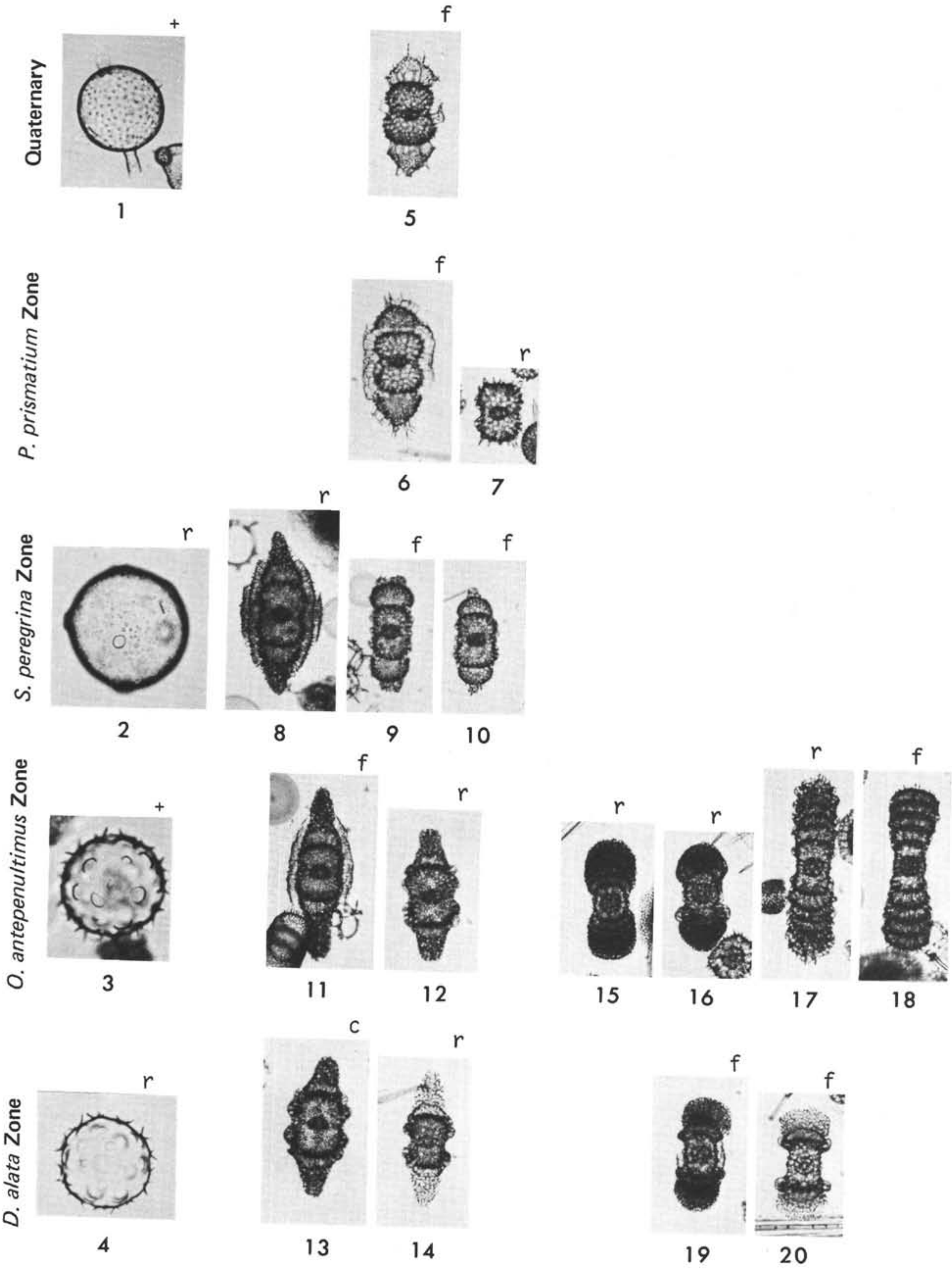


Quaternary
1 f
2 f
P. prismatium Zone
3 f
4 +
16 +
S. peregrina Zone
5 r
6 r
7 f
17 +
O. antepenultimus Zone
8 +
9 r
10 f
11 r
D. alata Zone
12 r
13 f
14 f
15 +

PLATE 1C

Figures 1, 2	*Siphonosphaera* spp. 1: Ph. 1, Q27/4 (150×). 2: Ph. 1, J52/4 (150×).
Figures 3, 4	*Siphonosphaera* (?) 3: Ph. 1, T52/0 (150×). 4: Ph. 1, F48/1 (150×).
Figures 5-7	*Ommatartus tetrathalamus* (Haeckel) 5: Ph. 1, X44/2 (95×). 6: Ph. 1, P51/2 (95×). 7: Ph. 1, K52/2 (95×).
Figures 8-10	*Ommatartus penultimus* (Riedel) 8: Sl. 1, 018/0 (95×). 9: Ph. 1, H17/1 (95×). 10: Ph. 1, S40/3 (95×).
Figures 11, 12	*Ommatartus antepenultimus* Riedel and Sanfilippo 11: Sl. 1, K23/0 (95×). 12: Sl. 1, G47/0 (95×).
Figures 13, 14	*Cannartus laticonus* Riedel 13: Sl. 1, N49/3 (95×). 14: Sl. 1, N24/4 (95×).
Figures 15, 16	*Cannartus* (?) sp. aff. *C.* (?) *petterssoni* Riedel and Sanfilippo 15: Sl. 1, K42/4 (95×). 16: Ph. 1, X21/0 (95×).
Figures 17, 18	*Ommatartus hughesi* (Campbell and Clark) 17: Ph. 1, Q17/2 (95×). 18: Sl. 1, E42/1 (95×).
Figures 19, 20	*Cannartus* (?) *petterssoni* Riedel and Sanfilippo 19: Ph. 1, E39/0 (95×). 20: Sl. 1, L38/4 (95×).

PLATE 1C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P. prismatium Zone
S. peregrina Zone
O. antepenultimus Zone
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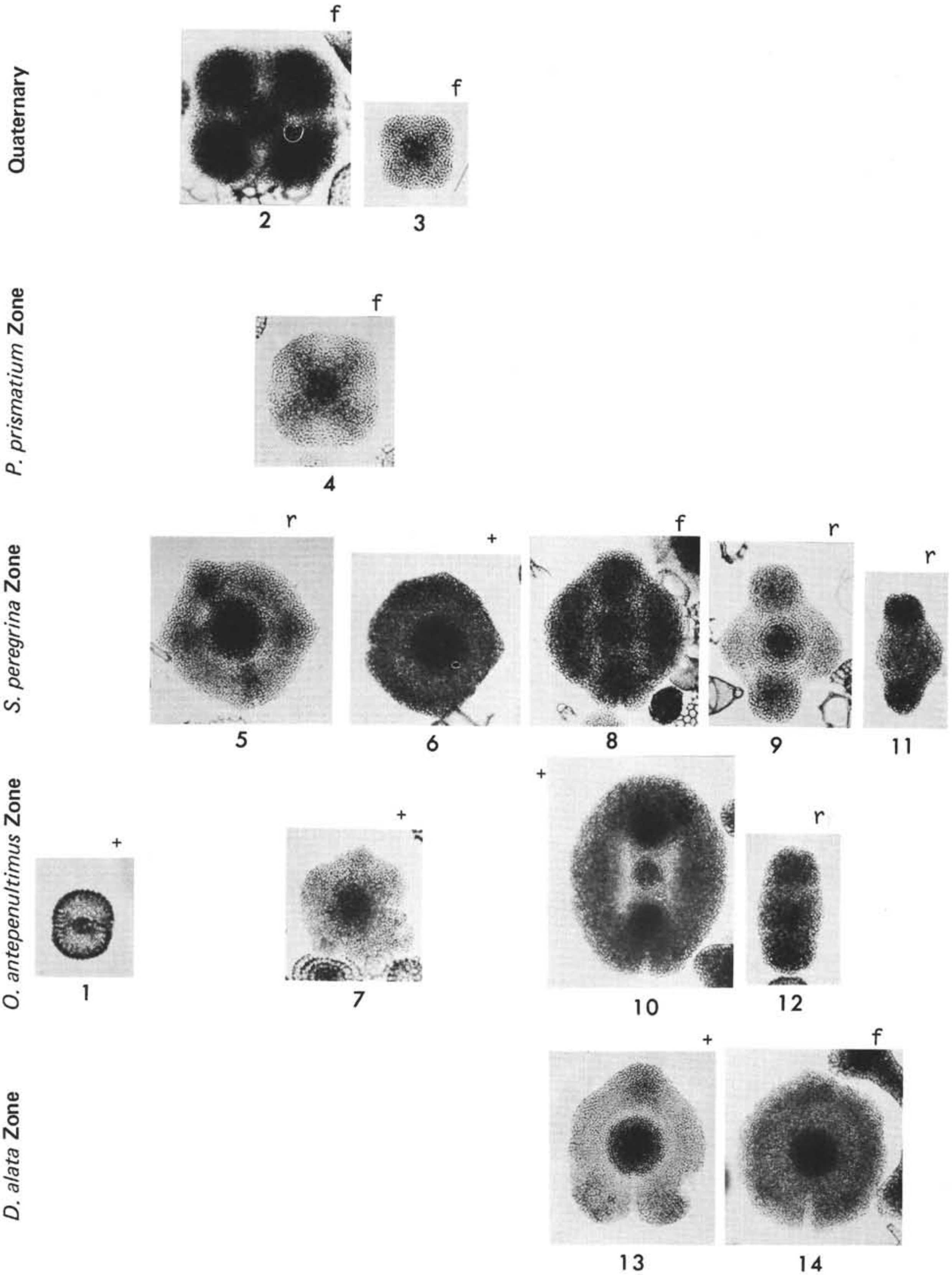
PLATE 1D

(Magnification 95X)

Figure 1	*Cannartus* sp. Sl. 1, D12/3.
Figures 2-4	*Spongaster tetras* Ehrenberg 2: Sl. 1, X53/2. 3: Sl. 1, Q14/1. 4: Sl. 1, S35/2.
Figures 5-7	*Spongaster pentas* Riedel and Sanfilippo 5: 66.1-3-3, 25-27 cm, Sl. 1, D36/0. 6: Sl. 1, M15/2. 7: Sl. 1, R51/0.
Figures 8-10	*Spongaster klingi* Riedel and Sanfilippo n. sp. 8: Sl. 1, W17/0. 9: Sl. 1, P18/4. 10: Cse. 1, F52/3.
Figures 11, 12	*Spongaster* sp. (?) 11: Sl. 1, D47/2. 12: Ph. 1, V46/4.
Figures 13, 14	Spongodiscids, gen. et sp. indet. 13: Cse. 1, K51/0. 14: Cse. 1, K20/3.

PLATE 1D



Quaternary
P. prismatium Zone
S. peregrina Zone
O. antepenultimus Zone
D. alata Zone
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PLATE 1E

Figures 1,2	*Dictyocoryne ontongensis* Riedel and Sanfilippo, n. sp. 1: Cse. 1, Q31/4 (95X). 2: Cse. 1, E39/0 (95X).
Figure 3	*Liriospyris elevata* Goll Sl. 1, W29/0 (150X).
Figures 4-6	*Cyclampterium* (?) *neatum* Sanfilippo and Riedel 4: Cse. 1, E37/4 (80X). 5: 66.1-3-1, 25-27 cm, Cse. 1, V37/2 (80X). 6: 66.1-3-3, 25-27 cm, Cse. 1, F31/4 (80X).
Figure 7	*Cyclampterium* (?) *brachythorax* Sanfilippo and Riedel Cse. 1, M28/0 (80X).
Figures 8-10	*Cyclampterium* (?) *tanythorax* Sanfilippo and Riedel 8: 66.1-6-6, 25-27 cm, Cse. 1, E33/4 (80X). 9: 66.1-7-3, 70-72 cm, Cse. 1, R35/1 (80X). 10: 66.1-7-5, 25-27 cm, Cse. 1, B20/4 (80X).

PLATE 1E

Quaternary

P. prismatium Zone

S. peregrina Zone

O. antepenultimus Zone

D. alata Zone

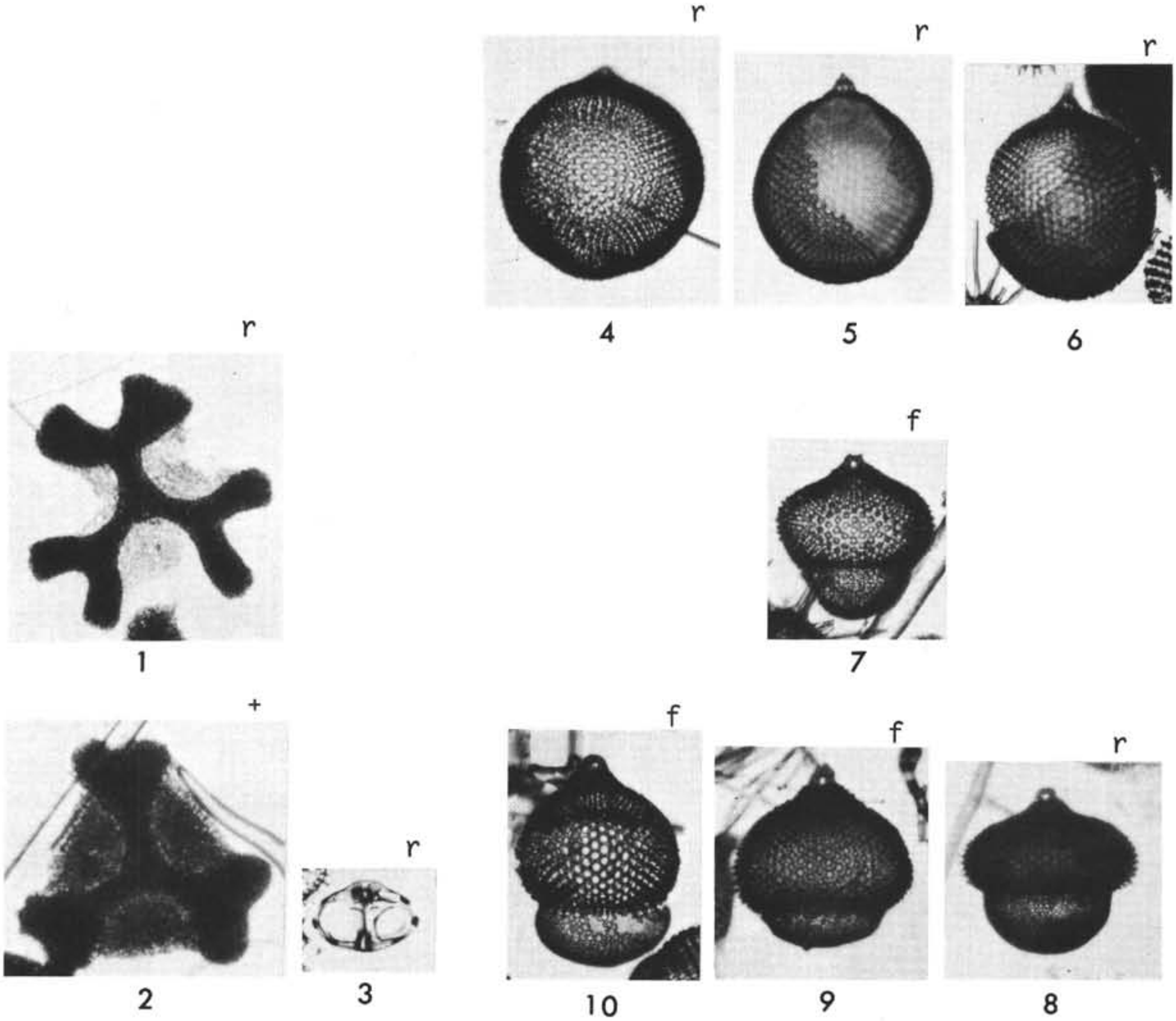

PLATE 1F

(Magnification 150×)

Figure 1	*Cyrtocapsella japonica* (Nakaseko) Sl. 1, V25/0.
Figures 2-4	*Stichocorys peregrina* (Riedel) 2: Ph. 1, W36/0. 3: Ph. 1, T24/3. 4: Ph. 1, U47/3.
Figures 5-7	*Stichocorys delmontensis* (Campbell and Clark) 5: Sl. 1, L16/1. 6: Sl. 1, P46/0. 7: Sl. 1, L27/2.
Figure 8	*Lithopera thornburgi* Sanfilippo and Riedel Ph. 1, T15/0.
Figure 9	*Lithopera baueri* Sanfilippo and Riedel Ph. 1, X34/2.
Figures 10-13	*Lithopera bacca* Ehrenberg 10: Sl. 1, N24/3. 11: Sl. 1, Y30/1. 12: Sl. 1, H20/2. 13: Sl. 1, H25/2.
Figures 14, 15	*Lithopera neotera* Sanfilippo and Riedel 14: Ph. 1, O16/2. 15: Sl. 1, L27/2.

PLATE 1F

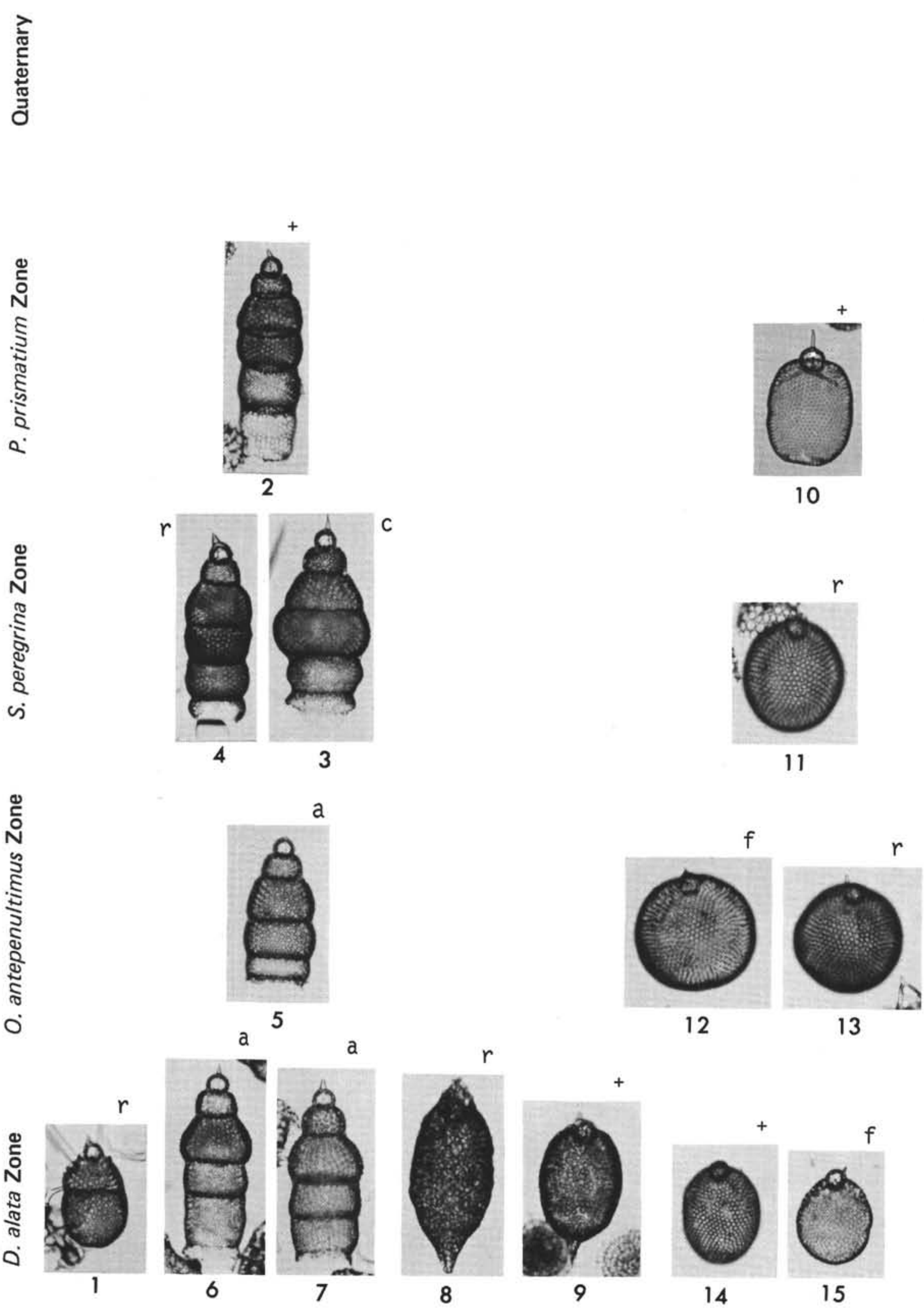
Quaternary
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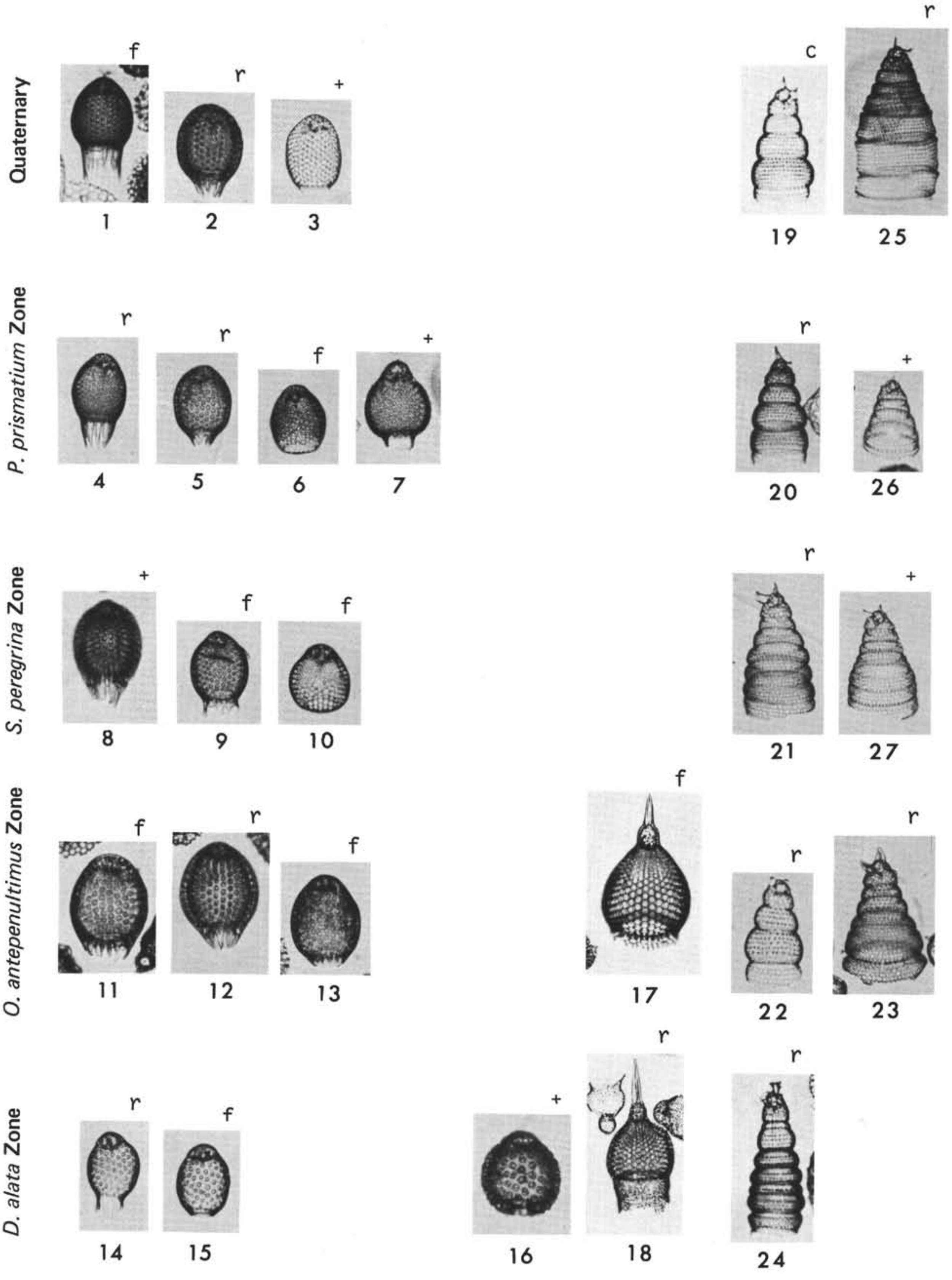
PLATE 1G

Figures 1-6, 7 (?), 8-13, 14 (?), 15 (?)	*Carpocanistrum* spp. 1: Sl. 1, U26/4 (150X). 2: Sl. 1, Q41/1 (150X). 3: Sl. 1, Q46/3 (150X). 4: Sl. 1, H19/2 (150X). 5: Sl. 1, X24/2 (150X). 6: Sl. 1, U34/2 (150X). 7: Sl. 1, U36/3 (150X). 8: Sl. 1, S18/0 (150X). 9: Sl. 1, O35/0 (150X). 10: Sl. 1, W17/3 (150X). 11: Sl. 1, R37/3 (150X). 12: Sl. 1, M43/2 (150X). 13: Sl. 1, U24/1 (150X). 14: Sl. 1, M44/0 (150X). 15: Sl. 1, W44/4 (150X).
Figure 16	*Carpocanopsis cristatum* (Carnevale) (?) Sl. 1, R14/4 (150X).
Figures 17, 18	*Calocycletta* sp. 17: Ph. 1, P38/1 (95X). 18: Ph. 1, E34/1 (95X).
Figures 19-24	*Spirocyrtis* sp. aff. *S. scalaris* Haeckel 19: Ph. 1, R53/0 (150X). 20: Ph. 1, O24/0 (150X). 21: Sl. 1, Q42/0 (150X). 22: Ph. 1, G37/3 (150X). 23: Ph. 1, Y42/2 (150X). 24: Ph. 1, P20/3 (150X).
Figures 25-27	*Spirocyrtis scalaris* Haeckel 25: Sl. 1, Q38/4 (150X). 26: Ph. 1, E36/1 (150X). 27: Sl. 1, W36/3 (150X).

PLATE 1G



Quaternary
P. prismatium Zone
S. peregrina Zone
O. antepenultimus Zone
D. alata Zone
f
r
+
c
1
2
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19
25
4
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16
18
24

PLATE 1H

(Magnification 150X)

Figures 1-3	*Artostrobium doliolum* Riedel and Sanfilippo, n. sp. 1: Ph. 1, K17/0. 2: Ph. 1, Y28/0. 3: Ph. 1, X43/0.
Figure 4	*Artostrobium* sp. aff. *A. doliolum* Riedel and Sanfilippo, n. sp. Ph. 1, Y16/2.
Figures 5-8	*Artostrobium auritum* (Ehrenberg) group 5: Ph. 1, U48/1. 6: Ph. 1, O50/2. 7: Ph. 1, R26/0. 8: Ph. 1, T40/0.
Figures 9-17	*Artostrobium miralestense* (Campbell and Clark) 9: Ph. 1, E36/0. 10: Ph. 1, V35/3. 11: Ph. 1, U47/2. 12: Ph. 1, S41/1. 13: Sl. 1, H27/0. 14: Sl. 1, H48/3. 15: Sl. 1, V51/2. 16: Sl. 1, N52/0. 17: Ph. 1, J23/3.
Figures 18-25	*Siphocampe corbula* (Harting) 18: Sl. 1, K52/2. 19: Ph. 1, P19/0. 20: Ph. 1, Q26/0. 21: Ph. 1, J40/3. 22: Sl. 1, S39/2. 23: Ph. 1, Q31/3. 24: Sl. 1, L24/0. 25: Ph. 1, L50/3.
Figures 26-28	*Siphocampe* sp. aff. *S. corbula* (Harting) 26: Ph. 1, F22/4. 27: Ph. 1, X49/1. 28: Ph. 1, C33/4.

PLATE 1H

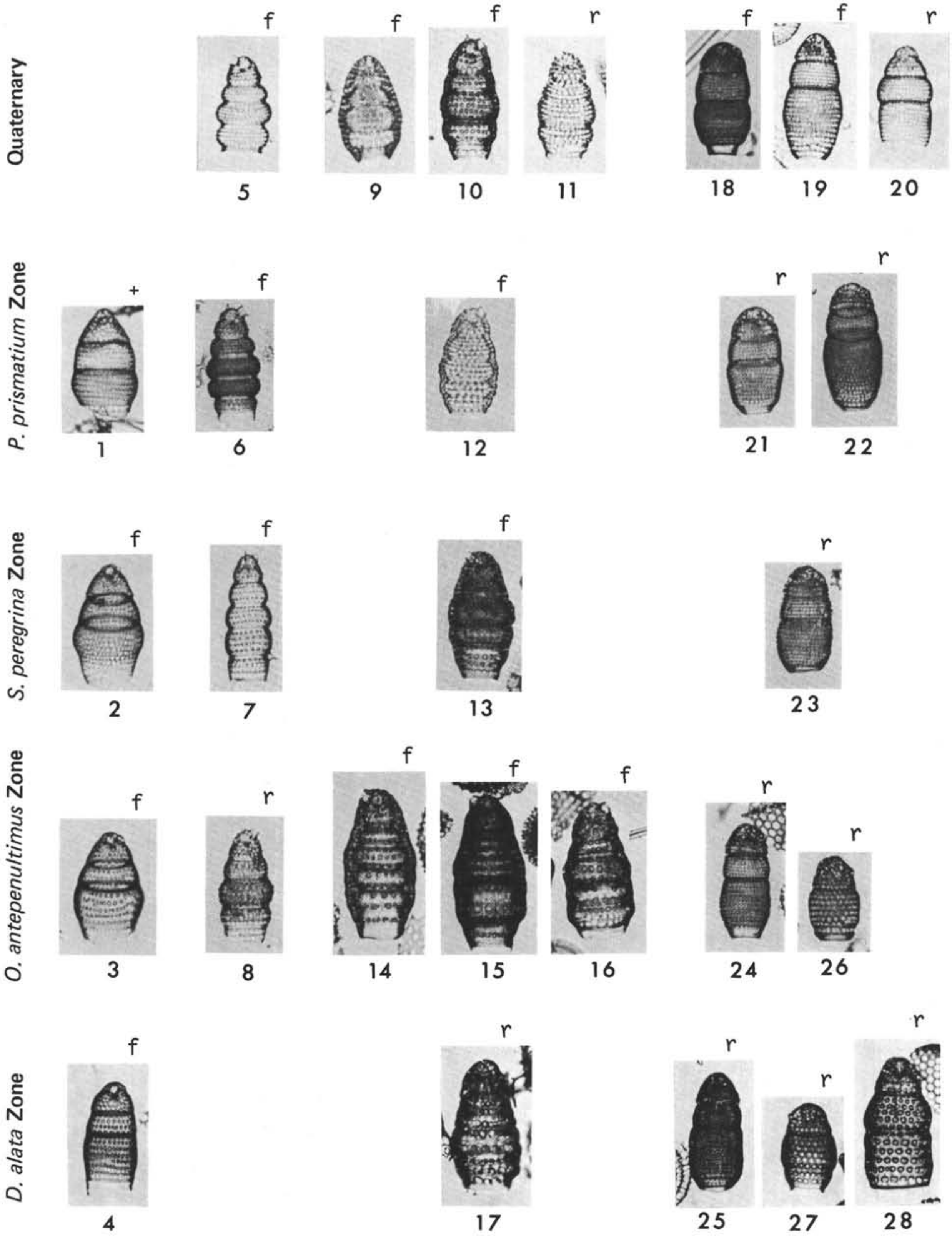
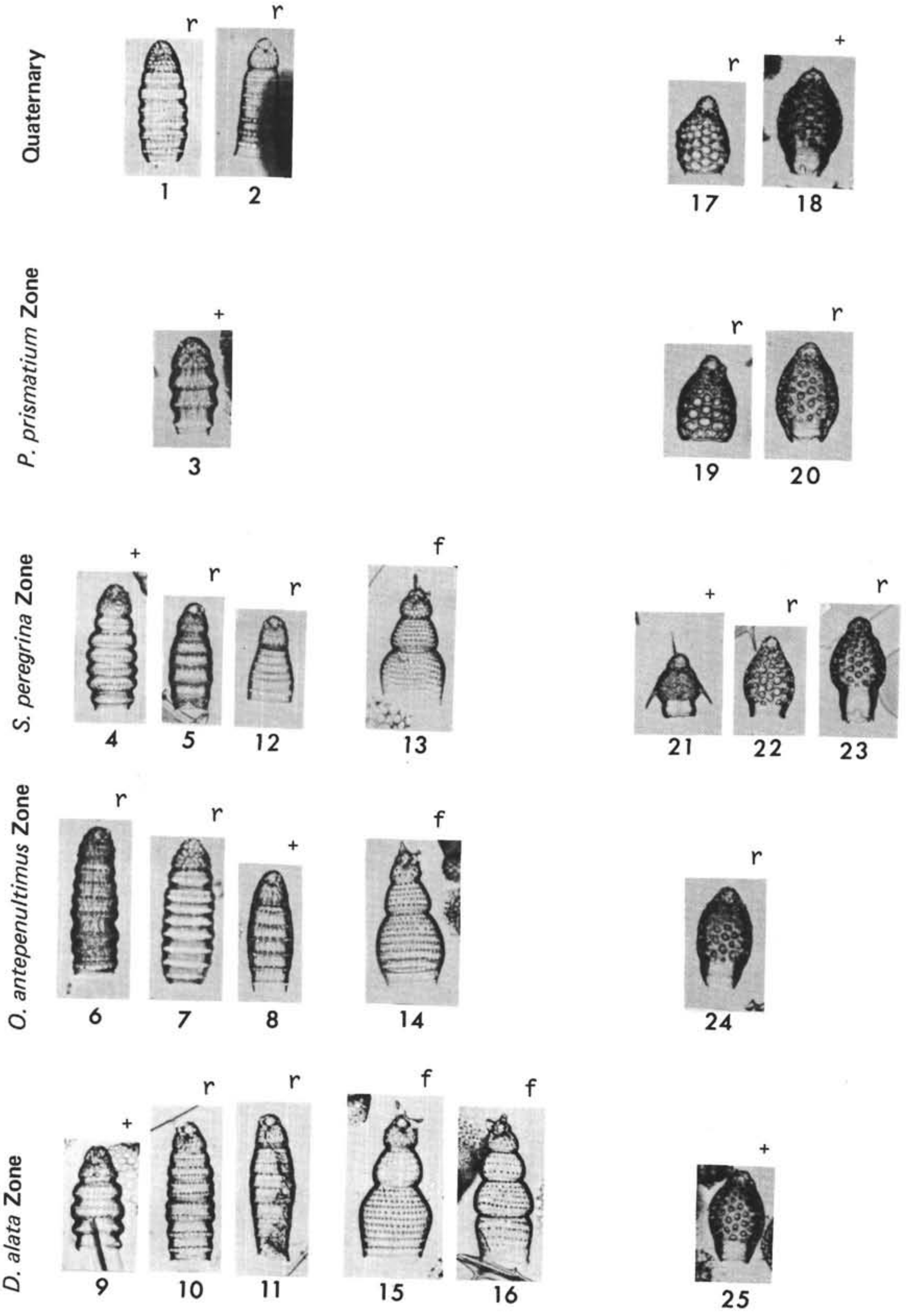

Quaternary
P. prismatium Zone
S. peregrina Zone
O. antepenultimus Zone
D. alata Zone

PLATE 11

(Magnification 150X)

Figures 1-11	*Lithomitra lineata* (Ehrenberg) group 1: Ph. 1, K28/0. 2: Sl. 1, J34/0. 3: Ph. 1, Q30/4. 4: Sl. 1, E19/2. 5: Sl. 1, Q43/3. 6: Sl. 1, H20/0. 7: Ph. 1, O41/3. 8: Ph. 1, T28/1. 9: Ph. 1, E36/4. 10: Ph. 1, M24/0. 11: Ph. 1, M31/1.
Figure 12	*Lithomitra* sp. aff. *L. lineata* (Ehrenberg) group Ph. 1, O24/0.
Figures 13-15	*Phormostichoartus corona* Haeckel 13: Ph. 1, Y31/0. 14: Ph. 1, M53/2. 15: Ph. 1, Y54/1.
Figure 16	*Phormostichoartus* sp. aff. *P. corona* Haeckel (?) Ph. 1, M34/3.
Figures 17-25	*Carpocanarium* spp. 17: Sl. 1, L29/4. 18: Sl. 1, E23/3. 19: Sl. 1, G15/4. 20: Sl. 1, O16/0. 21: Sl. 1, U29/2. 22: Sl. 1, V29/0. 23: 66.1-4-1, 110-111 cm, Sl. 1, Q44/4. 24: Sl. 1, Q18/3. 25: Sl. 1, Y14/4.

PLATE 11



Quaternary
P. prismatium Zone
S. peregrina Zone
O. antepenultimus Zone
D. alata Zone
r
r
1
2
r
+
17
18
+
3
r
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19
20
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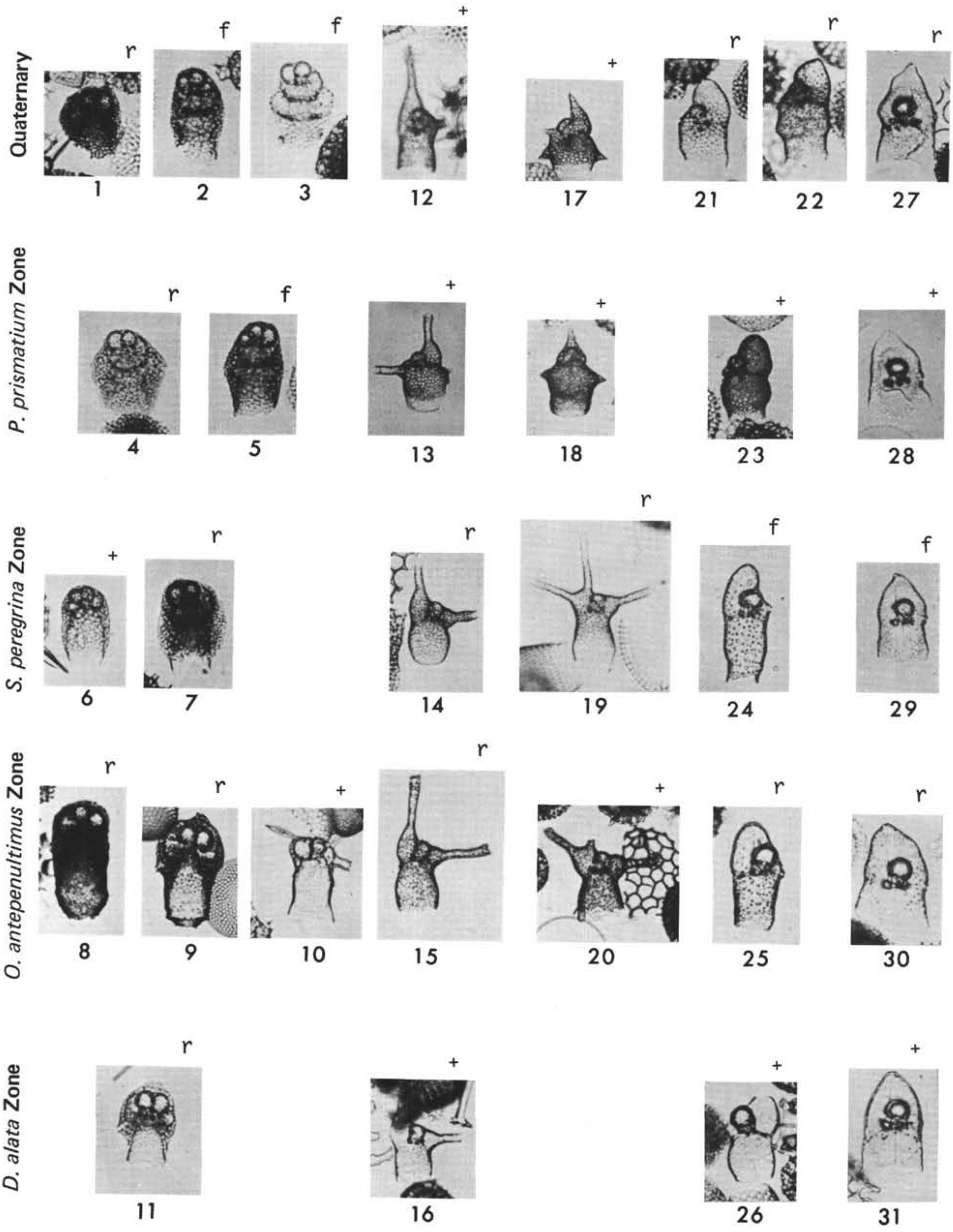
r
r
+
f
6
7
8
14
r
24
+
r
r
f
f
9
10
11
15
16
+
25

PLATE 1J

(Magnification 150X)

Figures 1-11	*Botryocyrtis* spp. 1: Sl. 1, S53/2. 2: Sl. 1, C29/0. 3: Sl. 1, H33/3. 4: Sl. 1, Q40/1. 5: Sl. 1, Q39/4. 6: Sl. 1, K40/0. 7: Sl. 1, T20/4. 8: Sl. 1, O51/1. 9: Sl. 1, L41/0. 10: Sl. 1, R34/0. 11: Sl. 1, V35/0.
Figures 12-16	*Acrobotrys* spp. 12: Sl. 1, X25/3. 13: Sl. 2, O20/0. 14: Sl. 1, V24/2. 15: Sl. 1, M21/3. 16: Sl. 1, H38/3.
Figures 17, 18	Gen. et sp. indet. 17: Sl. 1, X24/0. 18: Sl. 2, K33/0.
Figures 19, 20	*Acrobotrys tritubus* Riedel 19: 66.1-3-3, 25-27 cm, Sl. 1, N29/3. 20: Sl. 1, P52/3.
Figures 21-26	*Botryopyle dictyocephalus* Haeckel group 21: Sl. 1, D20/0. 22: Sl. 1, U30/1. 23: Sl. 1, F45/0. 24: Sl. 1, Q34/1. 25: Sl. 1, T31/2. 26: Sl. 1, K48/0.
Figures 27-31	*Centrobotrys thermophila* Petrushevskaya 27: Sl. 1, D20/4. 28: Sl. 1, O32/0. 29: Sl. 1, Q34/4. 30: Sl. 1, Q24/0. 31: Sl. 1, E33/4.

PLATE 1J



Quaternary
P. prismatium Zone
S. peregrina Zone
O. antepenultimus Zone
D. alata Zone
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26
31

PLATE 2A

(Magnification 150×)

Figures 1, 2	*Collosphaera* spp.	
	1: Ph. 1, T40/2.	
	2: Ph. 1, E43/2.	
Figure 3	*Collosphaera* (?)	
	Ph. 1, Y29/2.	
Figures 4-10	*Solenosphaera* spp.	
	4: Ph. 1, M27/2.	
	5: Ph. 1, N35/0.	
	6: Ph. 1, D8/0.	
	7: Ph. 1, N20/1.	
	8: Ph. 1, O37/3.	
	9: Sl. 1, H12/2.	
	10: Sl. 1, Y38/3.	
Figures 11-15	*Polysolenia* spp.	
	11: Ph. 1, E50/1.	
	12: Ph. 1, V47/0.	
	13: Ph. 1, P35/0.	
	14: Sl. 1, Y48/0.	
	15: Ph. 2, Y26/0.	

PLATE 2A

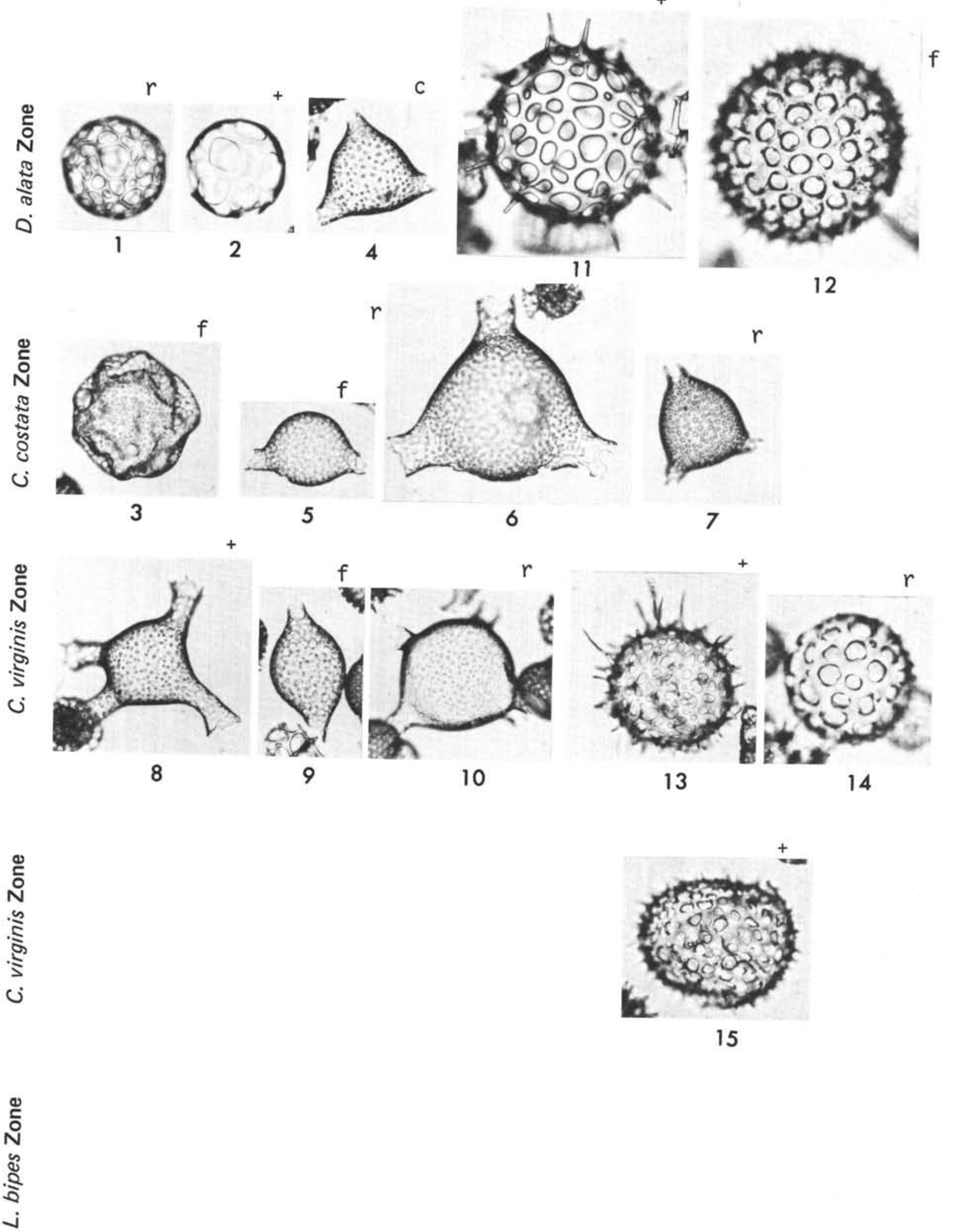

D. alata Zone
C. costata Zone
C. virginis Zone
C. virginis Zone
L. bipes Zone
r
+
c
+
f
1
2
4
11
12
f
r
f
r
3
5
6
7
+
f
r
+
r
8
9
10
13
14
+
15

PLATE 2B

Figures 1-4	*Polysolenia* (?) 1: Ph. 1, E45/4 (150X). 2: Ph. 1, T52/0 (150X). 3: Ph. 1, V33/2 (150X). 4: Ph. 1, O18/4 (150X).
Figure 5	*Siphonosphaera* sp. Sl. 1, X44/0 (150X).
Figures 6-8	*Tribonosphaera* sp. 6: Ph. 1, T27/0 (150X). 7: Ph. 1, X49/3 (150X). 8: Ph. 1, C6/4 (150X).
Figures 9, 10	*Cannartus* sp. 9: Ph. 1, V23/4 (95X). 10: Ph. 1, E44/4 (95X).

PLATE 2B

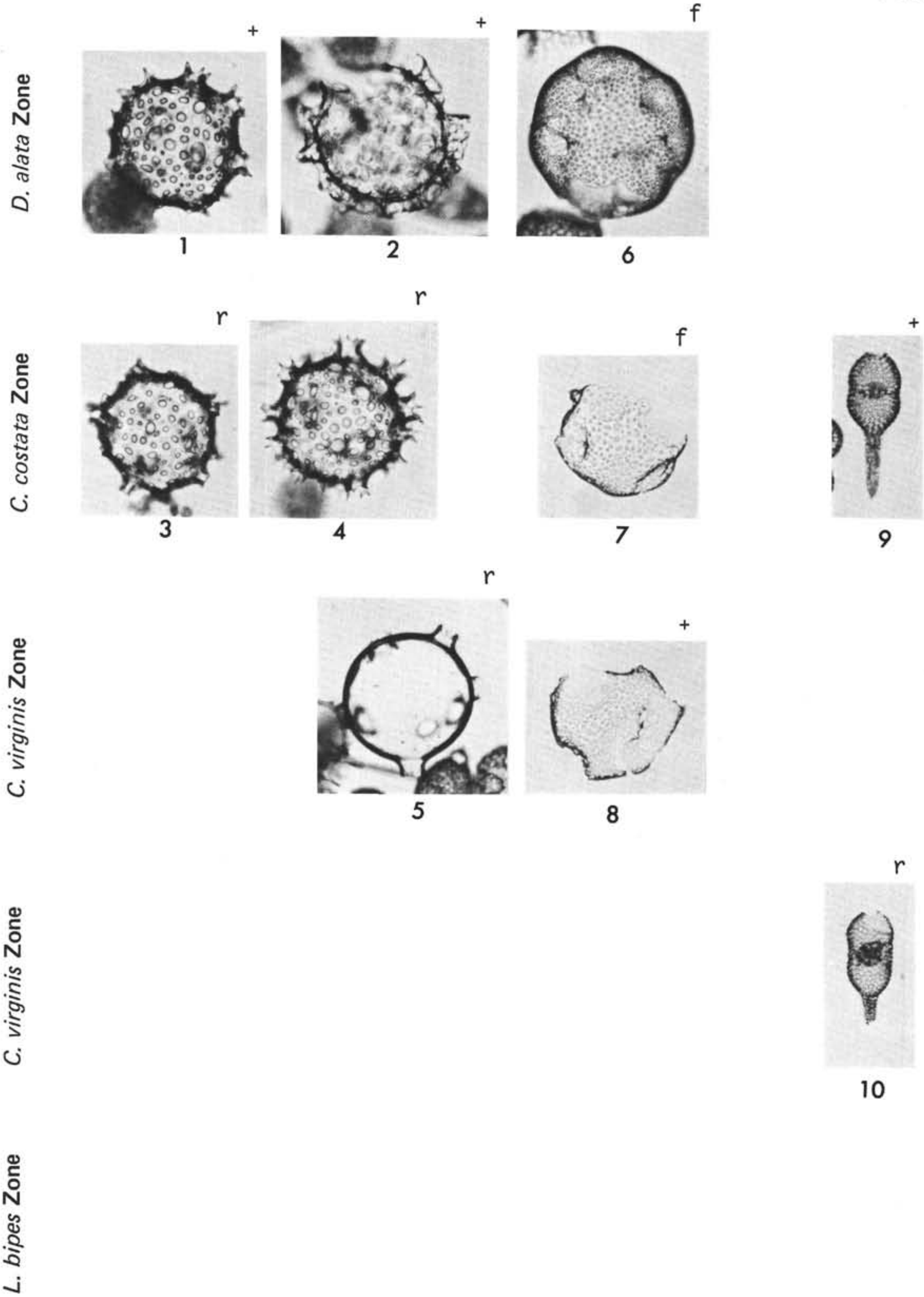

D. alata Zone
C. costata Zone
C. virginis Zone
C. virginis Zone
L. bipes Zone
+
+
f
1
2
6
r
r
f
+
3
4
7
9
r
+
5
8
r
10

PLATE 2C

Figures 1-3	*Cannartus mammiferus* (Haeckel) 1: Ph. 1, Q39/0 (95X). 2: Ph. 1, Y18/1 (95X). 3: Ph. 1, V13/2 (95X).
Figures 4-7	*Cannartus violina* Haeckel 4: Ph. 1, F37/1 (95X). 5: Ph. 1, J19/1 (95X). 6: Ph. 1, T35/0 (95X). 7: Ph. 1, J25/1 (95X).
Figures 8-10	*Cannartus tubarius* (Haeckel) 8: Ph. 1, V37/1 (95X). 9: Sl. 1, V29/1 (95X). 10: Ph. 1, G39/4 (95X).
Figures 11-13	*Cannartus prismaticus* (Haeckel) 11: Ph. 1, S19/0 (95X). 12: Sl. 1, V42/1 (95X). 13: Ph. 1, T14/4 (95X).
Figure 14	*Cannartus* (?) sp. aff. *C. prismaticus* (Haeckel) Sl. 1, S30/1 (95X).
Figure 15	*Liriospyris parkerae* Riedel and Sanfilippo, n. sp. Ph. 1, Z28/2 (150X).
Figures 16-19	*Liriospyris stauropora* (Haeckel) 16: Ph. 1, U44/3 (150X). 17: Ph. 1, N33/4 (150X). 18: Sl. 1, T42/1 (150X). 19: Sl. 1, V13/0 (150X).
Figures 20-23	*Dorcadospyris forcipata* (Haeckel) 20: Cse. 2, V27/0 (60X). 21: Cse. 1, C17/0 (60X). 22: Cse. 1, K30/1 (60X). 23: Cse. 1, L15/0 (60X).

PLATE 2C

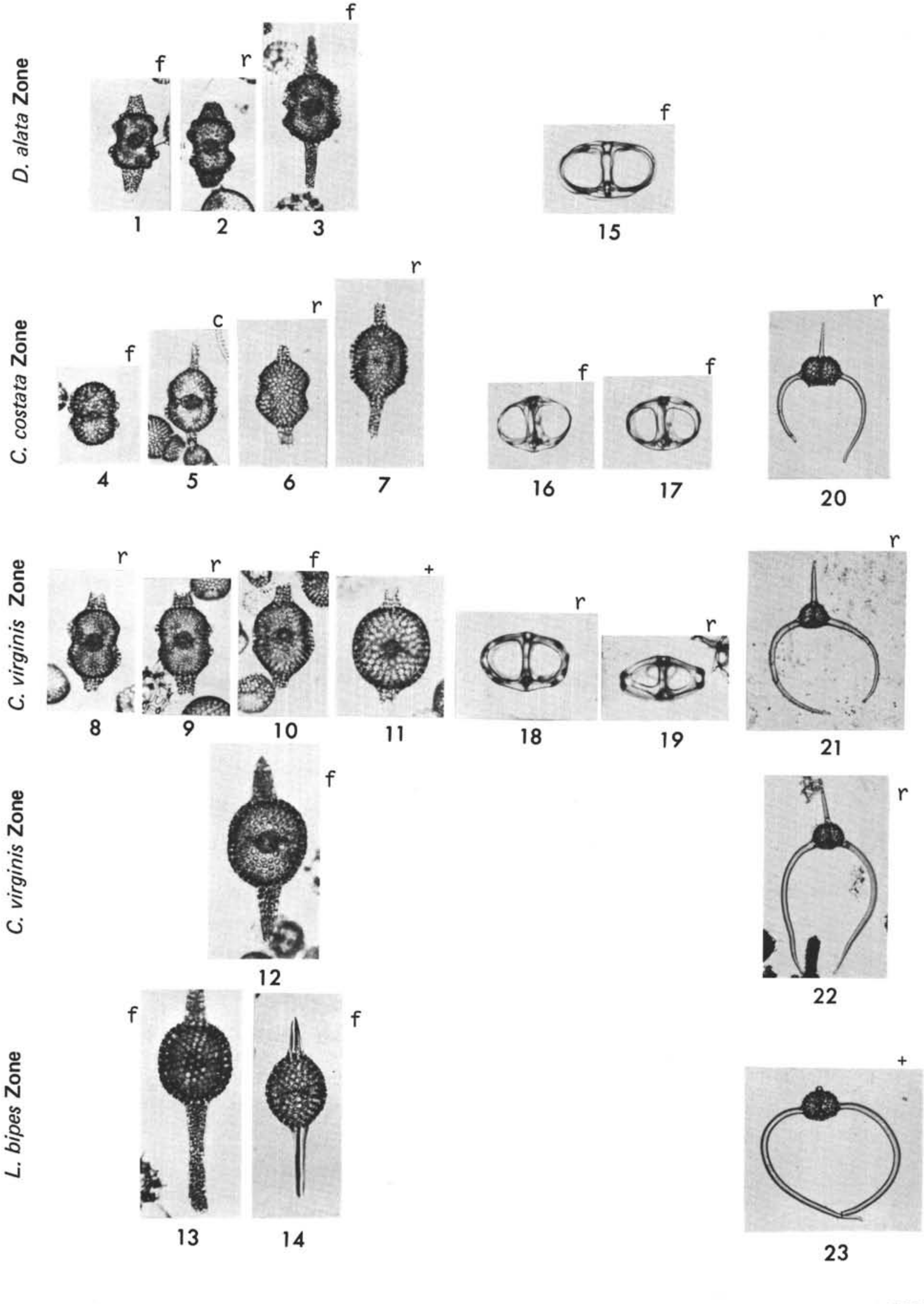

D. alata Zone
C. costata Zone
C. virginis Zone
C. virginis Zone
L. bipes Zone

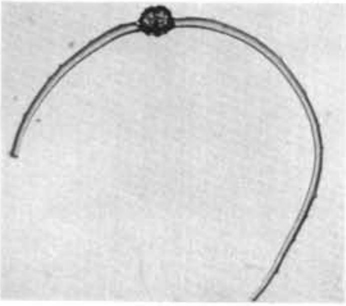
PLATE 2D

Figure 1	*Dorcadospyris alata* (Riedel) Cse. 1, E26/1 (60X).
Figures 2, 3	*Dorcadospyris dentata* Haeckel 2: Cse. 1, N16/3 (60X). 3: Cse. 1, K16/2 (60X).
Figures 4, 5	*Dorcadospyris papilio* (Riedel) 4: Cse. 1, J30/0 (60X). 5: Cse. 2, G20/4 (60X).
Figure 6	*Dorcadospyris ateuchus* (Ehrenberg) Cse. 1, Q28/3 (60X).
Figures 7, 8	*Cyclampterium* (?) *tanythorax* Sanfilippo and Riedel 7: Cse. 1, E40/1 (80X). 8: Cse. 1, E36/0 (80X).
Figures 9-12	*Cyclampterium* (?) *leptetrum* Sanfilippo and Riedel 9: Cse. 2, M27/0 (80X). 10: Cse. 1, G18/2 (80X). 11: 64.1-6-CC, Cse. 1, T23/3 (80X). 12: 64.1-6-CC, Cse. 1, S22/2 (80X).
Figures 13, 14	*Cyclampterium* (?) *pegetrum* Sanfilippo and Riedel 13: 64.0-7-3, 84-86 cm, Cse. 1, N20/0 (80X). 14: 64.0-7-3, 84-86 cm, Sl. 1, N19/2 (80X).

PLATE 2D

D. alata Zone

r



1

f

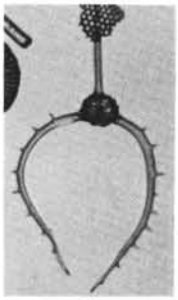
7

f

8

C. costata Zone

r



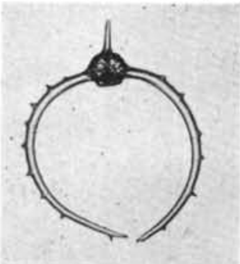
2

r

9

C. virginis Zone

r



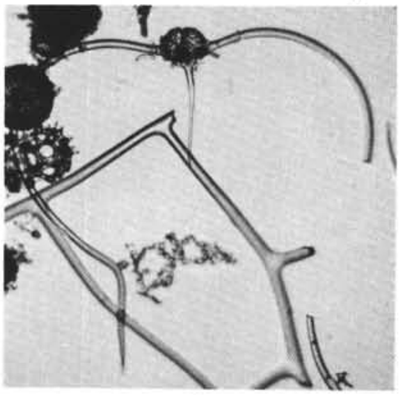
3

r

10

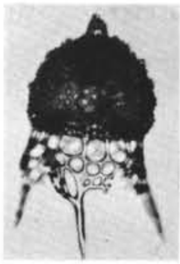
C. virginis Zone

+



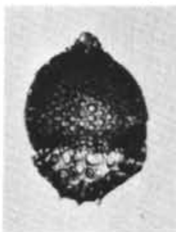
4

+



11

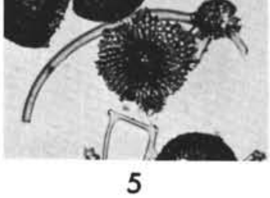
+



12

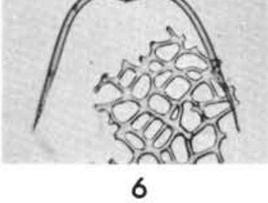
L. bipes Zone

r



5

r



6

r

13

r

14

PLATE 2E

(Magnification 150X)

Figures 1-4	*Cyrtocapsella cornuta* Haeckel 1: Ph. 1, P32/3. 2: Sl. 1, N21/0. 3: Ph. 1, H33/0. 4: Sl. 1, N30/0.
Figures 5-7	*Cyrtocapsella tetrapera* Haeckel 5: Ph. 1, V41/2. 6: Ph. 1, W14/0. 7: Sl. 1, S26/0.
Figures 8, 9	*Stichocorys wolffii* Haeckel 8: Ph. 1, T37/4. 9: Ph. 1, V38/0.
Figures 10, 11	*Stichocorys delmontensis* (Campbell and Clark) 10: Ph. 1, X21/0. 11: Ph. 1, T38/1.
Figure 12	*Cyrtocapsella japonica* (Nakaseko) Ph. 1, Y5/3.
Figures 13-15	*Stichocorys armata* (Haeckel) 13: Ph. 1, W27/3. 14: Sl. 1, S31/4. 15: Ph. 1, S38/4.
Figure 16	*Stichocorys diploconus* (Haeckel) Sl. 1, E14/0.
Figures 17, 18	*Lithopera renzae* Sanfilippo and Riedel 17: Sl. 1, O29/0. 18: Ph. 1, V36/0.
Figure 19	*Lithopera neotera* Sanfilippo and Riedel Ph. 1, M25/1.

PLATE 2E

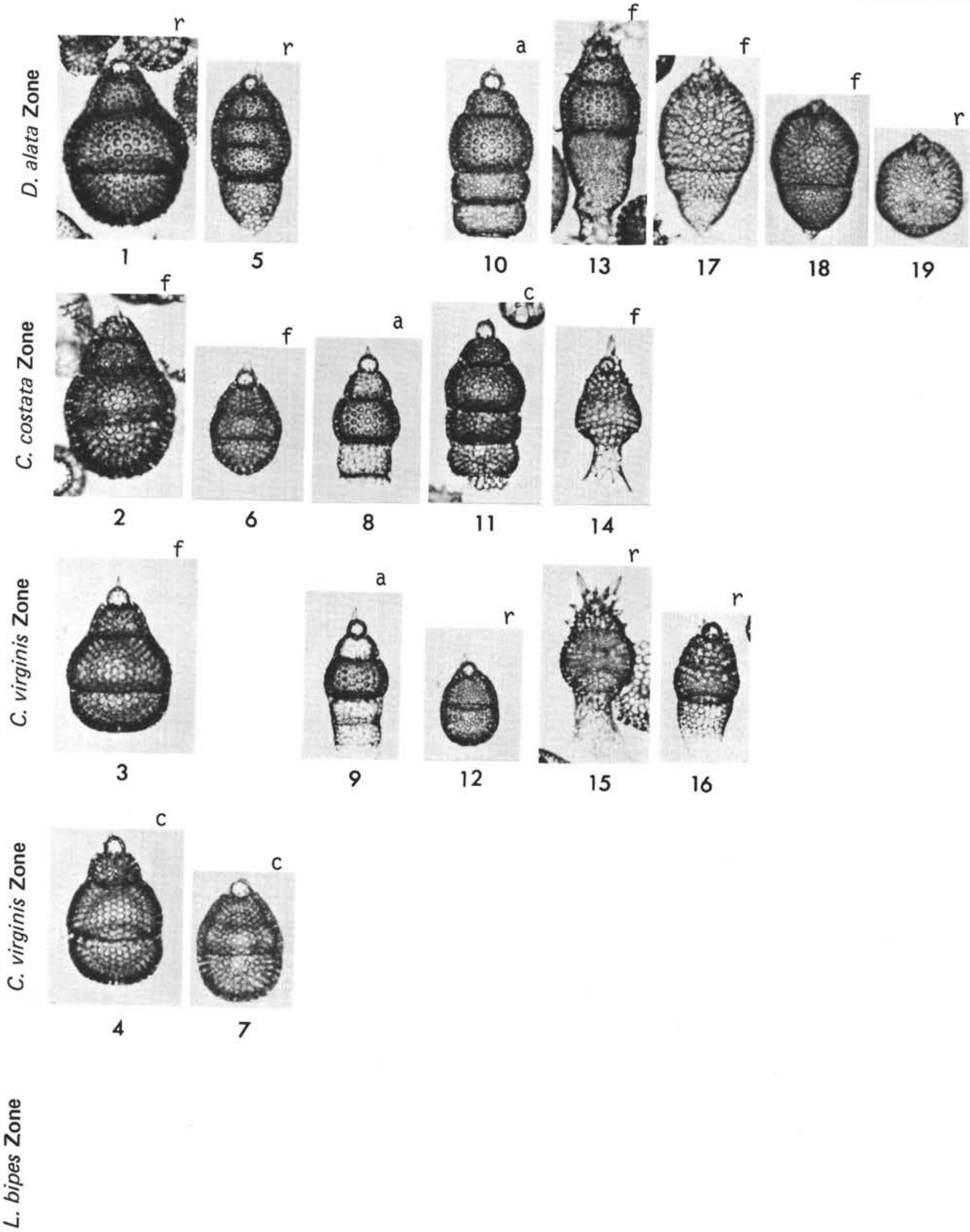

D. alata Zone
C. costata Zone
C. virginis Zone
C. virginis Zone
L. bipes Zone
1 r
5 r
10 a
13 f
17 f
18 f
19 r
2 f
6 f
8 a
11 c
14 f
3 f
9 a
12 r
15 r
16 r
4 c
7 c

PLATE 2F

Figures 1, 2	*Lychnocanium bipes* Riedel 1: Cse. 1, E25/3 (95X). 2: Ph. 1, V29/0 (95X).
Figure 3	*Theocorys* sp. (?) Sl. 1, E32/2 (80X).
Figure 4	*Theocorys spongoconum* Kling Sl. 1, T40/2 (150X).
Figures 5-16	*Carpocanistrum* spp. 5: Sl. 1, M36/4 (150X). 6: Sl. 1, T26/0 (150X). 7: Sl. 1, D35/0 (150X). 8: Sl. 1, M40/1 (150X). 9: Sl. 1, W37/2 (150X). 10: Ph. 1, W18/2 (150X). 11: Sl. 1, X20/2 (150X). 12: Sl. 1, P33/3 (150X). 13: Sl. 1, Q37/2 (150X). 14: Sl. 1, V43/3 (150X). 15: Sl. 1, K32/0 (150X). 16: Sl. 1, D17/0 (150X).

PLATE 2F

D. alata Zone

C. costata Zone

C. virginis Zone

C. virginis Zone

L. bipes Zone

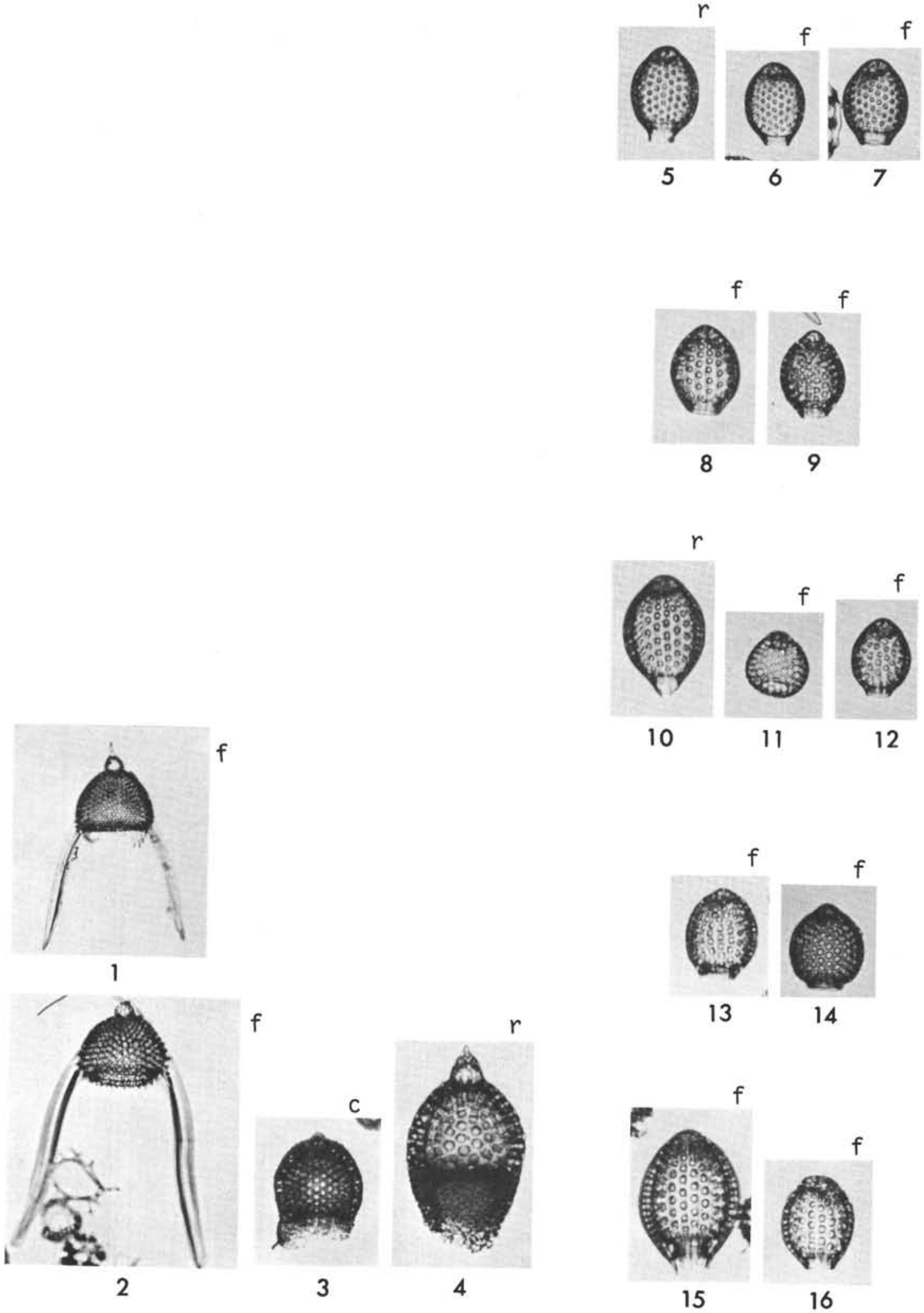


PLATE 2G

(Magnification 150×)

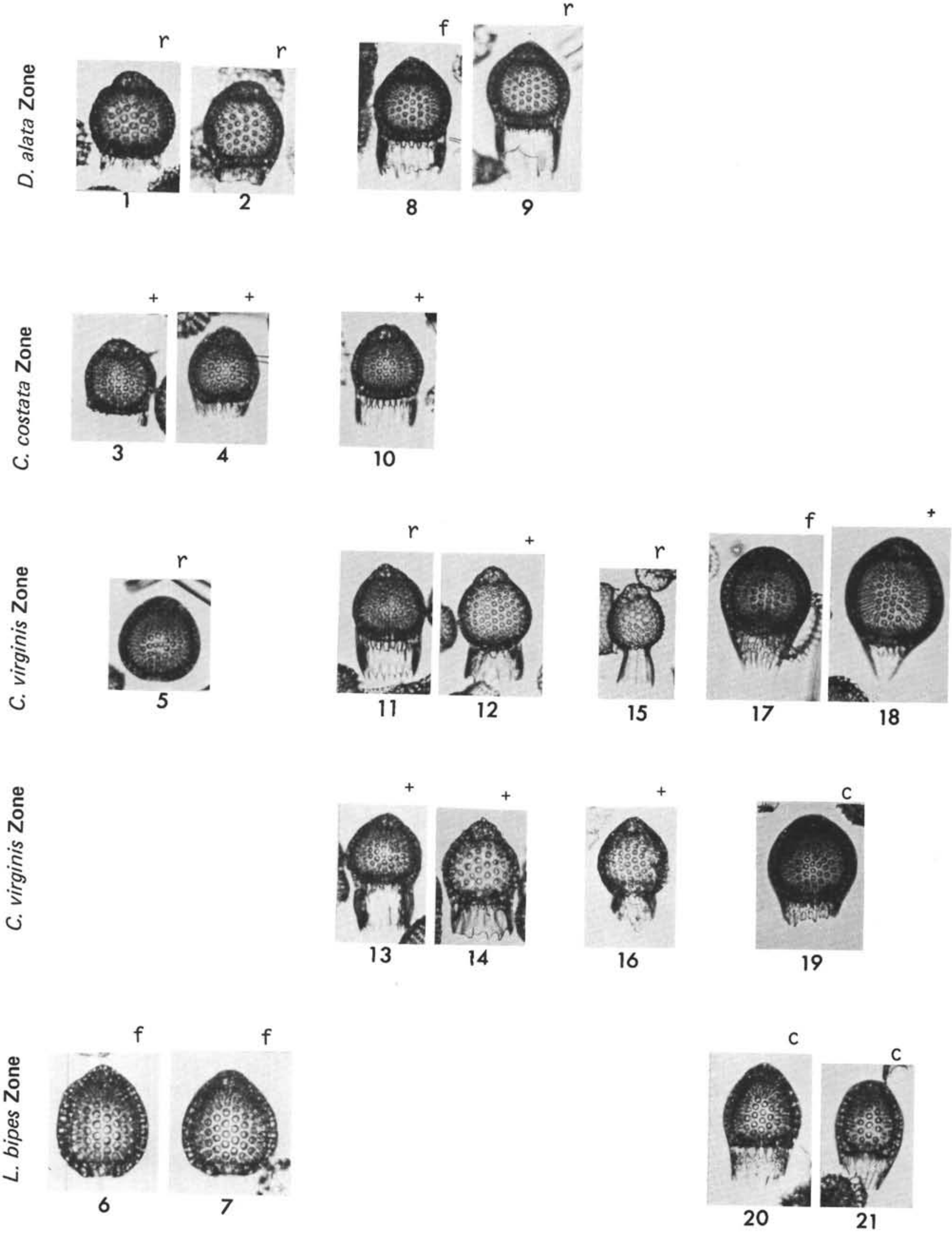
Figures 1-7 — *Carpocanopsis cristatum* (Carnevale) (?)
1: Sl. 1, T39/0.
2: 66.1-7-3, 70-72 cm, Sl. 1, V14/4.
3: Sl. 1, J36/0.
4: Sl. 1, R25/0.
5: Sl. 1, S41/0.
6: Sl. 1, K49/0.
7: Sl. 1, N24/3.

Figures 8-14 — *Carpocanopsis bramlettei* Riedel and Sanfilippo, n. sp.
8: Sl. 1, V21/4.
9: 66.1-7-3, 70-72 cm, Sl. 1, L14/1.
10: Sl. 1, L35/3.
11: Sl. 1, N25/0.
12: Ph. 1, D27/0.
13: Sl. 1, B49/4.
14: Sl. 1, K37/1.

Figures 15, 16 — *Carpocanopsis favosum* (Haeckel)
15: Sl. 1, W30/2.
16: Sl. 1, Y19/0.

Figures 17-21 — *Carpocanopsis cingulatum* Riedel and Sanfilippo, n. sp.
17: Sl. 1, R18/2.
18: Sl. 1, T16/0.
19: Sl. 1, K46/1.
20: Sl. 1, L43/1.
21: Sl. 1, M49/0.

PLATE 2G


D. alata Zone
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C. costata Zone
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C. virginis Zone
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C. virginis Zone
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c
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L. bipes Zone
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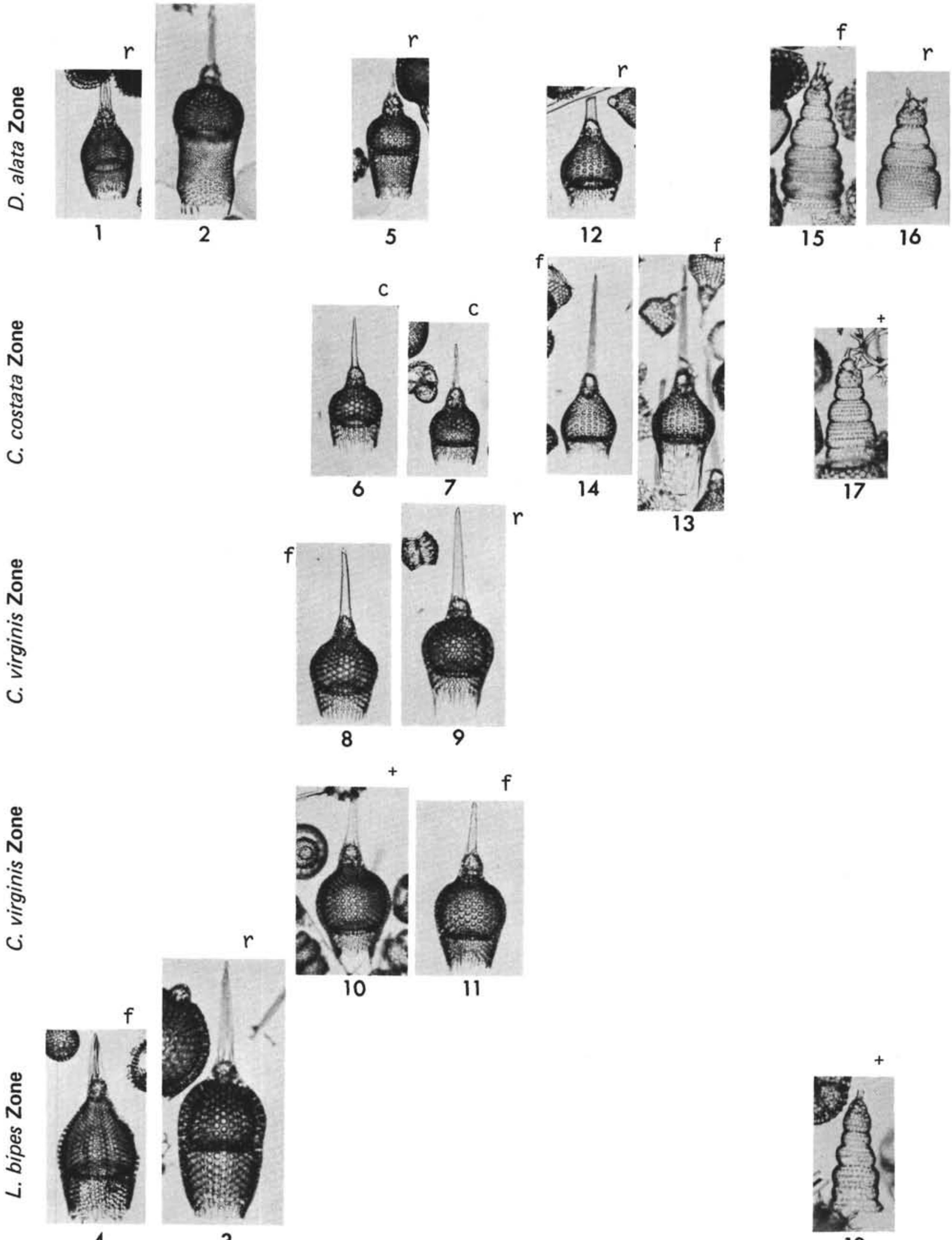
21

PLATE 2H

Figures 1-3	*Calocycletta* sp. 1: Ph. 1, K19/2 (95X). 2: Ph. 1, P20/4 (95X). 3: Sl. 1, P33/0 (95X).
Figure 4	*Theocyrtis annosa* (Riedel) Ph. 1, R16/2 (95X).
Figures 5-11	*Calocycletta virginis* Haeckel 5: Ph. 1, D51/2 (95X). 6: Ph. 1, G45/0 (95X). 7: Ph. 1, F21/0 (95X). 8: Ph. 1, Q19/2 (95X). 9: Ph. 1, W34/0 (95X). 10: Sl. 1, B24/3 (95X). 11: Ph. 1, N23/3 (95X).
Figures 12-14	*Calocycletta costata* (Riedel) 12: Sl. 1, K39/4 (95X). 13: Sl. 1, X29/0 (95X). 14: Ph. 1, J33/2 (95X).
Figures 15-18	*Spirocyrtis* sp. aff. *S. scalaris* Haeckel 15: Sl. 1, U29/4 (150X). 16: Ph. 1, U34/0 (150X). 17: Sl. 1, X42/2 (150X). 18: Sl. 1, L51/2 (150X).

PLATE 2H



D. alata Zone
C. costata Zone
C. virginis Zone
C. virginis Zone
L. bipes Zone
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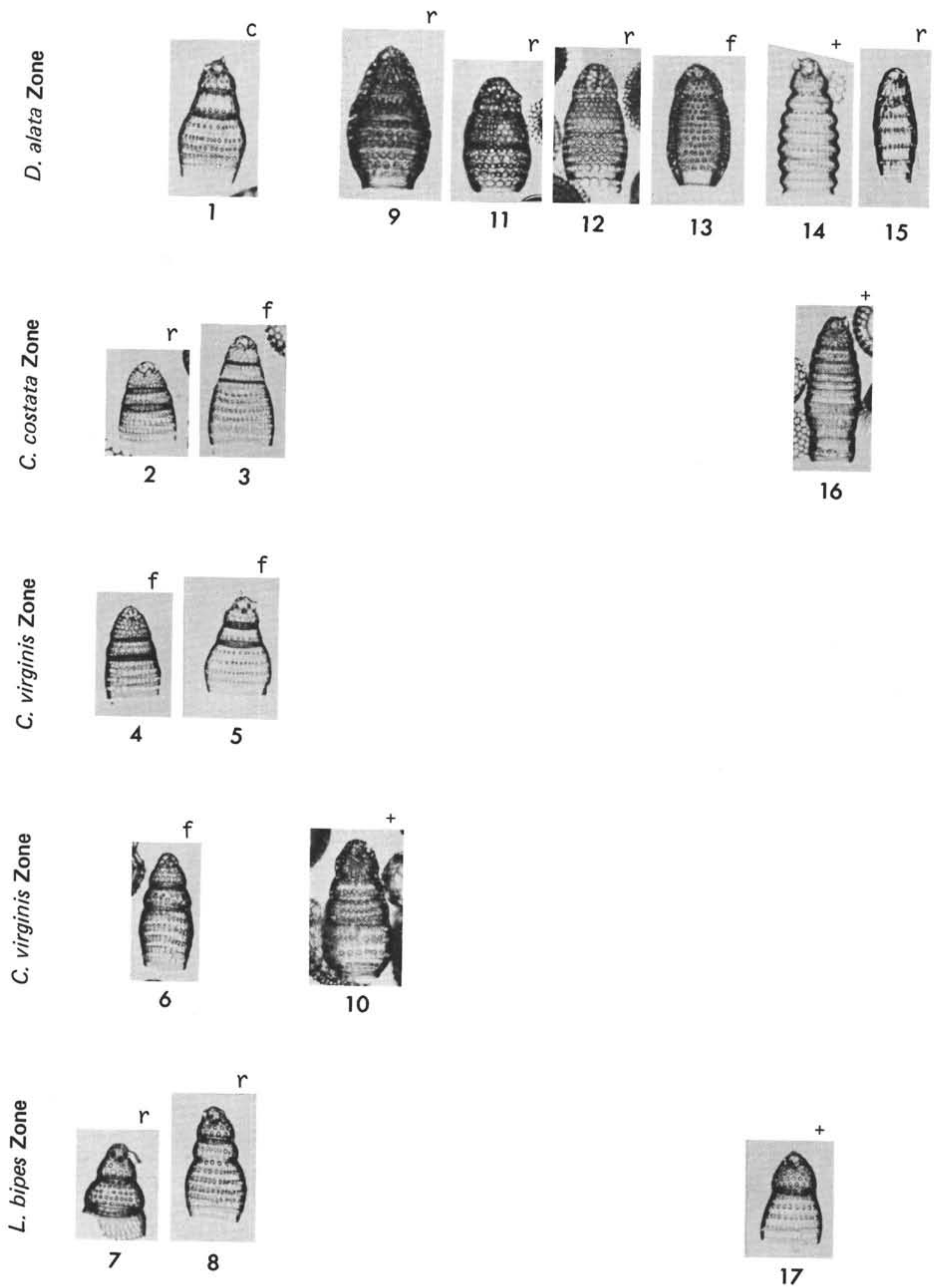
PLATE 21

(Magnification 150X)

Figures 1-8	*Artostrobium* sp. aff. *A. doliolum* Riedel and Sanfilippo, n. sp. 1: Sl. 1, X23/0. 2: Sl. 1, O40/2. 3: Ph. 1, O28/0. 4: Ph. 1, P35/4. 5: Ph. 1, X39/0. 6: Sl. 1, D21/3. 7: Ph. 1, C30/2. 8: Sl. 1, H14/0.
Figures 9, 10	*Artostrobium miralestense* (Campbell and Clark) 9: Ph. 1, S41/1. 10: Sl. 1, O43/4.
Figures 11-13	*Siphocampe* sp. aff. *S. corbula* (Harting) 11: Ph. 1, D45/4. 12: Sl. 1, M37/3. 13: Sl. 1, T24/2.
Figures 14-16	*Lithomitra lineata* (Ehrenberg) group 14: Ph. 1, U29/4. 15: Ph. 1, F34/2. 16: Sl. 1, X44/0.
Figure 17	*Lithomitra* sp. aff. *L. lineata* (Ehrenberg) group Ph. 1, W40/1.

PLATE 21



D. alata Zone
C. costata Zone
C. virginis Zone
C. virginis Zone
L. bipes Zone
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PLATE 2J

(Magnification 150X)

Figures 1-5	*Phormostichoartus corona* Haeckel 1: Ph. 1, K23/0. 2: Ph. 1, J38/4. 3: Ph. 1, R30/0. 4: Sl. 1, X11/0. 5: Sl. 1, R29/1.
Figures 6, 7	*Phormostichoartus* sp. aff. *P. corona* Haeckel 6: Sl. 1, R35/0. 7: Sl. 1, G35/4.
Figures 8, 9	*Carpocanarium* spp. 8: Sl. 1, X24/1. 9: Sl. 1, P34/3.
Figures 10-12	*Botryocyrtis* spp. 10: Sl. 1, T41/3. 11: Sl. 1, V40/0. 12: Sl. 1, R15/4.
Figures 13-15	*Acrobotrys* spp. 13: Sl. 1, R19/0. 14: Sl. 1, P18/3. 15: Sl. 1, E21/4.
Figures 16-18	*Botryopyle dictyocephalus* Haeckel group 16: Sl. 1, Q40/3. 17: Ph. 1, H39/4. 18: Ph. 1, U14/1.
Figure 19	*Centrobotrys thermophila* Petrushevskaya 19: Sl. 1, S24/2.
Figures 20, 21	*Botryopyle* sp. A 20: Sl. 1, D41/1. 21: Ph. 1, W17/0.

PLATE 2J

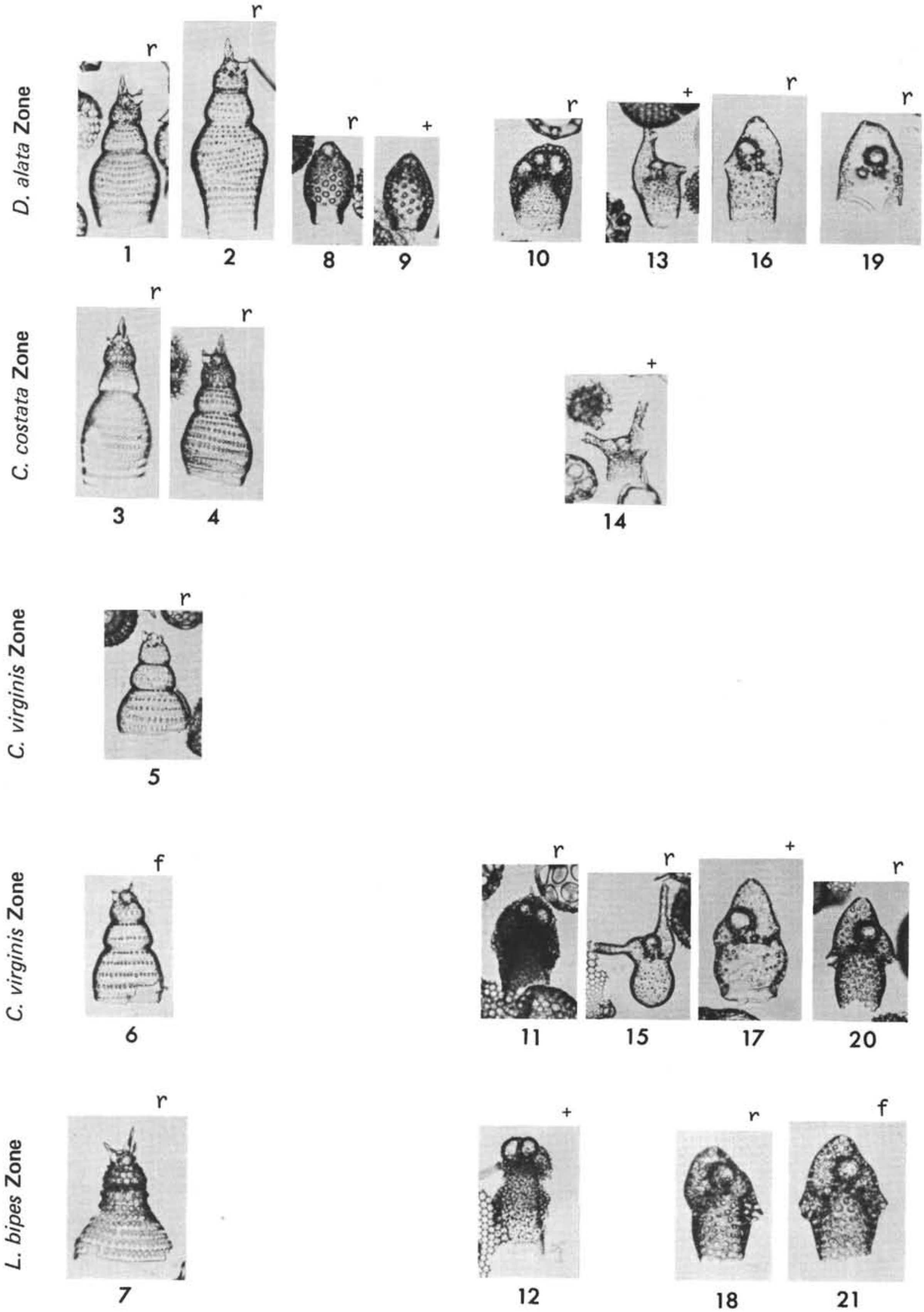
D. alata Zone
C. costata Zone
C. virginis Zone
C. virginis Zone
L. bipes Zone
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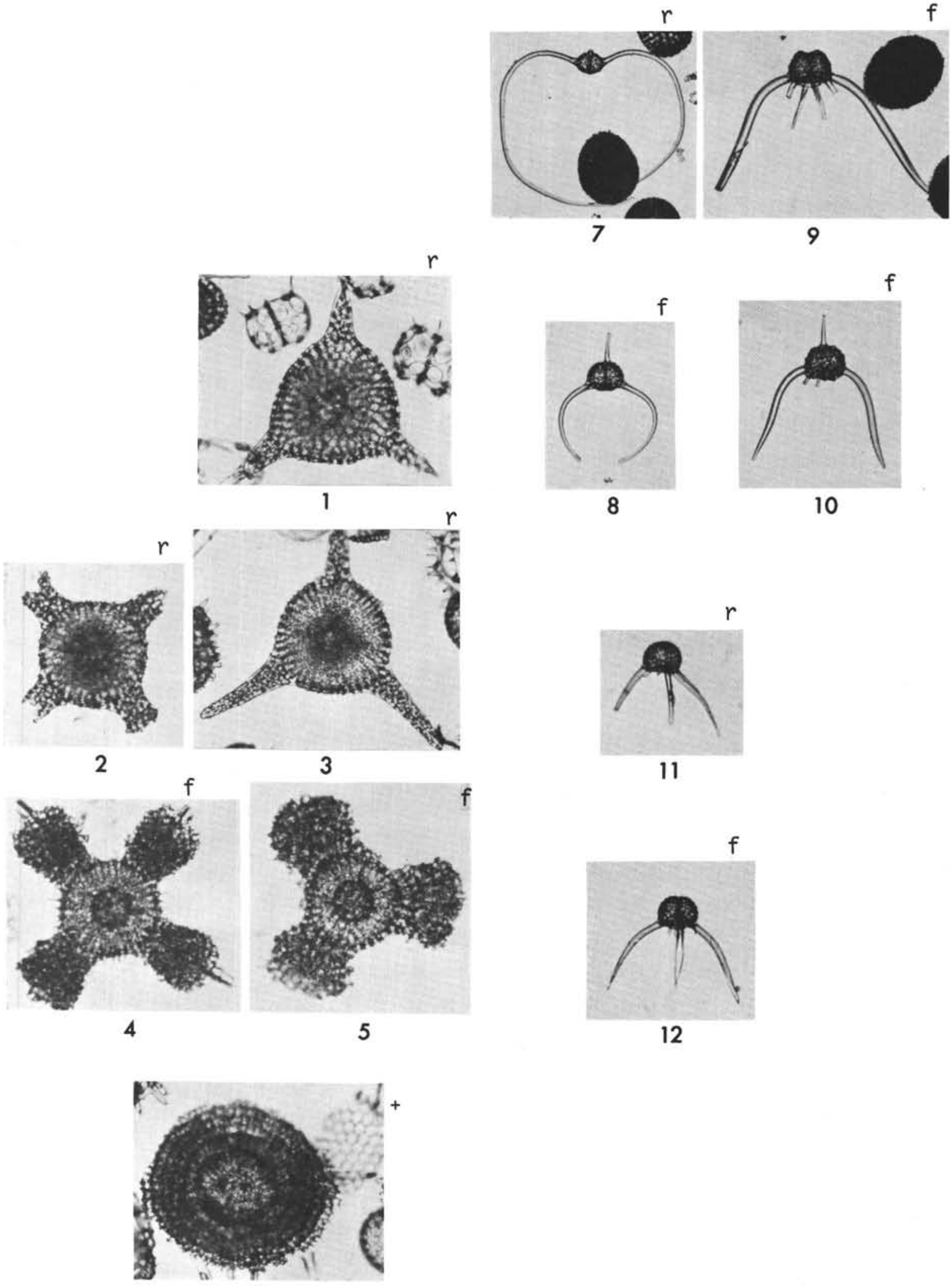
PLATE 3A

Figures 1, 3	*Lithocyclia angustum* (Riedel) 1: Sl. 1, Y41/2 (150X). 3: Sl. 1, Q41/1 (150X).
Figure 2	*Lithocyclia* sp. cf. *L. angustum* (Riedel) Sl. 1, K36/0 (150X).
Figures 4, 5	*Lithocyclia aristotelis* (Ehrenberg) group 4: Cse. 1, Y37/1 (150X). 5: Cse. 1, W26/3 (150X).
Figure 6	*Lithocyclia ocellus* Ehrenberg group Sl. 1, T49/4 (150X).
Figure 7	*Dorcadospyris papilio* (Riedel) Cse. 1, N18/1 (60X).
Figure 8	*Dorcadospyris forcipata* (Haeckel) Cse. 1, N22/0 (60X).
Figures 9, 10	*Dorcadospyris ateuchus* (Ehrenberg) 9: Cse. 1, N18/4 (60X). 10: Cse. 1, F20/1 (60X).
Figures 11, 12	*Tristylospyris triceros* (Ehrenberg) 11: Cse. 1, J24/3 (60X). 12: Cse. 1, U26/4 (60X).

PLATE 3A



D. ateuchus Zone

D. ateuchus Zone

T. tuberosa Zone

T. bromia Zone

P. mitra Zone

PLATE 3B

Figures 1, 2	*Cyclampterium* (?) *pegetrum* Sanfilippo and Riedel 1: 64.1-8-CC, Cse. 1, D27/4 (80X). 2: 64.1-8-CC, Cse. 1, M24/0 (80X).
Figure 3	*Cyclampterium* (?) *milowi* Riedel and Sanfilippo, n. sp. 64.0-10-1, Top, Cse. 1, Y19/0 (80X).
Figure 4	*Calocycloma* (?) *ampulla* (Ehrenberg) Cse. 1, L32/0 (95X).
Figures 5-7	*Artophormis gracilis* Riedel 5: Ph. 1, Y24/1 (150X). 6: Ph. 1, O29/4 (150X). 7: Ph. 1, K34/1 (150X).
Figures 8, 9	*Artophormis barbadensis* (Ehrenberg) 8: Sl. 1, D24/0 (150X). 9: Cse. 1, R35/0 (150X).
Figures 10, 11	*Cycladophora hispida* (Ehrenberg) 10: Sl. 1, X39/4 (95X). 11: Sl. 1, R25/4 (95X).
Figure 12	*Lychnocanium trifolium* Riedel and Sanfilippo, n. sp. Sl. 1, T31/0 (150X).
Figure 13	*Sethochytris babylonis* (Clark and Campbell) group Sl. 1, M42/2 (150X).
Figure 14	*Eusyringium fistuligerum* (Ehrenberg) Sl. 1, V40/2 (95X).

PLATE 3B

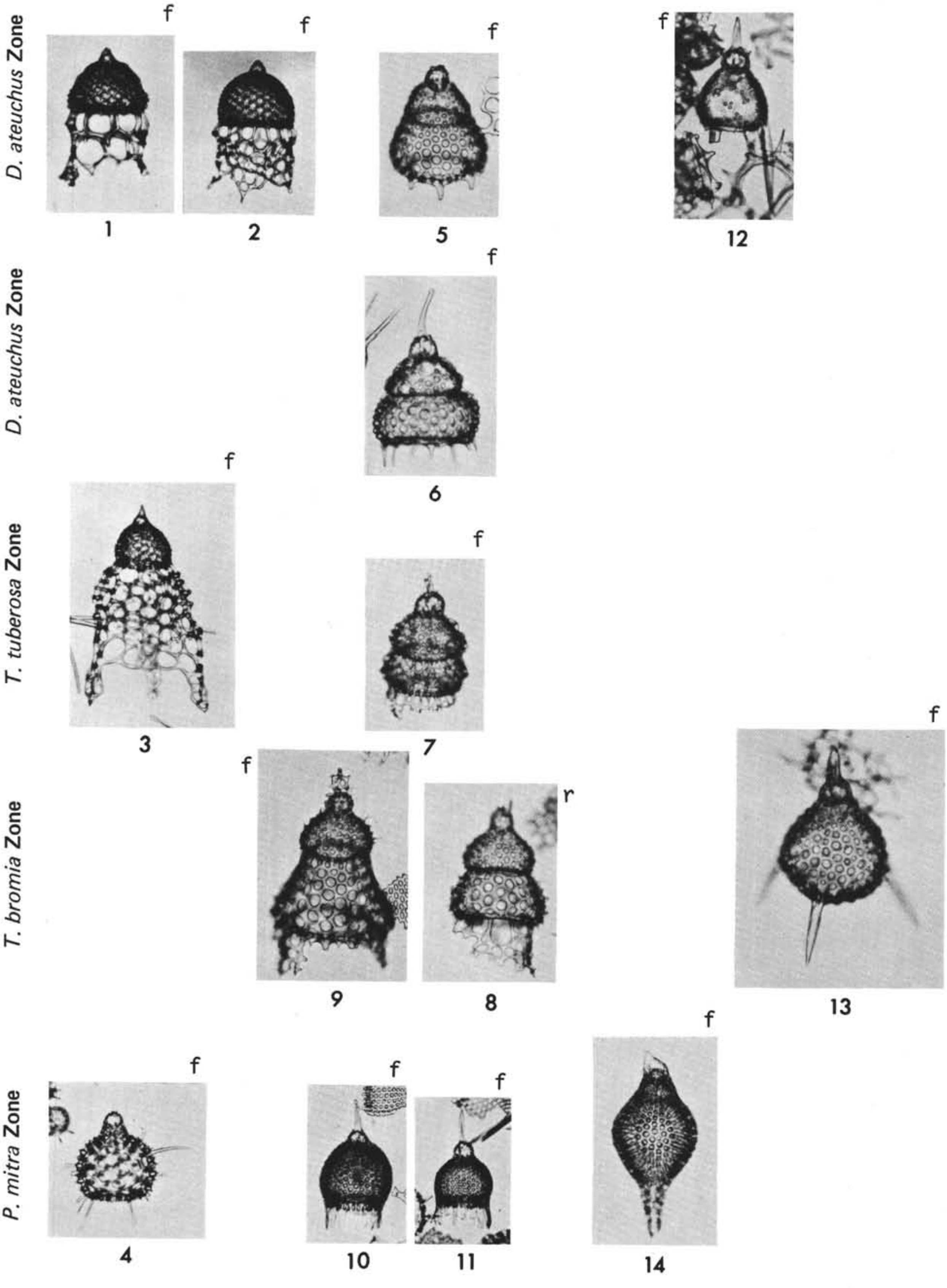

D. ateuchus Zone
D. ateuchus Zone
T. tuberosa Zone
T. bromia Zone
P. mitra Zone
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PLATE 3C

Figures 1, 2	*Lychnocanium* sp. aff. *L. bellum* Clark and Campbell 1: Ph. 1, L46/1 (95X). 2: Ph. 1, T48/0 (95X).
Figure 3	*Theocorys spongoconum* Kling Ph. 1, N41/1 (150X).
Figures 4, 5	*Lophocyrtis* (?) *jacchia* (Ehrenberg) 4: Ph. 1, T10/3 (95X) 5: Ph. 1, O39/2 (95X)
Figure 6	*Thyrsocyrtis rhizodon* Ehrenberg Cse. 1, L32/0 (95X).
Figure 7	*Thyrsocyrtis triacantha* (Ehrenberg) Ph. 1, E52/0 (95X).

PLATE 3C

D. ateuchus Zone

D. ateuchus Zone

T. tuberosa Zone

T. bromia Zone

P. mitra Zone

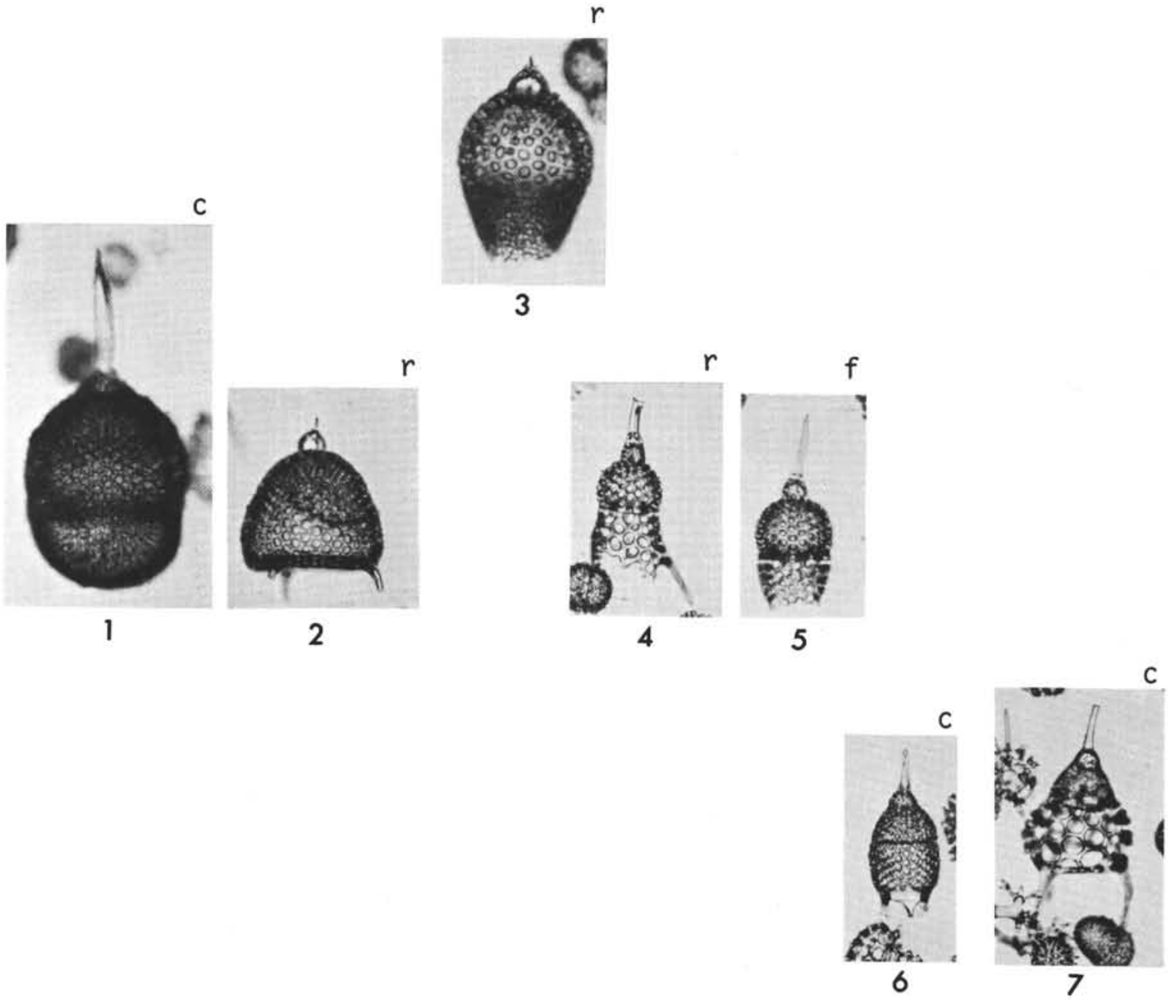
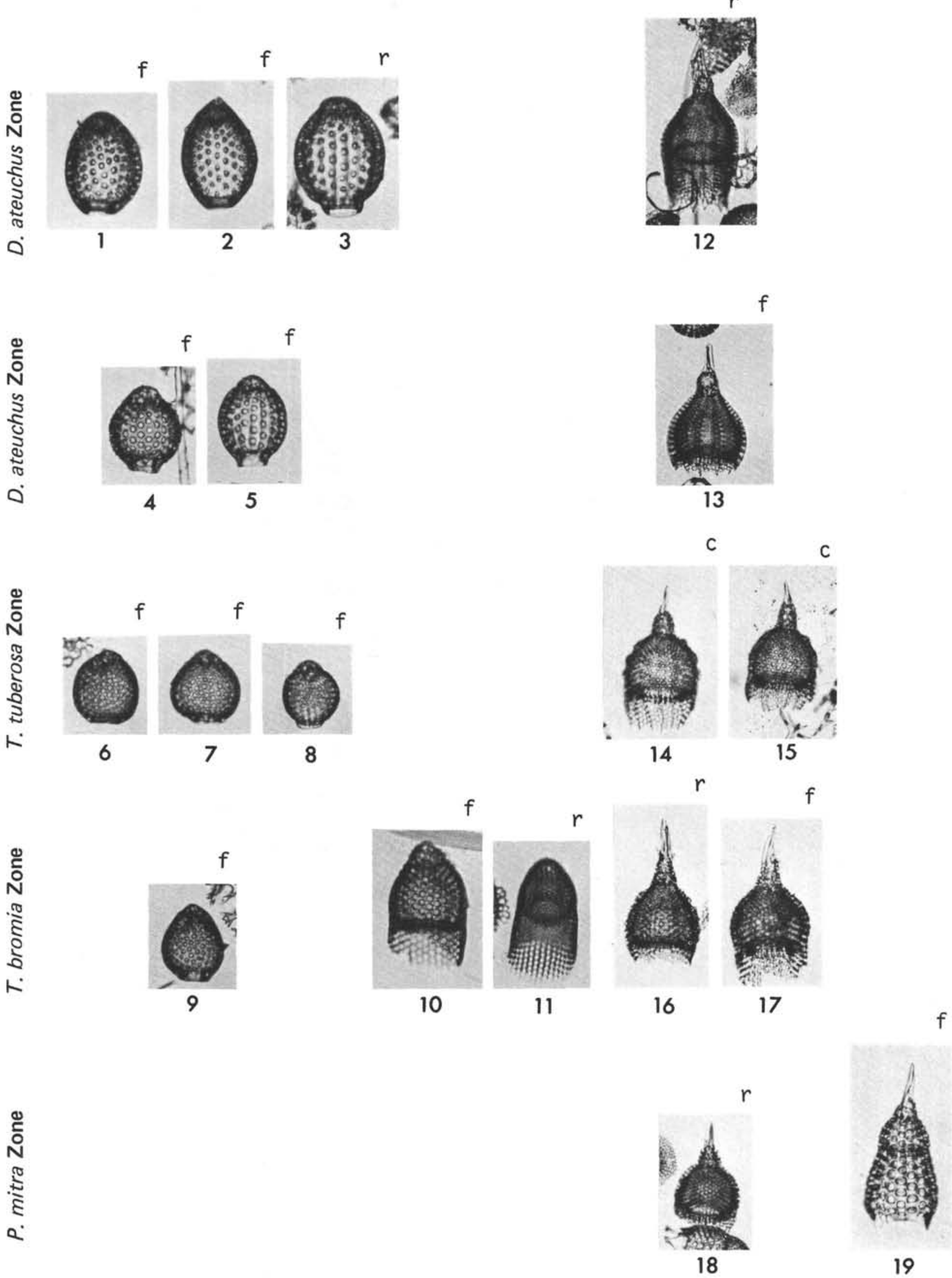


PLATE 3D

Figures 1, 2, 3-5 (?), 6, 7, 8 (?), 9	*Carpocanistrum* spp. 1: Ph. 1, K51/4 (150X). 2: Ph. 1, J44/3 (150X). 3: Ph. 1, Q46/2 (150X). 4: Sl. 1, N50/2 (150X). 5: Sl. 1, J36/4 (150X). 6: Sl. 1, F28/4 (150X). 7: Sl. 1, G30/0 (150X). 8: Sl. 1, O48/2 (150X). 9: Sl. 1, R52/3 (150X).
Figures 10, 11	*Cryptoprora ornata* Ehrenberg 10: Sl. 1, T34/0 (150X). 11: Sl. 1, D16/1 (150X).
Figures 12, 13	*Theocyrtis annosa* (Riedel) 12: Sl. 1, Y42/0 (95X). 13: Sl. 1, M20/2 (95X).
Figures 14, 15	*Theocyrtis tuberosa* Riedel 14: Sl. 1, U43/0 (95X). 15: Ph. 1, C52/4 (95X).
Figures 16-18	*Theocyrtis* sp. aff. *T. tuberosa* Riedel 16: Sl. 1, Q20/0 (95X). 17: Sl. 1, K41/0 (95X). 18: Sl. 1, V19/0 (95X).
Figure 19	*Podocyrtis mitra* Ehrenberg

PLATE 3D


D. ateuchus Zone
D. ateuchus Zone
T. tuberosa Zone
T. bromia Zone
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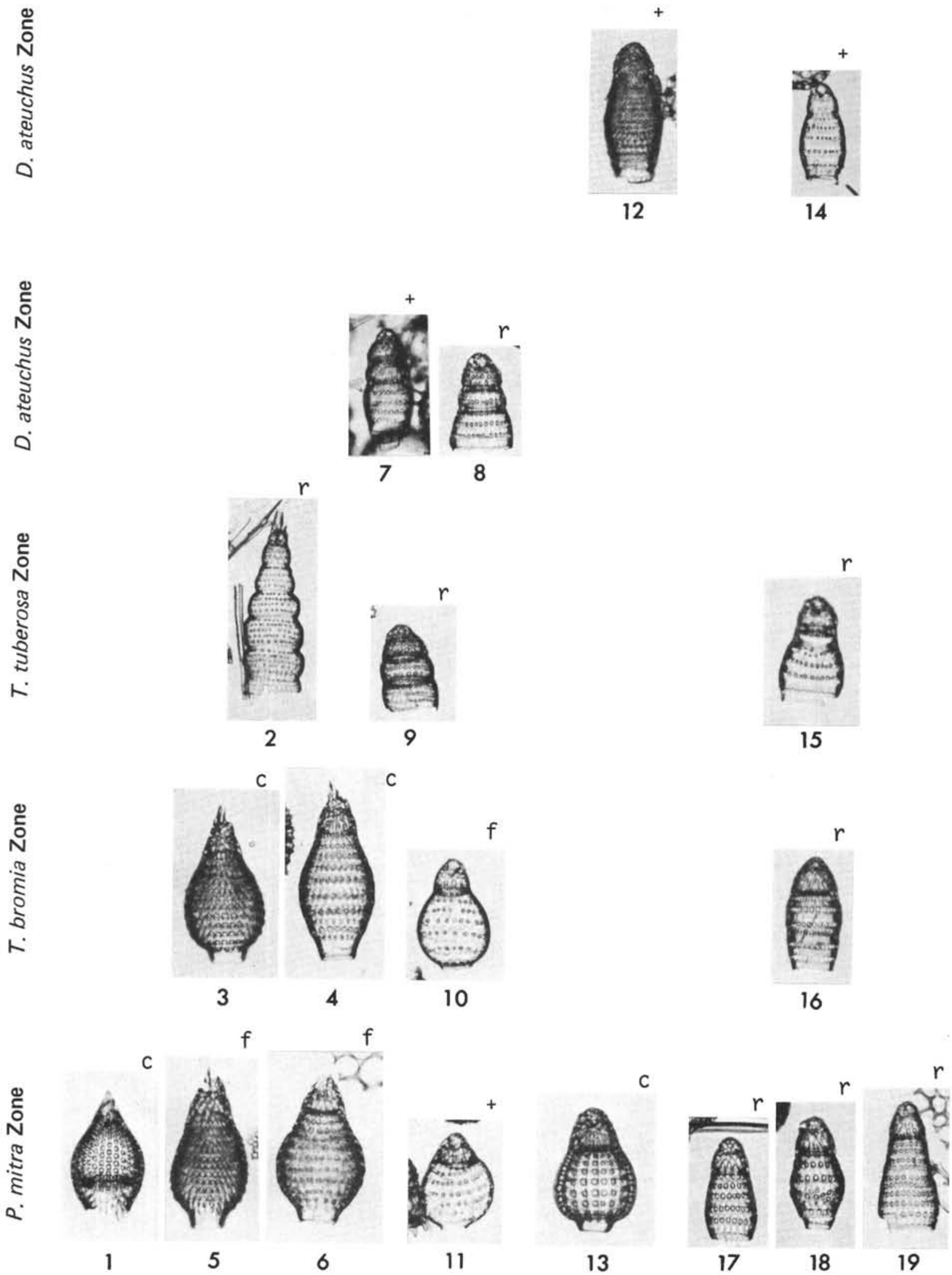
16 r
17 f
18 r
19 f

PLATE 3E

Figure 1	*Podocyrtis papalis* Ehrenberg Sl. 1, X21/1 (95X).
Figure 2	*Spirocyrtis* sp. aff. *S. scalaris* Haeckel Sl. 1, U46/0 (150X).
Figures 3-6	*Theocampe armadillo* (Ehrenberg) group 3: Ph. 1, R44/4 (150X). 4: Sl. 1, B22/3 (150X). 5: Sl. 1, N48/4 (150X). 6: Ph. 1, Q29/1 (150X).
Figures 7-9	*Artostrobium* sp. aff. *A. doliolum* Riedel and Sanfilippo, n. sp. 7: Sl. 2, V18/4 (150X). 8: Sl. 2, B28/0 (150X). 9: Sl. 1, U46/0 (150X).
Figures 10, 11	*Theocampe pirum* (Ehrenberg) 10: Sl. 1, M37/1 (150X). 11: Ph. 1, Y26/4 (150X).
Figure 12	*Artostrobium miralestense* (Campbell and Clark) Ph. 1, J30/1 (150X).
Figure 13	*Theocampe mongolfieri* (Ehrenberg) Ph. 1, Y49/3 (150X).
Figure 14	*Lithomitra lineata* (Ehrenberg) group Sl. 1, G32/3 (150X).
Figures 15-19	*Lithomitra* sp. aff. *L. lineata* (Ehrenberg) group 15: Sl. 1, H18/4 (150X). 16: Sl. 1, R22/0 (150X). 17: Sl. 1, Y29/0 (150X). 18: Sl. 1, W43/0 (150X). 19: Sl. 1, W43/0 (150X).

PLATE 3E


D. ateuchus Zone
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D. ateuchus Zone
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P. mitra Zone
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PLATE 3F

(Magnification 150×)

Figures 1-6	*Phormostichoartus* sp. aff. *P. corona* Haeckel 1: Ph. 1, S35/2. 2: Ph. 1, U41/1. 3: Sl. 1, E18/4. 4: Sl. 1, J41/4. 5: Sl. 1, B47/4. 6: Sl. 1, L36/3.
Figure 7	*Botryocyrtis* sp. Ph. 1, R43/4.
Figure 8	*Acrobotrys* sp. Sl. 1, G27/3.
Figures 9-12	*Botryopyle dictyocephalus* Haeckel group 9: Sl. 1, U31/2. 10: Ph. 1, S38/0. 11: Ph. 1, L32/3. 12: Ph. 1, U35/4.
Figure 13	*Botryopyle* sp. A Ph. 1, C16/2.
Figure 14	*Centrobotrys thermophila* Petrushevskaya Ph. 1, Q17/0.
Figures 15, 16	*Centrobotrys* (?) sp. A 15: Sl. 1, P37/0. 16: Ph. 1, Q35/0.

PLATE 3F

D. ateuchus Zone

D. ateuchus Zone

T. tuberosa Zone

T. bromia Zone

P. mitra Zone

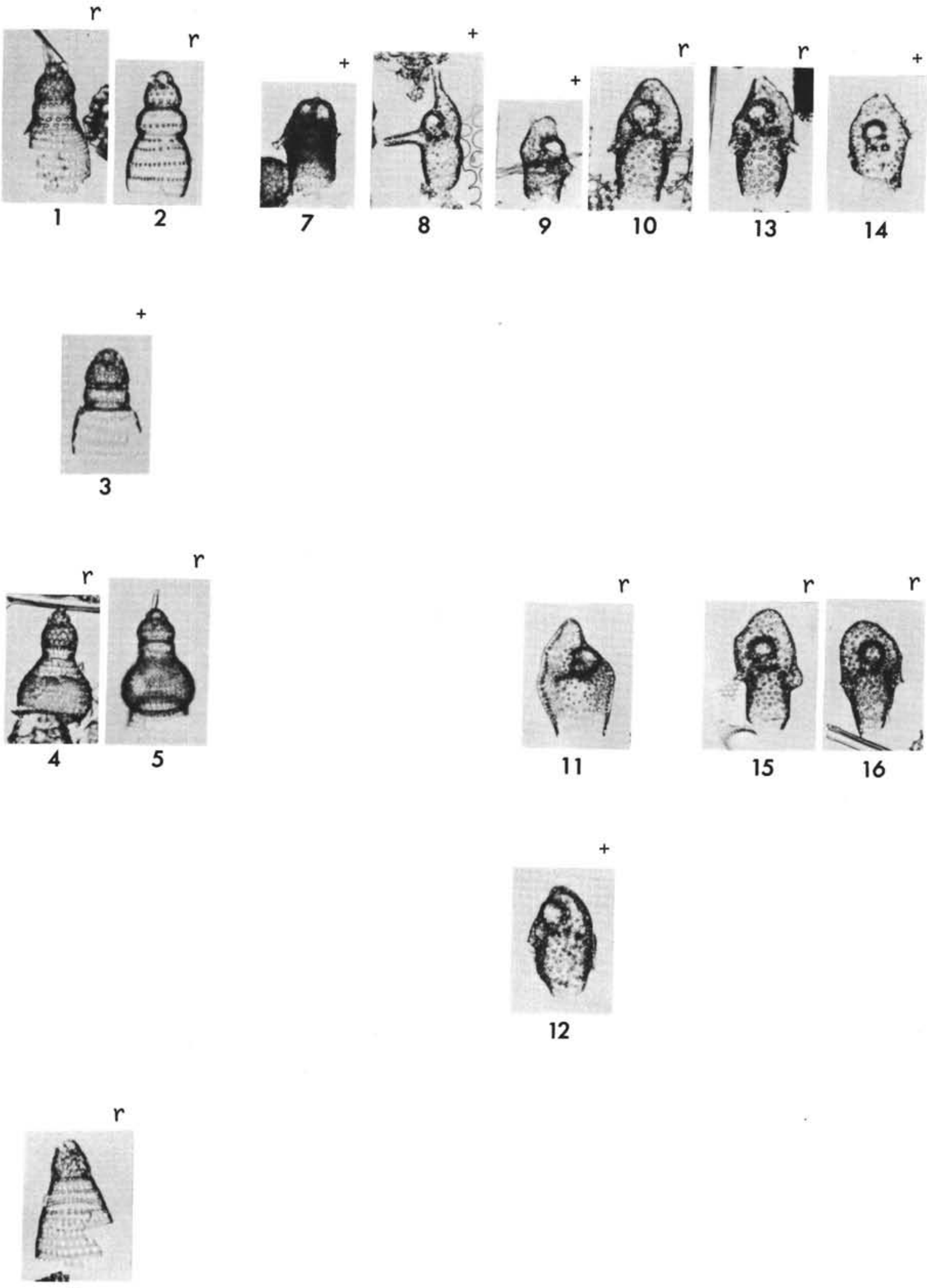


PLATE 4

Figures 1, 2	*Solenosphaera omnitubus* Riedel and Sanfilippo, n. sp. 1: Holotype, 62.1-22-2, 84-86 cm, Sl. 1, V32/0 (255X). 2: 62.1-22-2, 84-86 cm, Sl. 1, C29/2, (255X).
Figure 3	*Dorydruppa* sp. or *Doryprunum* sp. 62.0-5-2, 84-86 cm, Sl. 1, Q19/4 (150X).
Figure 4	*Doryphacus* sp. WRE-100, Sl. 2, V21/0 (150X).
Figure 5	*Cannartus prismaticus* (Haeckel) 64.0-9-CC, Ph. 1, V12/0 (165X).
Figure 6	*Ommartartus avitus* (Riedel) 66.1-3-1, 55-57 cm, Ph. 1, Y20/0 (165X).
Figures 7, 8	*Spongaster klingi* Riedel and Sanfilippo, n. sp. 7: Holotype, 66.1-3-5, 25-27 cm, Sl. 1, M15/2 (95X). 8: Specimen with distinct pylome-tube, 66.1-5-3, 30-32 cm, Cse. 1, F52/3 (150X).
Figures 9-11	*Dictyocoryne ontongensis* Riedel and Sanfilippo, n. sp. 9: Holotype, 66.1-5-3, 30-32 cm, Cse. 1, Q31/4 (150X). 10: Specimen with short and wide bifurcations, 66.1-6-4, 25-27 cm, Cse. 1, E39/0 (150X). 11: Specimen with double bifurcations, 66.1-5-1, 25-27 cm, Cse. 1, N21/0 (150X).

PLATE 4

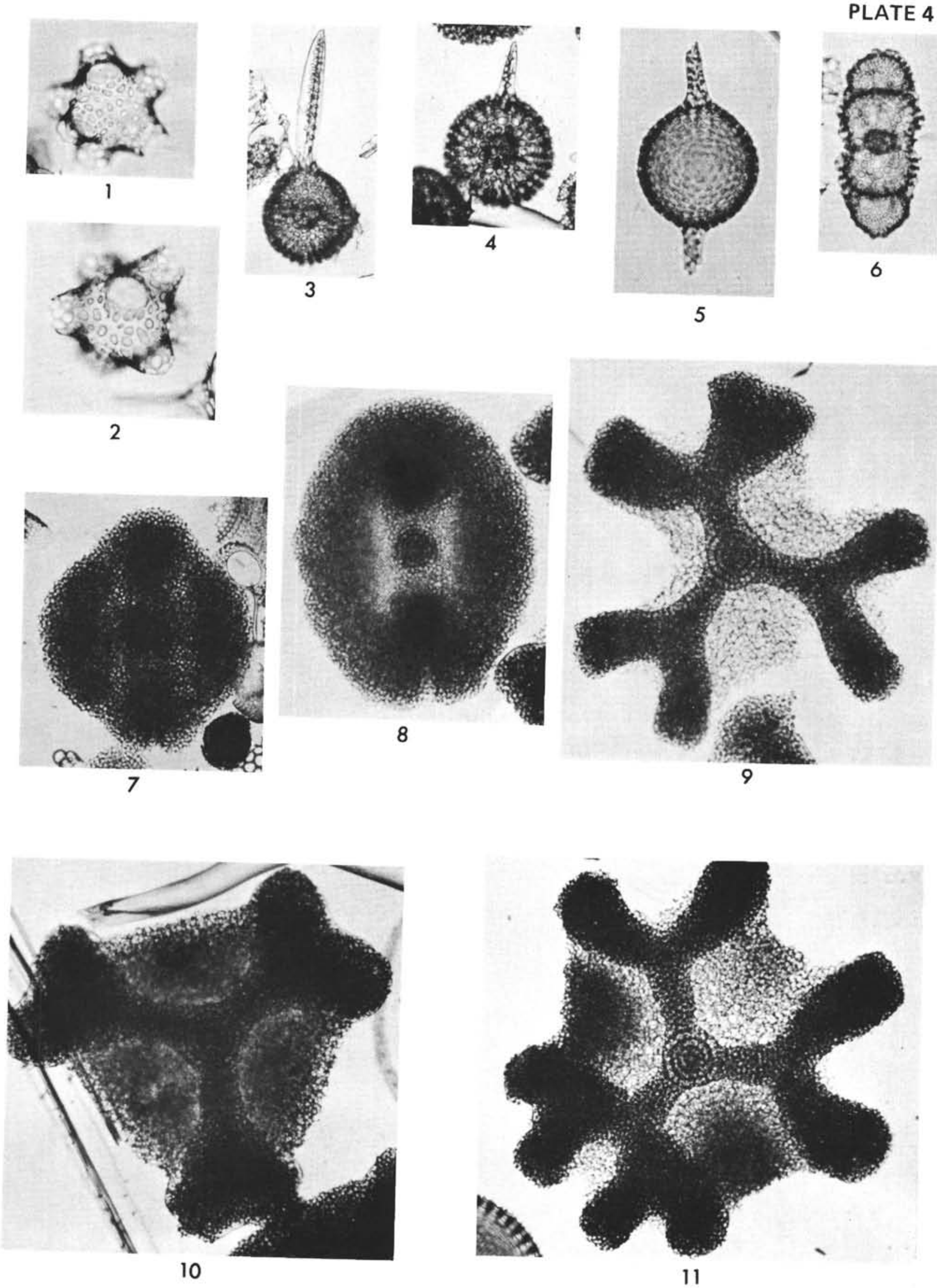


PLATE 5

Figure 1	Spongodiscid, gen. et sp. indet., similar to *Spongaster* but evidently not related. 66.1-8-3, 25-27 cm, Ph. 1, G25/0 (150X).
Figure 2	*Dorcadospyris simplex* (Riedel) WRE-96, Sl. 2, H58/2 (150X).
Figure 3	*Dorcadospyris* sp. aff. *D. dentata* Haeckel La Mirada, Mallorca, No. 2, Y14/4 (165X).
Figure 4	*Liriospyris parkerae* Riedel and Sanfilippo, n. sp. 66.1-8-3, 25-27 cm, Ph. 1, Z28/2 (255X).
Figures 5-7	*Dendrospyris anthocyrtoides* (Bütschli) 5: 66.0-3-4, 25-27 cm, Cse. 2, H29/3 (150X). 6: 66.0-3-CC, S1.1, T39/0 (150X). 7: 66.0-3-5, 125-127 cm, Cse. 2, S12/0 (150X).
Figures 8-10	*Psychospyris parva* Riedel and Sanfilippo, n. sp. 8: 66.0-3-5, 125-127 cm, Cse. 2, D32/4 (150X). 9: Holotype, 66.0-3-5, 25-27 cm, Cse. 1, T23/0 (150X). 10: 66.0-3-5, 125-127 cm, Cse. 1, U12/4 (150X).
Figure 11	*Psychospyris intermedia* Riedel and Sanfilippo, n. sp. Holotype, 66.0-3-3, 25-27 cm, Cse. 1, E41/0 (150X).

PLATE 5

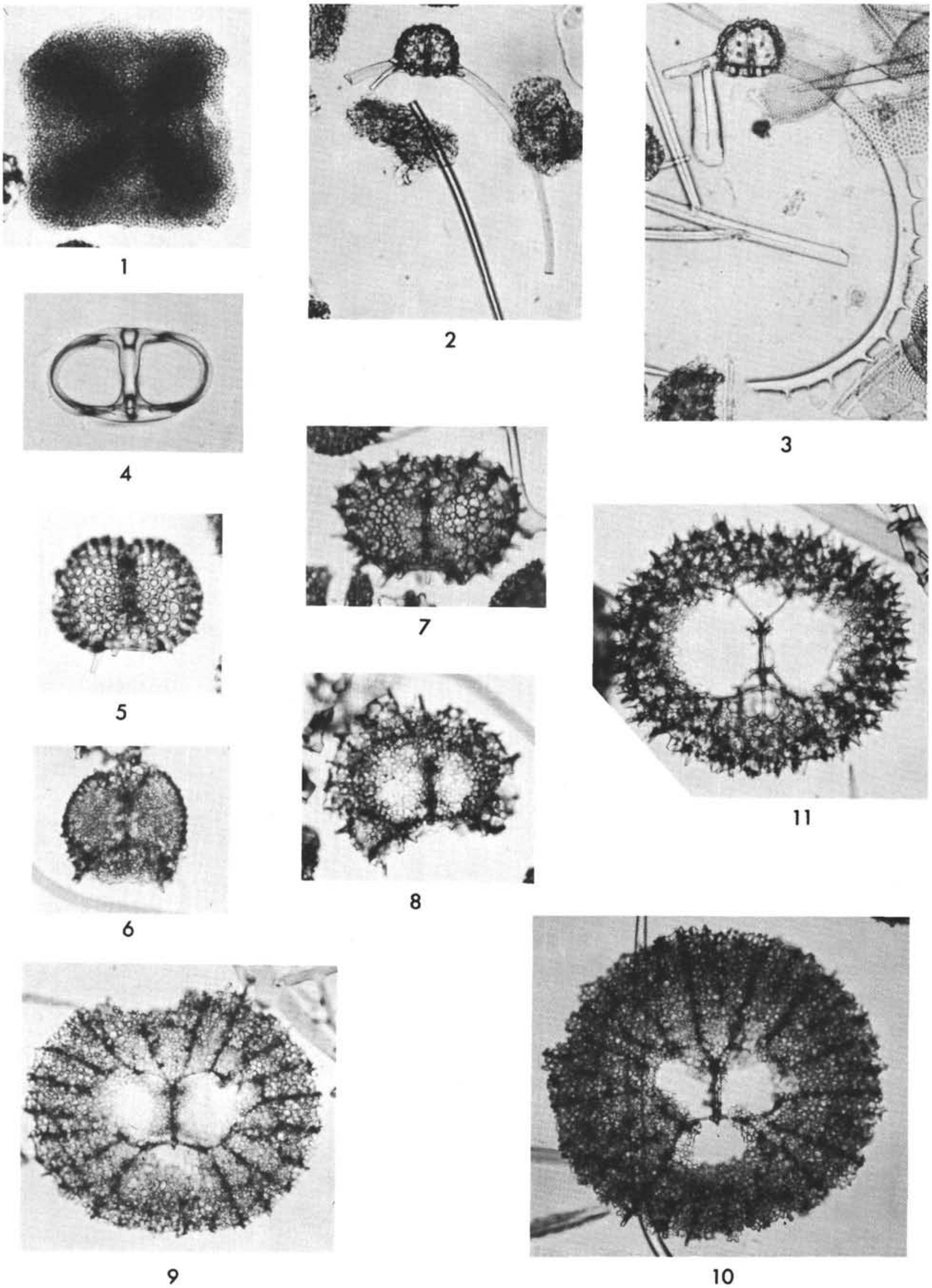
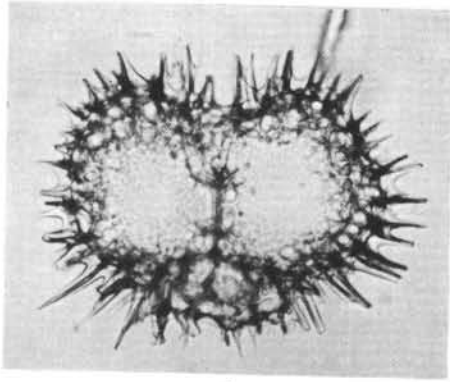


PLATE 6

Figures 1, 2	*Psychospyris intermedia* Riedel and Sanfilippo, n. sp. 1: 66.0-3-1, 125-127 cm, Cse. 1, E40/0 (150X). 2: 66.0-2-CC, Cse. 1, W44/4 (150X).
Figures 3-5	*Psychospyris grandis* Riedel and Sanfilippo, n. sp. 3: 66.0-2-CC, Cse. 1, Q50/4 (150X). 4: 66.0-2-3, 25-27 cm, Cse. 2, U47/4 (150X). 5: Holotype, 66.1-8-CC, Cse. 2, U32/0 (150X).
Figure 6	*Artophormis dominasinensis* (Ehrenberg) 65.0-16-CC, Sl. 1, U33/0 (165X).
Figure 7	*Artophormis gracilis* Riedel Ca'Lombasini, near Salsomaggiore, Italy, WRE-107, Sl. 2, S23/2 (165X).
Figure 8	*Bekoma* sp. Belus, France, C2.712, L30/3 (165X).

PLATE 6



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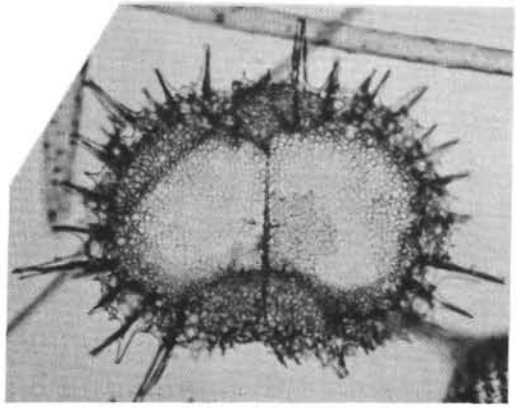

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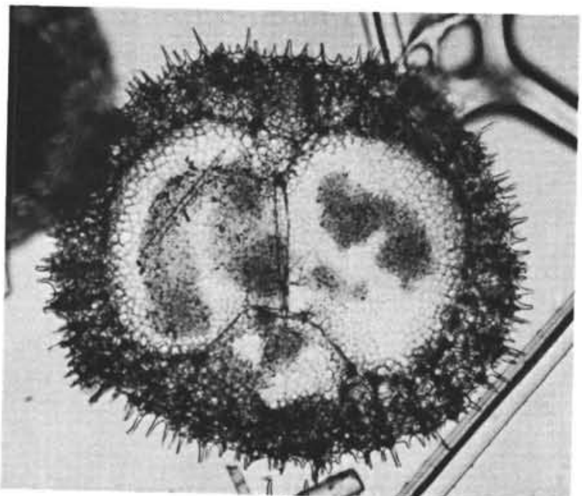

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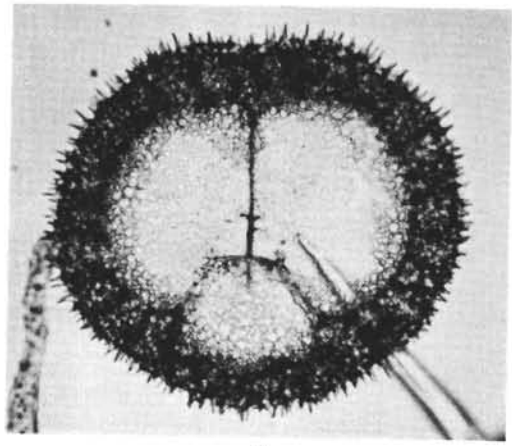

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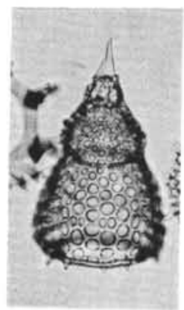

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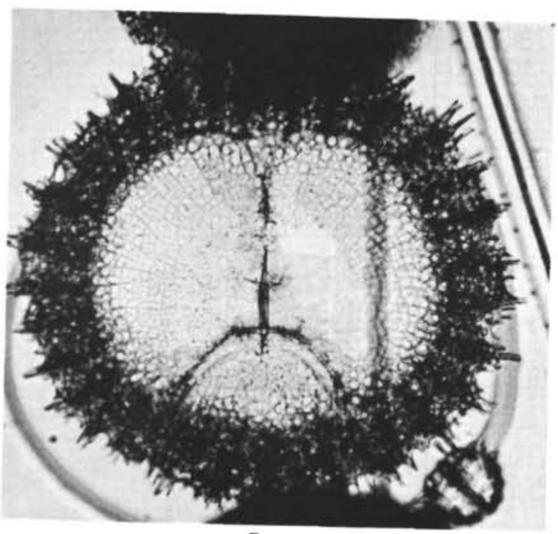

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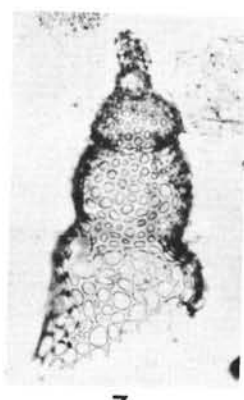

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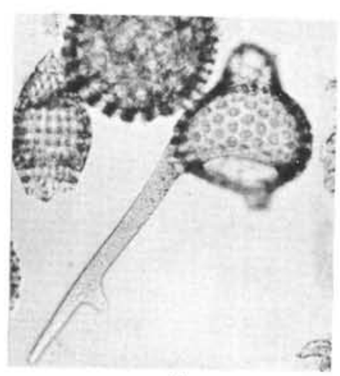


8

PLATE 7

Figures 1-4	*Bekoma bidarfensis* Riedel and Sanfilippo, n. sp. Ibbaritz-Bidarf, France, 1: Holotype, Cl. 457½, L22/2 (165X). 2: Cl. 456½, M27/1 (165X). 3: side view of two feet joined by bar distally, Cl. 456½, Q21/4 (165X). 4: plan view of bar joining two feet distally, Cl. 455½, P22/3 (165X).
Figures 5-7	*Bekoma bidarfensis* Riedel and Sanfilippo, n. sp. 67.1-2-CC, 5: Ph. 2, X34/3 (165X). 6: Ph. 2, Z24/2 (165X). 7: Sl. 2, V14/3 (165X).
Figures 8, 9	*Cyclampterium (?) milowi* Riedel and Sanfilippo, n. sp. 8: Holotype, 65.0-14-1, 25-27 cm, Cse. 1, S35/1 (95X). 9: same sample, Cse. 1, D20/2 (95X).
Figures 10, 11	*Eucyrtidium cubense* Riedel and Sanfilippo, n. sp. 67.1-2-CC, 10: Holotype, Sl. 2, G11/4 (165X). 11: Ph. 2, J13/4 (165X).
Figure 12	*Lithocampium* sp. A 67.1-2-CC, Sl. B, D36/1 (165X).
Figure 13	*Lithochytris archaea* Riedel and Sanfilippo 67.1-2-CC, Sl. 1, O24/3 (165X).
Figure 14	*Lithopera renzae* Sanfilippo and Riedel La Mirada, Mallorca, No. 3, W28/0 (255X).
Figure 15	*Lithopera* sp. aff. *L. renzae* La Mirada, Mallorca, No. 3, S23/3 (255X).
Figure 16	*Lophocyrtis* (?) *jacchia* (Ehrenberg) 64.1-9-1, 30-32 cm, Sl. 1, T10/3 (150X).

PLATE 7

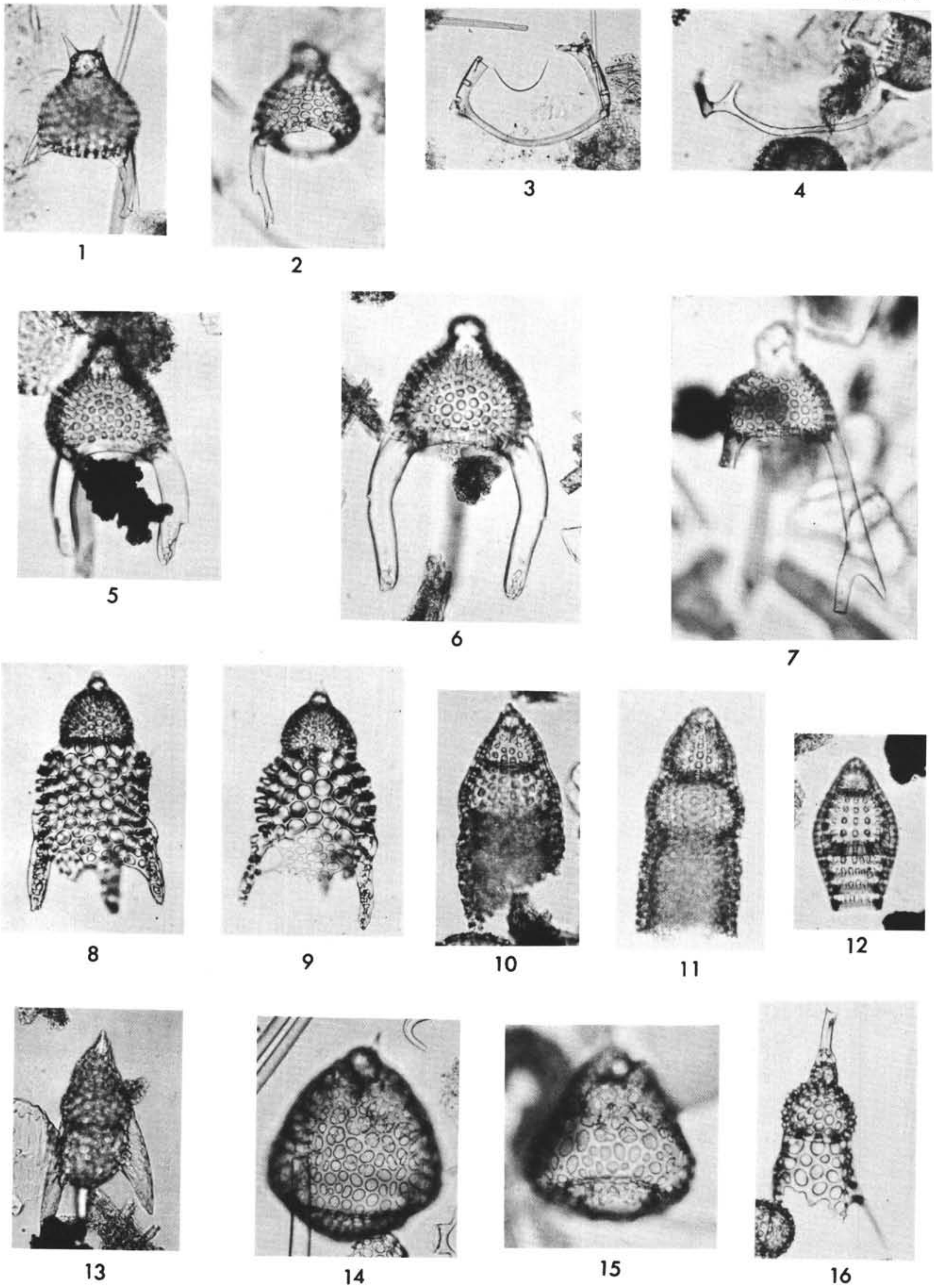
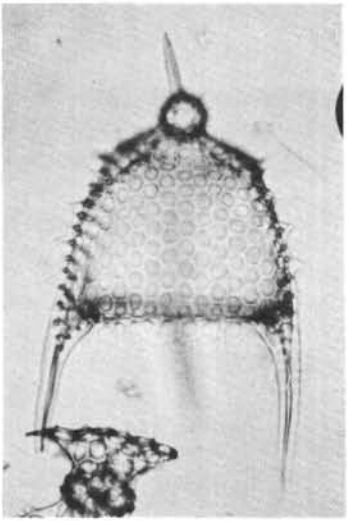


PLATE 8

Figure 1	*Pterocanium prismatium* Riedel 66.1-2-3, 25-27 cm, Ph. 1 (255×).
Figures 2, 3	*Lychnocanium trifolium* Riedel and Sanfilippo, n. sp. 2: Holotype, 64.0-8-CC, Sl. 1, V42/2 (150×). 3: same slide, V35/2 (150×).
Figure 4	*Phormocyrtis striata* Brandt Specimen with abdomen triangular in section, 67.1-2-CC, Sl. 1, B42/4 (165×).
Figure 5	*Stichocorys peregrina* (Riedel) Tabianian 6509, S12/0 (255×).
Figure 6	*Thyrsocyrtis bromia* Ehrenberg 65.0-16-CC, Sl. 1, S42/1 (165×).
Figure 7	*Carpocanopsis bramlettei* Riedel and Sanfilippo, n. sp. Holotype, 63.1-14-1, 10-12 cm, N25/0 (255×).
Figure 8	*Carpocanopsis cingulatum* Riedel and Sanfilippo, n. sp. Holotype, 63.1-14-1, 10-12 cm, Sl. 1, P36/0 (255×).
Figures 9-11	*Carpocanopsis favosum* (Haeckel) 9: 66.0-3-1, 25-27 cm, Sl. 1, H17/0 (255×). 10: Specimen with thick wall obscuring external lumbar stricture, 64.1-4-3, 84-86 cm, Sl. 1, J37/3 (255×). 11: Specimen with unusually long peristome (abdomen), 62.0-4-CC, Sl. 1, V40/0 (255×).
Figure 12	*Calocycletta* sp. cf. *C. virginis* Haeckel 63.0-4-CC, Sl. 1, H18/4 (165×).
Figure 13	*Podocyrtis goetheana* (Haeckel) 65.1-5-CC, Cse. 1, Q43/4, (150×).
Figures 14, 15	*Artostrobium doliolum* Riedel and Sanfilippo, n. sp. 14: Holotype, 66.1-4-3, 25-27 cm, Ph. 1, N21/4, (255×). 15: same sample, Sl. 1, Q46/0 (255×).

PLATE 8



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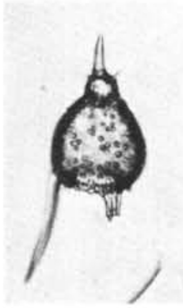

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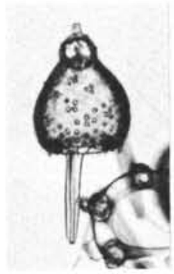

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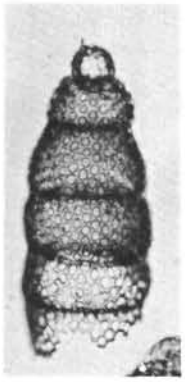

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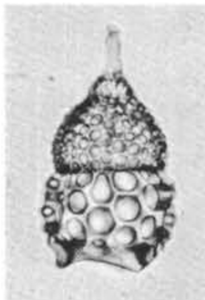

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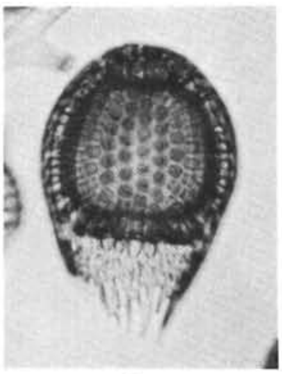

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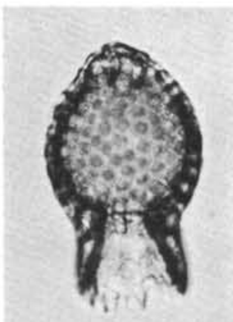

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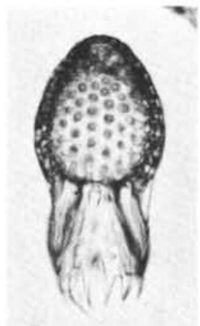

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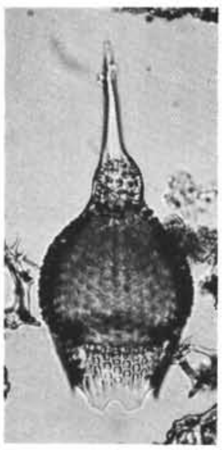

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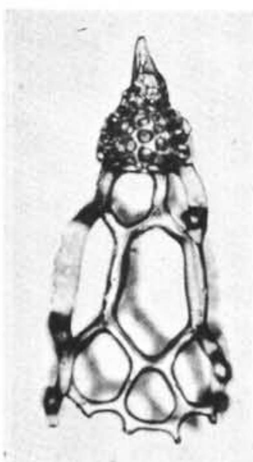

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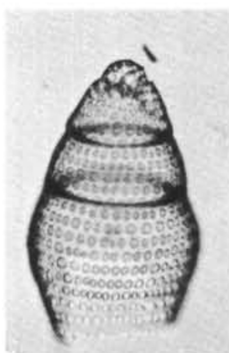

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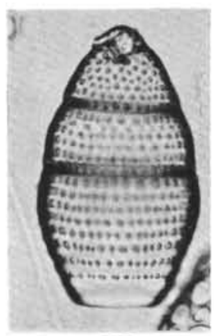

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12. INDEX OF RADIOLARIAN NAMES

Only genus-group and species-group taxa are indexed. In order to facilitate use of the index for taxa for which there are many entries, the principal reference and illustrations are printed in **bold face**, and this is preceded by entries referring to brief mentions in discussion, and followed by entries referring to occurrences and stratigraphic range.