24. LATE CRETACEOUS TO PLEISTOCENE ARCHAEOMONADS, EBRIDIANS, ENDOSKELETAL DINOFLAGELLATES, AND OTHER SILICEOUS MICROFOSSILS FROM THE SUBANTARCTIC SOUTHWEST PACIFIC, DSDP, LEG 29

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ABSTRACT

Late Cretaceous, late Eocene, and Neogene archaeomonads, ebridians, endoskeletal dinoflagellates, and some siliceous microfossils of uncertain affinity found in the siliceous sequences penetrated on DSDP Leg 29 are described and illustrated. As much as possible, their stratigraphic distribution on Leg 29 is indicated, discussed, and compared with other reports. Some new archaeomonads and two new ebridians are described.

INTRODUCTION

Recently (Dumitrica, 1973), presented a thorough investigation of the Cenozoic endoskeletal dinoflagellates from the southwestern Pacific sediments cored during DSDP Leg 21. On DSDP Leg 29, in an area immediately to the south of Leg 21 (Figure 1), cored sediments range in age from Late Cretaceous to Pleistocene and contain siliceous spicules of endoskeletal dinoflagellates. The same sediments usually contain common to abundant diatoms, and often radiolarians (Petrushevskaya, this volume), as well as archaeomonads and ebridians. The latter were discussed by Ling (1973), from DSDP Leg 19 in the North Pacific.

Dumitrica (1973) described and discussed the few genera and species of Actiniscidae and has given their stratigraphic distribution from the middle Oligocene to the middle Pleistocene. In this report, the siliceous spicules of the endoskeletal dinoflagellates of Late Cretaceous and late Eocene to Pleistocene age are illustrated on Plate 10, and their stratigraphic distribution is shown in Tables 1 to 3. On the same tables the distribution of the archaeomonads and ebridians illustrated on Plates 1 to 9 and 12 is also shown. In the following discussion each group is considered separately.

Methods of Study

The samples studied for this report were either smear slides prepared for coccolith investigations, or slides prepared from samples treated with diluted HCl, and then washed several times by centrifuging. In this manner, the very small forms could be observed. For some samples an extra slide was prepared from material washed through a 53μ sieve to permit an easier survey of the larger forms. Canada balsam was used as a mounting medium.

ARCHAEOMONADS

The Archaeomonadaceae are a family of fossil marine chrysomonadins and probably have led a planktonic life in the photic zone of the oceans. During their life cycle the single cells formed cysts consisting of SiO_2 which may be considered as resting stages. The cysts have an opening of different size and form, which served as an escape tunnel for the protoplasmatic cell content. This was after the resting stage in the protective SiO_2 sphere was over (Stradner, 1971).

Archaeomonads are known from the Late Cretaceous to the Miocene. So far no archaeomonads have been described from the Oligocene and the Pliocene (Tynan, 1971). It is therefore of special interest to note their occurrence in the Oligocene at Sites 278 and 280 and in the (?)Pliocene at Site 278.

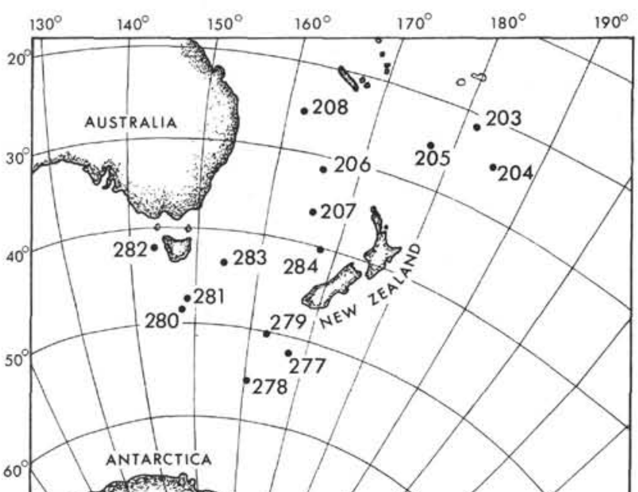

Figure 1. *DSDP Leg 29 site localities and some Leg 21 site localities.*

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TABLE 1
Distribution of Siliceous Endoskeletal Dinoflagellates and Archaeomonads at Site 275: R = rare, F = few

Age	Sample (Interval in cm) \ Taxa	*Carduifolia* cf. *C. onoporoides*	*Archaeomonas glabra* (Plate 1, Fig. 31)	*A. semplica* (32)	*A. kreyenhagensis* (33)	*A. mirabilis* (34)	*A. mangini* (36)	*Litheusphaerella cretacea* (39)	*L. spectabilis* (40)	*Archaeomonas rampii* (42)	*A. cretacea* (46)	*Pararchaeomonas* sp. (47)	*A* cf. *A. heteroptera* (48)	*A. ambigua* (50)	*A. transversa* (52)	*A* cf. *A. membranosae* (54)	*Pararchaeomonas* cf. *colligera* (56)	*Archaeomonas* cf. *A. scabratula* (57)	*A. paucispinosa* (58)	*Litheusphaerella frenguellii* (59)
Late Cretaceous	1-1, 130	R	R		R	R	R	R	R	R			R		R					
	1-3, 50				R		F	F	R		I		F	F		I	R			
	1-4, 50	R		R	R		F	R			R			R		R		R		
	1, CC	R			R		F	F			R		R	F		F				
	2-2, 50		R		R		R		R	R	R		R	R		R				I
	2-4, 50	R		R			R			R	R	R		R				R	I	
	2, CC										R									
	4-2, 50																			

TABLE 2
Distribution of Some Siliceous Microfossils at Site 277

Age	Sample (Interval in cm) \ Taxa	*Actiniscus pentaradiatus*	*A. elongatus*	*Carduifolia gracilis*	*C. lata*	*Ammodochium rectangulare*	*A. ampulla*	*A. speciosum*	*Ebriopsis crenulata*	*Parebriopsis fallax*	*Craniopsis octo*	*E. cornuta*	*Pseudammodochium sphericum*	*Pseudorocella corona*	*Archaeomonas cratera*
Oligocene	5-4, 110					R			R				R		
	6-4, 110	R				R							R	R	
	7-4, 110	R				R							R		
	8-4, 110	R				F							F		
	9-4, 110	R				F							F		
	10-4, 110		R			R							F		
	11-4, 110					R			R				F		
	12-4, 110					R			R						
	13-4, 110					R			R						
	14-4, 110														
	15-4, 110														
	16-4, 110														
	17-4, 110	R				R			R	?					
	18-2, 110		R	?		R			R				R		
	19-2, 110		R			R	R		R				R		
	20-4, 144		R	?		F			R		?		R		
Eocene Late	21-2, 110	R	R			F		R	R	F		R	R		
	22-2, 110					F	R		F	R	R		R		R
	23-2, 110	R			R	F	R		F	R	R		R		
	24-2, 110					F			R	R	R		R		

TABLE 3
Distribution of Some Siliceous Microfossils at Sites 278, 280, 281, and 283

Age	Sample (Interval in cm)	*Actiniscus pentasterias*	*A. tetrasterias*	*A. elongatus*	*Foliactiniscus* cf. *F. mirabilis*	*Carduifolia gracilis*	*Ammodochium rectangulare*	*A. ampulla*	*Ebriopsis crenulata*	*Hermesinum geminum*	*Micromaisupium anceps*	*Parebriopsis fallax*	*Ammodochium* ?sp.	*Craniopsis octo*	*Hermesinella transversa*	*Ebriopsis* cf. *E. aplanata*	*Archaeomonas* cf. *A. chenevieri*	*A. japonica*	*A. striata*	*A. inconspicua*	*A.* cf. *chenevieri*	*A. vermiculosa*	*A.* cf. *A. circuligera*	*A. ornata*	*Archaeomonadopsis* cf. *A. elegante*	*Archaeomonas* cf. *A. nebulosa*	*A. sphaeroidea*	*A. cratera*	*A. edwardsii*	*A. heteroptera*	*A. americana*	*A. cylindropora*	*A. reticulosa*	*A.* cf. *A. japonica*	*A. dubia*	*Archaeosphaeridium australensis*	*A. dumitricae*	*A. tasmaniae*	*Rocella gemma*
																	Plate 1, Figures: 1	3	4	6	7	9	13	15	19	21	22	23	24	25	26	27	28	29	30	Plate 2, Figures: 5	16	23	
	Site 278																																						
Pleistocene	1-3, 118	R																																					
	2, CC																																						
	3, CC	R																																					
	4, CC																																						
	5, CC																																						
	6, CC	R																																					
Plioc. L	7, CC	R																																					
	8, CC																R																						
Plioc. E	9-3, 110	F	R	R													R	R																					
Miocene Late	10-5, 110	R																R	R																				
	11-1, 110	F		R														R																					R
	12, CC	R		R																																			
	13, CC	R		R														R																					
	14, CC	F		R																R																			R
	15, CC	R		R														F																					
Miocene Middle	16, CC	R		R														R		R	R																		
	17, CC	R																F		R	R	R																	
	18, CC	R																F		R	R																		
	19, CC																																						
	20-6, 110			R														F		R	R																		R
	21-6, 110	R				R												R			?	R																	
	22-3, 110			R													?	F		R	?																		
	23-3, 110																																						
	24, CC					R												R																					
Miocene Early	25, CC																																						R
	26, CC																	R		R																			R
	27, CC	R																R																					R
	28, CC																	R																					
	29, CC																																						R
	30, CC	R																R																				+	R
Oligocene Late	31, CC	R			R					R														R															C[a]
	32-1, 99					R							F					R																					
Oligocene	**Hole 280A**																																						
	1-2, 120					R	F		R	R	R	R													R													F	?
	2-3, 110						F		R	R																												R	
	3-3, 110					R	R			R	R																									R		R	
	4-3, 110						R				F		R			R																R				R		R	
	5-2, 110					R	F			R	R	R																										R	
	6-2, 110						R			R	R																											R	
Eocene	7-3, 110					R	F			R	R																											R	
	Site 281																																						
	14, CC					R	R	R	R			R			R													R		R						R	R	?	
	15, CC					R	R		R		R	R											R													R	F		
	16, CC					R	F	R	R		R	R															R	R								R	F		
	Site 283																																						
Eocene Late	5-1						F		F		R		R	R												R			R				R	R		F	R		
	5-2, 117						R	R	R		F			R																						R	R		
	6-2, 117					R	R		R		F	F		R																R					R	R	R		
		Dinoflagellate					Ebridians										Archaeomonads																						

Note: C=common; F=few; R=rare

[a]In 31-2

Late Cretaceous

The siliceous Upper Cretaceous sequence penetrated at Site 275 yielded few to common archaeomonads. The most well known and common, *Micrampulla parvula* Hanna, has been described as a diatom, but was later considered to be an archaeomonad. It apparently can be shown to be a diatom (Hajós, this volume). The archaeomonads found at Site 275 belong mainly to the genus *Archaeomonas;* however, few forms of *Litheusphaerella* and *Pararchaeomonas* were also found. The assemblage includes species described from other Late Cretaceous localities, as well as new species and forms otherwise known from the Paleocene to early Eocene. Of the Cretaceous species described from Moreno, California (Rampi, 1940), many were also found at Site 275.

Late Eocene

Siliceous upper Eocene sediments were recovered at Sites 277, 280, 281, and 283. With the exception of Site 277, they all yielded quite rich assemblages of archaeomonads, including well known and new species. Many species are well known from the upper Eocene diatomite of Oamaru, New Zealand, or other Eocene and Miocene deposits. The archaeomonads are usually rare.

Archaeosphaeridium australensis is consistently present in the late Eocene at Sites 281 and 283, and in Oligocene samples from Site 280. The diversity of archaeomonads in the upper Eocene samples studied here is considerably lower than the one reported from the diatomite of the same age from Oamaru, New Zealand. This may be due to the very limited time available for this present study as compared to the studies carried out on the Oamaru material.

Oligocene

Siliceous Oligocene sequences were cored at Sites 277, 278, and 280. However, archaeomonads were only found at Sites 278 and 280, where they are rare to few. Two new species, *Archaeosphaeridium tasmaniae* and *A. australensis,* were found in the Oligocene and late Eocene at Site 280, as well as in the late Eocene at Sites 281 and 283. Other species are rare and occur only sporadically. This is the first report on the occurrence of Oligocene archaeomonads.

Miocene and Pliocene

Archaeomonads are rare and show low diversity in the lower and upper Miocene and (?)Pliocene sediments cored at Site 278. They are more common and diverse in the middle Miocene. This is in agreement with the observation, that most Miocene archaeomonads described are from the middle Miocene. The species represented are all well known from other Miocene and/or older localities.

Pleistocene

No archaeomonads were found in the Pleistocene siliceous samples from Sites 278 and 281. This agrees with the observations made by Tynan (1971), that they are missing in the Pleistocene.

SYSTEMATIC PALEONTOLOGY

The taxonomy presently used is artificial and was proposed by Deflandre (1932a) who also described most of the species found in the siliceous sediments cored during DSDP Leg 29. It is based on the morphology and geometry of the siliceous cysts and their opening. All species described before 1969 are illustrated in Deflandre and Deflandre-Rigaud (1970). Their stratigraphic distribution is compiled in Tynan (1971).

Genus ARCHAEOMONADOPSIS Deflandre, 1938

Archaeomonadopsis cf. A. elegante Rampi, 1940
(Plate 1, Figures 19, 20)

Remarks: The form illustrated here is similar to *A. elegante* in having a reticulate ornamentation. The latter, however, is coarser in *A. elegante* described from the Upper Cretaceous Moreno Shale. In the Moreno Shale the specimens only measure about one-third of what they measure in the Oligocene at Site 280, where they are rare.

Genus ARCHAEOMONAS Deflandre, 1932a

Archaeomonas ambigua Rampi, 1940
(Plate 1, Figures 50, 51)

Remarks: The specimens illustrated here from the Upper Cretaceous at Site 275 show a good resemblance with the somewhat schematical drawing of *A. ambigua* from the Upper Cretaceous Moreno Shale. The size of the spines varies, and the number of spines is small in comparison to, i.e., *Archaeomonas dentata* Deflandre from the lower Eocene of Denmark. The spines are smaller in the Upper Cretaceous form *A. spinulosa* Rampi.

Archaeomonas americana Rampi, 1969
(Plate 1, Figure 26)

Remarks: *A. americana* is very rare in the late Eocene at Site 281. It was originally described from the Eocene diatomite of Kreyenhagen, California. The illustration of the holotype which cannot be located, shows fewer spines than are present on the specimen illustrated here.

Archaeomonas cf. A. circuligera Rampi, 1969
(Plate 1, Figures 13, 14)

Remarks: *A. circuligera* was described from the Eocene Kreyenhagen Shale in California, and Rampi noted 7-10 round depressions on the sphere. The specimen illustrated here was found in the late Eocene at Site 281 and shows more circular structures and a somewhat larger diameter than *A. circuligera.* Also, in our specimen, the circular structures are not of equal size as they are in *A. circuligera.* In this detail our form resembles *A. scrobiculata* Rampi from the Late Cretaceous which, however, has very small circular structures that are missing in the specimen illustrated here.

Archaeomonas cf. A. chenevieri Deflandre, 1932d
(Plate 1, Figures 1, 2, 7, 8, 11, and 12)

Remarks: The specimens illustrated here constitute some of the rare archaeomonads in the Miocene and Pliocene at Site 278. They resemble *A. chenevieri* from reworked Eocene of the Caspian Sea, but differ from it by the greater parallel orientation of the ornaments. They differ from *A. deflandriana* Hajos and *A. gratiosa* Hajos by the lack of a high neck, and from the equally Miocene *A. vermiculosa* Deflandre by the coarser ornamentation.

Archaeomonas cratera Deflandre, 1933b
(Plate 1, Figures 2, 3)

Remarks: *A. cratera* was originally described from the upper Eocene radiolarite of Springfield, Barbados, and occurs only in the late Eocene at Site 281, where it is rare. The pore is somewhat wider in the specimen illustrated here than in the holotype.

Archaeomonas cretacea Rampi, 1940
(Plate 1, Figure 32)

Remarks: The specimen illustrated here shows the same hexagonal pattern of the ornamentation as *A. cretacea,* described from the Upper

Cretaceous Moreno Shale of California. It occurs only in the Late Cretaceous at Site 275.

Archaeomonas cylindropora Deflandre, 1932b
(Plate 1, Figure 27)

Remarks: *A. cylindropora* was originally described from the lower Eocene of Denmark, where the spines are somewhat longer than in the specimens illustrated here from the Oligocene at Site 280. These also resemble *A. oamaruensis* Deflandre, which, however, has a spine-bearing neck.

Archaeomonas dubia Deflandre, 1933b
(Plate 1, Figure 30)

Remarks: *A. dubia,* originally described from the upper Eocene diatomite at Oamaru, New Zealand, has a dense ornamentation with regularly distributed small spines on a spherical cyst. Specimens such as the one illustrated here are rare in the late Eocene at Site 283.

Archaeomonas edwardsii n.sp.
(Plate 1, Figure 24)

Name: After A. R. Edwards, New Zealand, who curates the New Zealand diatomites.
Holotype: Plate 1, Figure 24.
Diagnosis: *Archaeomonas,* pear-formed, with a smooth surface, and a small pore.
Description: The pear-formed cyst has a smooth surface. The elongated part of the pear serves as a neck around the small pore.
Remarks: The pear-like form distinguishes the new species from other simple, smooth-walled species.
Occurrence: *A. edwardsii* is rare in the upper Eocene at Site 283.

Archaeomonas glabra Rampi, 1969
(Plate 1, Figure 31)

Remarks: *A. glabra,* as described from the Eocene Kreyenhagen Shale of California, does not show the slight asymmetry in the position of the neck. This is clearly visible in the specimen illustrated here from the Upper Cretaceous at Site 275.

Archaeomonas heteroptera Deflandre, 1932b
(Plate 1, Figure 25)

Remarks: *A. heteroptera,* originally described from the lower Eocene of Denmark and well illustrated by scanning electron-microscope (SEM) pictures by Deflandre and Deflandre-Rigaud (1970), is rare in the upper Eocene at Site 283. It has also been reported from the Upper Cretaceous Moreno Shale, California (cf. see below), the Miocene from Japan (?), and the Eocene diatomite of Kreyenhagen, California.

Archaeomonas cf. A. heteroptera Deflandre, 1932b
(Plate 1, Figures 48, 49)

Remarks: The specimens illustrated here resemble *A. heteroptera* from the Upper Cretaceous Moreno Shale in Rampi (1940). They differ from the species described from the lower Eocene of Denmark by Deflandre by the lesser height of the ornamentation in the Late Cretaceous forms.

Archaeomonas inconspicua Deflandre, 1933b
(Plate 1, Figure 6)

Remarks: *A. inconspicua* was originally described from the Sarmantian diatomite at Karand, Romania. It is one of the few species that occurs more or less consistently throughout the Miocene at Site 278.

Archaeomonas japonica Deflandre, 1933b
(Plate 1, Figure 3)

Remarks: The specimen illustrated here represents the only archaeomonad that occurs consistently from the late Oligocene to the (?)Pliocene at Site 278. Its neck is somewhat thinner than the holotype from the late Miocene of Japan.

Archaeomonas cf. A. japonica Deflandre, 1933b
(Plate 1, Figure 29)

Remarks: In the late Eocene at Site 283, rare specimens of an archaeomonad similar to *A. japonica* were found. They are not as perfectly spherical as this species.

Archaeomonas kreyenhagensis Rampi, 1969
(Plate 1, Figure 33)

Remarks: The outline of the specimen illustrated here from the Upper Cretaceous sediments at Site 275 is spherical, and the surface is completely smooth. Around the pore there is a short neck as described from *A. kreyenhagensis* from the Eocene from Kreyenhagen, California. The similarly simple form *A. sphaerica* from the lower Eocene of Denmark has no neck.

Archaeomonas mangini Deflandre, 1932a
(Plate 1, Figures 36-38[?])

Remarks: *A. mangini* was originally described from the Miocene of Maryland. Subsequently, was found in the Eocene and even in the Upper Cretaceous Moreno Shale (Rampi, 1940). The few specimens found in the Upper Cretaceous sequence at Site 275 show the same distribution, number, and size of spines as the holotype. The pore and neck also seem identical.

Archaeomonas cf. A. membranosa Rampi, 1940
(Plate 1, Figure 54)

Remarks: *A. membranosa* as described from the Upper Cretaceous Moreno Shale has small, diffuse spines, and a "double" neck around the pore. Similar forms, but with a simple neck, are rare in the Upper Cretaceous at Site 275.

Archaeomonas mirabilis n.sp.
(Plate 1, Figures 34, 35)

Holotype: Plate 1, Figures 34, 35.
Diagnosis: *Archaeomonas* with a continuous meandering ridge, and a simple pore.
Description: The outline of this new species is almost spherical, and it has only a simple pore without a neck. The ornamentation consists of a continuous meandering, low ridge which divides the cyst into two equal interlocking saddles.
Remarks: No similar archaeomonads have been previously described.
Size: 6μ; the pore has a diameter of about 1μ.
Occurrence: *A. mirabilis* was only found in the Upper Cretaceous Sample 275-1-1, 130 cm, in which it is very rare.

Archaeomonas cf. A. nebulosa Deflandre, 1938
(Plate 1, Figure 21)

Remarks: *A. nebulosa* was described originally from the mid-Miocene diatomite of Sicily, and has small, diffuse spines and a small, neckless pore. The specimen illustrated here, which was found in the late Eocene at Site 283, is very similar to *A. nebulosa,* but has a very shallow neck.

Archaeomonas ornata Rampi, 1969
(Plate 1, Figures 15, 16)

Remarks: *A. ornata* here occurs only in an upper Oligocene sample from Site 278. It was originally described from the Eocene diatomite of Kreyenhagen, California.

Archaeomonas paucispinosa Deflandre, 1938
(Plate 1, Figure 58; Plate 12, Figure 5)

Remarks: *A. paucispinosa* was originally described from the Paleocene-Eocene of the USSR and occurs in the Late Cretaceous at Site 275 where it is very rare. The form has fewer spines and is smaller than *Litheusphaerella cretacea,* with which it could be confused, when the latter's bifurcated part of the spines has been broken off.

Archaeomonas rampii n. sp.
(Plate 1, Figures 42-45)

Name: To honor L. Rampi, Italy, who described the archaeomonads from the Upper Cretaceous Moreno Shale.

Holotype: Plate 1, Figures 42-45.

Diagnosis: *Archaeomonas* with a high hexagonal ridge pattern and a funnel-shaped neck.

Description: The outline of this new species is spherical. The pore is at the bottom of a high, funnel-shaped neck. The ornamentation consists of high ridges arranged to form a hexagonal pattern.

Remarks: The new species resembles *A. cretacea* Rampi from the Upper Cretaceous Moreno Shale; the latter, however, does not have such a high ornamentation. Another form with a similar hexagonal pattern was described as *Litheusphaerella frenguelli* Deflandre from the Eocene of the USSR. It does not have a funnel-shaped neck.

Size: Ca. 8μ (cyst only) and ca. 11μ (including ornaments).

Occurrence: Few specimens of *A. rampii* were found in the Upper Cretaceous Sample 275-1-1, 130 cm.

Archaeomonas reticulosa Deflandre, 1932b
(Plate 1, Figure 28)

Remarks: *A. reticulosa*, with a simple pore and a regular ornamentation with small spines, was originally described from the Lower Eocene of Denmark and was only found in an upper Eocene sample from Site 283. Other, similar Eocene species are *A. granulata* Rampi which is smaller than *A. reticulosa*, and *A. multipunctata* Rampi has more and smaller spines.

Archaeomonas cf. A. scabratula Deflandre, 1932b
(Plate 1, Figure 57; Plate 12, Figure 6)

Remarks: *A. scabratula* was originally described from the lower Eocene diatomite from Fur, Denmark. It is characterized by a high number of spines with a relatively large base. The specimen illustrated here is somewhat smaller, and the spines are more slender than in the holotype. It is rare in the Late Cretaceous at Site 275.

Archaeomonas semplicia Rampi, 1940
(Plate 1, Figure 32)

Remarks: Like the holotype of *A. semplica*, the specimen with the smooth surface and small neck was found in Upper Cretaceous sediments at Site 275.

Archaeomonas sphaeroidea Deflandre, 1938
(Plate 1, Figure 22)

Remarks: This late Eocene species from Oamaru, New Zealand, is easily recognizable by its characteristic outline and small, simple pore. It only occurs here in the late Eocene at Site 281.

Archaeomonas striata Deflandre, 1933b
(Plate 1, Figures 4, 5)

Remarks: *A. striata*, which was described from the lower Eocene of Denmark, is found here in a single sample of Miocene age at Site 278. The striae seem to be somewhat coarser in the specimen illustrated here than in the much older holotype.

Archaeomonas transversa n.sp.
(Plate 1, Figure 34)

Name: From the transverse orientation of the ornamentation in respect to the pore and neck.

Holotype: Plate 1, Figure 34.

Diagnosis: *Archaeomonas* with mainly almost horizontal low ridges as ornamentation.

Description: The outline of the new form is nearly spherical with a small neck with parallel sides. The ornamentation consists of low ridges most of which are oriented nearly horizontally.

Remarks: *A. transversa* differs from other species by the almost horizontal orientation of most ridges which constitute the ornamentation. *A. didinium* Deflandre has only two parallel, horizontal ridges. *A. caulleryi* Deflandre has more prominent ridges and a more well-developed neck.

Size: Ca. 6μ.

Occurrence: *A. transversa* is very rare in the Upper Cretaceous Sample 275-1-1, 130 cm.

Archaeomonas vermiculosa Deflandre, 1932b
(Plate 1, Figures 9, 10)

Remarks: *A. vermiculosa*, which was found to be rare in the Miocene at Site 278 was originally described from the Miocene diatomite of Maryland.

Genus ARCHAEOSPHAERIDIUM Deflandre, 1932a

Archaeosphaeridium australensis n.sp.
(Plate 2, Figures 1-10)

Name: From Australia, which is near the three sites where the species was found.

Holotype: Plate 2, Figure 4.

Diagnosis: *Archaeosphaeridium* with a small number of downward-oriented spines and a short, large neck.

Description: The surface of the cyst is smooth and it bears a short neck with a diameter over half the size of the cyst. The spines point downwards and are long. Forms with one (Plate 2, Figures 9, 10) two, and three (Plate 2, Figure 1) spines were found; those with two spines are most common.

Remarks: *A. australensis* differs from *A. tasmanensis* n.sp. by the large neck and the length and orientation of the spines. It has also a different neck, a fewer number and differently oriented spines than *A. dumitricae*. *A. laticolle* Deflandre from the upper Eocene of Oamaru has a similar large neck, but no spines.

Size: Usually around 15μ to 20μ; spines up to 40μ.

Occurrence: *A. australensis* was found to occur rare to few in the late Eocene at Sites 281 and 283 and in the Oligocene at Site 280.

Archaeosphaeridium dumitricae n.sp.
(Plate 2, Figures 11-17)

Name: To honor P. Dumitrica, Romania, who kindly helped the author with the introduction to siliceous microfossils.

Holotype: Plate 2, Figure 16.

Diagnosis: *Archaeosphaeridium* with short, robust spines in all directions and a small pore and neck.

Description: The surface of the cyst is smooth, and it has a small pore with a somewhat larger neck. The length and form of the numerous spines vary considerably: some have bifurcated ends, and some are connected by a thin siliceous wall. The spines have a broad base and are oriented in all directions.

Remarks: The new species resembles *A. pachyceros* Deflandre as described from the Miocene of Atlantic City, New Jersey. *A. pachyceros* has thinner, more regular spines, and *A. dentatum* Deflandre from the upper Eocene of Oamaru has more and shorter spines.

Size: Ca. 14μ to 20μ; spines up to 16μ.

Occurrence: *A. dumitricae* is rare to almost common in upper Eocene samples at Sites 281 and 283, but was not found in samples of the same age at Site 277.

Archaeosphaeridium tasmaniae n.sp.
(Plate 2, Figures 18-23; Plate 3, Figures 1-10;
Plate 12, Figures 1-3)

Name: From Tasmania, near to where the species was found.

Holotype: Plate 2, Figure 21.

Diagnosis: *Archaeosphaeridium* with two to six very long spines, and a medium-size neck.

Description: The surface of *A. tasmaniae* is smooth and the neck and pore are of an intermediate diameter between *A. dumitricae* and *A. australensis*. The spines are very long, usually bent, and oriented in all directions. Their number varies: forms with two to four spines are equally frequent, while those with five are less common, and those with six spines are rare.

Remarks: No archaeomonad with long spines has been described previously.

Size: Ca. 16μ to 30μ; spines up to 70μ.

Occurrence: *A. tasmaniae* was only found in the Oligocene samples from Site 280.

Genus LITHEUSPHAERELLA Deflandre, 1932a

Litheusphaerella cretacea n.sp.
(Plate 1, Figure 39)

Name: From Cretaceous, the age of the sediment in which this species was first found.

Holotype: Plate 1, Figure 39.

Diagnosis: *Litheusphaerella* with few bifurcated long spines.

Description: The outline of *L. cretacea* is nearly spherical. The pore is simple, and the spines are long (ca. 10μ), and some (the complete ones[?]) are bifurcated at the end.

Remarks: The generotype of *Litheusphaerella*, *L. spectabilis* has more and shorter spines.

Size: The diameter of the cyst measures about 9μ; the spines are up to 5μ long.

Occurrence: *L. cretacea* is very rare in the Upper Cretaceous at Site 275.

Litheusphaerella frenguelli Deflandre, 1938
(Plate 1, Figures 59-61)

Remarks: *L. frenguelli* was described from the Eocene of the USSR, and occurs here in the Late Cretaceous at Site 275. The specimen illustrated here shows a slightly greater number of smaller hexagonal or polygonal structures than the holotype, which also is a little larger.

Litheuspaherella spectabilis Deflandre, 1932a
(Plate 1, Figures 40, 41)

Remarks: *L. spectabilis* was originally described from the early Eocene of Denmark. Deflandre and Deflandre-Rigaud (1970) published excellent SEM pictures of this form. The rare specimens found in Upper Cretaceous samples from Site 275 show the same density of bifurcated spines as the holotype and are of a similar size.

Genus PARARCHAEOMONAS Deflandre, 1932b

Pararchaeomonas cf. P. colligera Deflandre, 1932b
(Plate 1, Figures 55, 56)

Remarks: *P. colligera* was described and well illustrated from the lower Eocene diatomite from Fur, Denmark. The specimen illustrated here was found in the Late Cretaceous at Site 275 and is smaller than *P. colligera*. The oblique view does not allow judgment as to whether the form has the same flattening around the neck as *P. colligera*.

Pararchaeomonas sp.
(Plate 1, Figure 47)

Remarks: A single specimen of a large *Pararchaeomonas* with a rough surface, and a well-developed neck was found in the Late Cretaceous at Site 275.

EBRIDIANS

Ebridians are marine planktonic silica-secreting organisms most commonly found in cold or temperate waters. Their fossil record goes back to the Paleocene, but most genera and species are recorded from the Eocene and Miocene.

Late Cretaceous

No ebridians were found in the Upper Cretaceous siliceous sequence cored at Site 275. This agrees with their reported absence in the other Late Cretaceous siliceous assemblages described so far (Loeblich et al., 1968).

Late Eocene

At Sites 277, 280 (Hole 280A), 281, and 283, where siliceous sequences were penetrated, ebridians are present in all samples. The rare to few specimens show poor to moderate preservation. The assemblages include many of the species described from the upper Eocene diatomites from Oamaru, New Zealand, but diversity is somewhat lower. This is due primarily to the lower temperatures to be expected at the higher latitude for the Leg 29 sites. However, the very limited time available for studying these samples certainly also had an effect on the relatively modest number of species recorded. *Ammodochium rectangulare* (Schulz) is the most common form and is present in all late Eocene samples. *Ebriopsis crenulata* Hovasse is also present in most samples in varying amounts. The other species occur more sporadically, and some distinct differences in their occurrence can be noted. *Craniopsis octo* Hovasse is consistently present at Sites 283 and 277, but is missing at Sites 280 (Hole 280A), and 281. It was originally described from the late Eocene from Oamaru. *Micromarsupium anceps* Deflandre is absent at Site 277, but present in all other sequences. It was also described originally from Oamaru. Whether these differences are due to different ages of the samples, different climates at the different sites, or the missing of a species due to non-preservation, cannot be determined as yet. The state of preservation certainly varies considerably.

Oligocene

Ebridians were found to be rare to common in the Oligocene siliceous sequences cored at Sites 277, 278, and 280 (Hole 280A). The only common species is, as in the late Eocene, *A. rectangulare*. As in the Eocene, too, not all species occur at all sites. Thus the new species *Hermesinum geminum* was found in all samples at Site 280 (Hole 280A), and in one sample at Site 278, while it is missing at Site 277. *H. geminum* seems to be restricted to the Oligocene with the exception of the occurrence in Cores 280A, 5-7 that were dated as late Eocene by Radiolaria. Generally the Oligocene includes the same, but less species as the late Eocene. The ebridian assemblage is richer in Hole 280A and the earliest Oligocene at Site 277 than higher up in the Oligocene at Site 277, and in the late Oligocene at Site 278.

Miocene to Pleistocene

Almost no ebridians were found in samples younger than late Oligocene. This is somewhat surprising, since Ling (1972, 1973) reports them from the western and northern Pacific in the Miocene and Pliocene. Lower temperatures in the southern high latitudes after the onset of glaciation on Antarctica might be responsible for these findings. The two only specimens were found in the late Miocene at Site 281 and belong to *Ammodochium rectangulare* and *Ammodochium* cf. *A. danicum curtum*.

SYSTEMATIC PALEONTOLOGY

In the following an inventory of the ebridians found on Leg 29 is given. No attempt was made to present the synonymy for each species or to discuss its history. The morphologic terms used are those commonly employed and summarized by Deflandre (1951). Extensive use was made of the descriptions and illustrations collected in Loeblich et al. (1968), where the original literature was not available.

The holotype of *Ebriopsis cornuta* n.sp. was designed in a sample (*Vema* 28-520) from the Voering Plateau in the Norwegian Sea, because of its better preservation there than in the Leg 29 material where it also occurs. The age assigned to the *Vema* sample by diatoms and silicoflagellates was (?)late Eocene (Bjørklund and Kellogg, 1972). According to recent investigations on the silicoflagellates, ebridians, and archaeomonads of these *Vema* samples, the age might well be Oligocene (Perch-Nielsen, in preparation).

Genus AMMODOCHIUM Hovasse, 1932

Ammodochium ampulla Deflandre, 1934
(Plate 4, Figures 17, 18, 29;
Plate 5, Figures 23-26)

Remarks: *A. ampulla* was found to be rare in the late Eocene and early Oligocene at Sites 277, 281, and 283. It was originally described from the upper Eocene diatomite of Oamaru, New Zealand.

Ammodochium cf. A. danicum curtum Deflandre
(Plate 5, Figures 3, 4)

Remarks: *A. danicum curtum* was originally described from the lower Eocene diatomites from Denmark. The form found in the upper Miocene at Site 281 seems very close to *A. danicum curtum*, but the upper window is only partly developed.

Ammodochium rectangulare (Schulz) Deflandre, 1933a
(Plate 4, Figures 19-28, 30-32; Plate 5,
Figures 13-17, 22; Plate 9, Figures 1-3, 6)

Remarks: *A. rectangulare* is the most common and often the only ebridian present in the upper Eocene and Oligocene siliceous sequences cored on Leg 29. Only one single specimen was found in the late Miocene at Site 281, the rest of the Neogene being devoid of ebridians. This species shows a considerable variety in size, and double skeletons are common. Specimens not having a rectangular outline, but an unregular pentagonal one (Plate 5, Figures 13-17), were found at four sites in the Oligocene and the late Eocene. These forms were diagrammed and discussed by Deflandre (1951).

Ammodochium speciosum Deflandre, 1934
(Plate 5, Figures 1, 2)

Remarks: *A. speciosum* was described from the upper Eocene diatomite at Oamaru, New Zealand, and recorded to also occur in the lower Eocene "diatomite of Skive," Denmark. In the present material, only two specimens were found in the latest Eocene at Site 277. They are only a little larger than the specimens measured by Deflandre, who gave a complete description of the species.

Genus CRANIOPSIS Hovasse ex Frenguelli, 1940

Craniopsis octo Hovasse ex Frenguelli, 1940
(Plate 4, Figures 1-10)

Remarks: *C. octo* was described originally from the upper Eocene diatomite of Oamaru, New Zealand. On Leg 29, it was found in the late Eocene at Sites 283 and 277, but not at Sites 280 and 281. The specimens from Site 277 are all larger and more fragile than those found at Site 283. No double skeletons or podamphores were observed.

Genus EBRIOPSIS Hovasse, 1932a

Ebriopsis antiqua Hovasse, 1932a
(Plate 4, Figure 15)

Remarks: *E. antiqua* was only found in few upper Eocene samples from Sites 281 and 283, but was originally described from Oamaru. The specimens have no axial spines as those reported from Miocene samples (Ling, 1972).

Ebriopsis cf. E. aplanata Deflandre, 1950
(Plate 7, Figure 12)

Remarks: A single specimen of an ebridian very similar to *E. aplanata* was found in the Oligocene at Site 280. *E. aplanata* was originally described from the Paleocene of Kuznetsk, USSR, and is relatively more robust and broader than the specimen found here.

Ebriopsis cornuta Dumitrica and Perch-Nielsen n.sp.
(Figure 2; Plate 7, Figures 8, 9)

Description: Elongate skeleton of structure similar to *E. valida* Deflandre, but with the opisthoclade 03, long and armed with a posterior horn. A short anterior horn may also exist on the anterior synclade sa31.

Holotype: Figure 2, *Vema* 28-520 cm, Voering Plateau, Norwegian Sea.

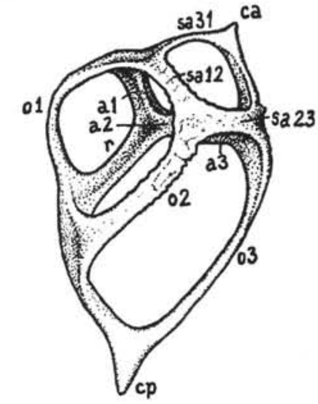

Figure 2. Ebriopsis cornuta *Dumitrica and Perch-Nielsen n. sp. holotype; r-rhabde, a-actine, p-proclade, o-opisthoclade, sa-anterior synclade, cp-posterior horn ca-anterior horn. From* Vema *28-520; magnification ca. 1290X.*

Dimensions: Length of shell with horns is 40μ.

Remarks: The species very likely comes from a skeleton of *E. valida* type. Both forms have the position of the opisthoclade 02 against the rhabde.

Distribution: In Leg 29 the species was recorded from the late Eocene at Site 277, where it is rare. Well preserved specimens also occur in (?)upper Eocene sample *Vema* 28-520 cm from the Voering Plateau in the Norwegian Sea.

Ebriopsis crenulata Hovasse, 1932b
(Plate 4, Figures 11-14; Plate 5, Figures 18-29)

Remarks: *E. crenulata* occurs more or less consistently in small numbers in the late Eocene and Oligocene at Sites 277, 280, 281, and 283, while it is missing in the late Oligocene at Site 278, the southernmost site. It was originally described from the upper Eocene diatomite of Oamaru, New Zealand.

Genus HERMESINELLA Deflandre, 1934

Hermesinella transversa Deflandre, 1934
(Plate 5, Figure 7)

Remarks: *H. transversa* was described originally from the upper Eocene diatomite at Oamaru, New Zealand. The very rare specimens here assigned to this species were found in the late Eocene at Site 281. Similar forms occur more frequently in the (?)upper Eocene diatomites cored on Voering Plateau in the Norwegian Sea (Bjørklund and Kellogg, 1972).

Genus HERMESINUM Zacharias, 1906

Hermesinum geminum Dumitrica and Perch-Nielsen n.sp.
(Figures 3-5; Plate 4, Figure 16;
Plate 8, Figures 1-16)

Description: Skeleton large, normally double. The young individuals (Plate 8, Figure 7) consist of a three-costulate triaena with a long rhabde and short actines. The latter are connected with one another by anterior synclades parting from very short proclades. Upper windows and opisthoclades 02 and 03 are absent. Opisthoclade 01 is well developed.

In the double skeletons the two individuals are connected with one another by the distal ends of actines a2 and a3 and by the very long rhabde. The two skeletons are thus arranged symmetrically about a plane passing through the three points of connection. They have in common the anterior synclade sa23. Their rhabdes are about six to

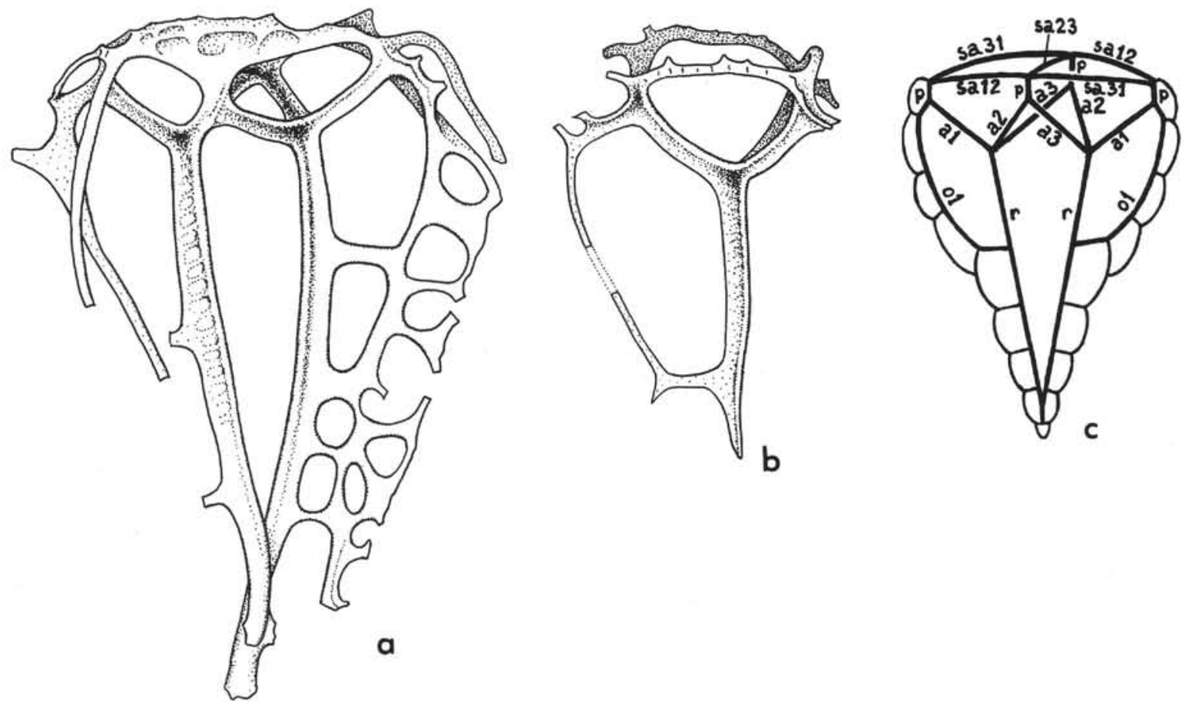

Figure 3. Hermesinum gerninum *Dumitrica and Perch-Nielsen, n. sp. (a) adult specimen, 920×; from sample 280A-6-2, 110 cm, from* Vema *28-520, Norwegian Sea. (b) young specimen with rhabde still free, but with actines a2 and a3 connected with the same actines of the partner (here broken out) 1290×. (c) skeletal scheme and mode of connection between the two individuals.*

seven times as long as the actines and are surrounded by a lattice corona lying in the plane of the opisthoclades 01, and actines a1 of both individuals.

Holotype: Plate 8, Figure 5.

Dimensions: Length of shell 50μ to 150μ.

Remarks: The double skeletons seem to have been the normal state of the species: all the specimens recorded, even the young ones, were found to be double skeletons. Onthogenetical, the connection between the two partners seems to first perform between the actines a2 and a3, and later between the rhabdes. The specimen illustrated in Figure 4 suggests such a succession.

From the morphology of the young individuals, the species is rather similar to *Hermesinum* ex gr. *adriaticum* Zach., from which it differs by absence of the upper windows. This last peculiarity removes the species from *Hermesinum,* and places it to *Ebriopsis.* However, the general aspect is of *Hermesinum.* At any rate, the species is of a quite particular interest. It is the only species known so far in which the normal state is a double skeleton.

Distribution: *H. geminum* occurs in the late Eocene and Oligocene at Site 280, and small forms of the species were also found in the late Oligocene at Site 278. It was not found at all in the thick siliceous Oligocene sequence at Site 277, or in any other late Eocene in the area. It was also found in (?)late Eocene from the Voering Plateau in the Norwegian Sea (Figure 4).

Genus MICROMARSUPIUM Deflandre, 1934

Micromarsupium anceps Deflandre, 1934
(Plate 6, Figures 1-11;
Plate 7, Figures 1-7, 9-13)

Remarks: *M. anceps* was described originally from the upper Eocene diatomites at Oamaru, New Zealand. In the material studied from Leg 29, it was observed in the late Eocene and Oligocene at Sites 280, 281, and 283. Questionable forms of the species only were found in a sample of late Eocene age at Site 277, and *M. anceps* was not found in the late Oligocene at Site 278. The forms assigned here to this species vary considerably in size. Forms with, and without a lorica, were found to be about equally frequent in the samples.

Genus PAREBRIOPSIS Hovasse, 1932d

Parebriopsis fallax Hovasse, 1932d
(Plate 4, Figures 33-35;
Plate 5, Figures 8-12; Plate 9, Figures 5, 7, 8)

Remarks: This species, too, was originally described from the upper Eocene diatomites in Oamaru. In the material studied here it was found in the late Eocene at Sites 281, 283, and 277, where it is usually rare. Single and questionable specimens were also observed in the Oligocene at Sites 280 and 277. *P. fallax* was, in a few samples from different sites, observed with a complete hypersilicified crest as shown on a fragment by Hovasse (1932a). Most specimens are, however, found without such a crest and show only little ornamentation of the skeleton.

Genus PSEUDAMMODOCHIUM Hovasse, 1932d

Pseudammodochium sphericum Hovasse, 1932d
(Plate 1, Figures 17, 18)

Remarks: The species was previously described from the late Eocene at Oamaru, New Zealand. There is a wide variability in the thickness of shell from thin-shelled skeletons with smooth surface to thick-shelled skeletons with rough surface having polygonally framed pores.

SILICEOUS ENDOSKELETAL DINOFLAGELLATES

Dumitrica (1973) has described, discussed, and illustrated all species mentioned in this report. His stratigraphic findings can be supported by the results from Leg 29. *Carduifolia* occurs mainly in the Paleogene (and in the Late Cretaceous), while *Actiniscus* dominates in the Neogene. Most species of these two genera are long-living, and thus useful for paleoecological rather than biostratigraphical studies.

None of the few relatively short-living species recorded by Dumitrica from Site 206 were found in Leg 29 material. This is probably due to cooler climates in the high latitude area for the sites of Leg 29.

Late Cretaceous

The siliceous Late Cretaceous sequence penetrated at Site 275 yielded only rare endoskeletal dinoflagellates. Most specimens can be attributed to *Carduifolia* cf. *C. onoporoides* Hovasse which was described from the early Eocene of Mors, Denmark. Dumitrica (1973) found *C. onoporoides* in the early Paleocene at Site 208 (Figure 1).

Late Eocene

Late Eocene siliceous sequences were penetrated at Sites 277, 280, 281, and 283. So far, the only endoskeletal dinoflagellates recognized are *Carduifolia gracilis* Hovasse, which Dumitrica (1973) found in the middle Miocene only, plus *Actiniscus pentasterias* Ehrenberg and *A. elongatus* Dumitrica. The last two occur only in samples from Site 277, where they are rare, as is *C. gracilis* at the other sites.

Oligocene

Oligocene siliceous sequences were cored at Sites 277, 278, and Hole 280A. Endoskeletal dinoflagellates are rare and include the same forms as in the Eocene plus *Foliactiniscus* cf. *F. mirabilis* Dumitrica. The latter was described from DSDP Site 206 (Figure 1) where it occurs from the Oligocene to the Pleistocene. On Leg 29, it so far has only been found in the late Oligocene at Sites 277 and 278. At Site 206, it is most common in the late Oligocene to early Miocene. *A. pentasterias* and *A. elongatus* are rare in the Oligocene at Sites 277 and 278, while none of them were found in Hole 280A, where *C. gracilis* is the only endoskeletal dinoflagellate. The latter occurs also at Site 278, and similar forms were found at Site 277. Comparing these assemblages with those from Site 206 described by Dumitrica (1973), who found up to six different species in a late Oligocene sample, we find, not surprisingly, fewer species in the high latitude sites of Leg 29. The difference in the assemblages at Site 277 and Hole 280A might be due to slightly warmer conditions during the Oligocene at Site 277. This is suggested by the silicoflagellates.

Miocene

An almost continuously siliceous sequence through the Miocene was cored at Site 278, and late Miocene siliceous microfossils were also found at Site 281. Endoskeletal dinoflagellates are absent to rare in the early Miocene, rare in the middle Miocene, and rare to few during the late Miocene. *A. pentasterias* is the dominant species, while *A. elongatus* and *C. gracilis* are absent or rare. The latter occurs only in the middle Miocene, during the same interval as at Site 206. There, too, *Actiniscus* dominates the assemblage and is most common in the middle and late Miocene.

Pliocene

Only one Pliocene siliceous sequence was penetrated during Leg 29, at Site 278, where only *Actiniscus* is represented. This is also the dominant genus at Site 206, where, however, other genera are also present.

Pleistocene

Pleistocene endoskeletal dinoflagellates were found at Sites 278 and 281 where they are very rare and represented only by *A. pentasterias*. Again, the assemblage reported by Dumitrica from Site 206 is richer, but also dominated by *A. pentasterias*.

SYSTEMATIC PALEONTOLOGY

Dumitrica (1973) has discussed the systematical considerations relating to the assignment of the genera found here to the family *Actiniscidae*. He also gave extensive descriptions of the different species, prepared synonymies lists, and discussed relationships between different genera and their vertical and horizontal distribution. It is therefore not necessary to repeat this here. Thus, the following remarks about the few forms found on Leg 29 are short, and the reader is referred to Dumitrica (1973) for more details.

Family ACTINISCIDAE Kützing

Genus ACTINISCUS Ehrenberg, 1854

Actiniscus pentasterias Ehrenberg, 1840
(Plate 10, Figures 2-10, 16)

Remarks: *A. pentasterias* includes forms with five to seven or eight arms and a wide variety and amount of ornamentation. It is the most common siliceous endoskeletal dinoflagellate in most Miocene and Pleistocene samples, and the only one in the Pleistocene. It also occurs in the Oligocene and late Eocene. Usually *A. pentasterias* is rare in the samples but reaches "few" in the late Miocene to mid-Pliocene at Site 278 and in the late Miocene at Site 281.

Actiniscus elongatus Dumitrica, 1968
(Plate 10, Figures 11-13)

Remarks: *A. elongatus* also shows a varying amount of ornamentation, but never is so richly ornamented as *A. pentasterias*. It is rare in samples from the late Miocene to (?)early Pliocene at Site 278, and the middle Miocene at Site 281, mainly where *A. pentasterias* reaches "few." While *A. elongatus* by Dumitrica (1973) was only found in the middle Miocene to early Pliocene, it also occurs sporadically in the Oligocene and late Eocene at Sites 277.

Actiniscus tetrasterias Ehrenberg, 1854
(Plate 10, Figure 1)

Remarks: *A. tetrasterias* is very rare in the (?)early Pliocene at Site 278. At Site 206 Dumitrica (1973) recorded it to be most common in the late Pliocene and otherwise rare from the Oligocene to the Pleistocene at this site.

Genus FOLIACTINISCUS Dumitrica, 1973

Foliactiniscus cf. F. mirabilis Dumitrica, 1973
(Plate 10, Figures 14-16)

Remarks: *F. mirabilis* is very rare in one sample of late Oligocene age at Site 278. It was recorded by Dumitrica from the late Oligocene to the Pleistocene, but is most frequent in the late Oligocene and early Miocene.

Genus CARDUIFOLIA Hovasse, 1932d

Carduifolia gracilis Hovasse, 1932d
(Plate 10, Figures 19-25)

Remarks: *C. gracilis* occurs more or less consistently in small numbers in the late Eocene and the Oligocene at all sites with such siliceous sequences. The exception is at Site 277, where only questionable pieces were found. Only few specimens were found in two middle Miocene samples at Site 278. *C. gracilis* was found by Dumitrica (1973) in the middle Miocene at Site 206. He also recorded them from the siliceous sediments of middle Miocene age in Rumania and Hungary.

Carduifolia cf. C. onoporoides Hovasse, 1932a
(Plate 10, Figures 26-30)

Remarks: *C.* cf. *C. onoporoides* was found in small numbers to occur in the Late Cretaceous (Campanian-Maestrichtian) at Site 275. Dumitrica (1973) found *C. onoporoides* in the Paleocene at Site 208. It was originally described from the early Eocene of Denmark. *C.* cf. *C. onoporoides* is the only siliceous endoskeletal dinoflagellate found so far in the Late Cretaceous.

Carduifolia lata Hovasse, 1932d
(Plate 10, Figure 18)

Remarks: The specimen illustrated here resembles *C. lata* which was originally described from the late Eocene at Oamaru, New Zealand. It is rare in the late Eocene at Site 277.

Carduifolia? sp.
(Plate 10, Figure 17)

Remarks: The form illustrated here seems to belong between *Actiniscus* and *Carduifolia,* but needs more study before it can be assigned to one or the other. It is very rare in the early Oligocene at Site 277.

Other siliceous microfossils

Besides radiolarians, diatoms, silicoflagellates (see Chapters 14, 15, 18, 24, and 26, this volume), and the groups treated in this chapter, other siliceous microfossils were found. Siliceous sponge spicules are often common, and sometimes are the only siliceous microfossils preserved in the sediment.Their investigation was planned but was abandoned due to lack of time.

Some siliceous microfossils which traditionally are treated together with silicoflagellates or the groups treated here, are, however, included in this report: *Rocella, Pseudorocella,* and *Micrampulla,* which probably are diatoms.

Genus MICRAMPULLA Hanna, 1927

Micrampulla parvula Hanna, 1927
(Plate 13, Figures 1-4, 10-14, 16-27)

Remarks: *M. parvula* was originally described from the Upper Cretaceous Moreno Shale and considered to be a diatom by its author. Since its general morphology suggested a closer relationship with the archaeomonads than the diatoms, it was usually considered with the former group. Hajos (this volume), however, also favors the view that *M. parvula* be considered as a diatom. Compared to the holotype, the forms found in Upper Cretaceous samples from Site 275 have an elliptical rather than a round outline.

Genus PSEUDOROCELLA Deflandre, 1938

Pseudorocella corona Deflandre, 1947
(Plate 11, Figure 11)

Remarks: *P. corona* was originally described from the late Miocene of Hungary and considered to be a silicoflagellate. In our material, it was found to be rare in the Oligocene at Site 277.

Genus ROCELLA Hanna, 1930

Rocella gemma Hanna, 1930
(Plate 11, Figures 1-10)

Remarks: *R. gemma* was considered to be a silicoflagellate by Hanna (1930) and described from the early Miocene of California. It was suggested to be a diatom by Lipps (1970), and its affiliation was left open by Ling (1972). The number and size of openings vary considerably in *R. gemma,* and this is not related to the size of the specimen. Thus specimens of the same size have few large openings (Plate 11, Figures 6, 8, 9). The common occurrence of *R. gemma* in the late Oligocene and early Miocene, makes this species a good indicator for sediments of this age. Single specimens were, however, also found later in the Miocene (Table 3). It was found to be most common in the uppermost upper Oligocene samples at Site 278.

Rocella ?sp. 1
(Plate 11, Figures 12, 13)

Remarks: Small, almost flat, circular siliceous bodies with small, round openings in the central part and smaller round openings around the borderline were found occasionally in the Oligocene at Sites 277 and 280.

ACKNOWLEDGMENTS

I would like to thank Dr. P. Dumitrica for his help in determining some of the siliceous microfossils, for describing the two new ebridians, and for critically reading an early version of the manuscript. I am also grateful to the "Laboratoire de Micropaléontologie, Ecole pratique des Hautes Etudes" in Paris for providing the opportunity to study their type collection, which includes the holotypes of many species treated here. My participation in Leg 29 was made possible by a grant from the Danish National Science Foundation.

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PLATE 1

Archaeomonads and ebridians.
(Figures 1-16, 26, 27, 32-46, 48-61, 2000×;
Figures 17-25, 28-31, 47, 800×)

Figures 1, 2, 7, 8, 11, 12	*Archaeomonas* cf. *A. chenevieri* Deflandre. 1, 2. Sample 278-9-5, 110 cm. 7, 8. Sample 278-16, CC. 11, 12. Sample 278-17, CC.
Figure 3	*Archaeomonas japonica* Deflandre; Sample 278-9-1, 110 cm.
Figures 4, 5	*Archaeomonas striata* Deflandre; Sample 278-10-5, 110 cm.
Figure 6	*Archaeomonas inconspicua* Deflandre; Sample 278-14, CC.
Figures 9, 10	*Archaeomonas vermiculosa* Deflandre; Sample 278-17, CC.
Figures 13, 14	*Archaeomonas* cf. *A. circuligera* Rampi; Sample 281-15, CC.
Figures 15, 16	*Archaeomonas ornata* Rampi; Sample 278-31, CC.
Figures 17, 18	*Pseudammodochium sphericum* Hovasse. 17. Sample 178-14, CC. 18. Sample 278-22-3, 110 cm.
Figures 19, 20	*Archaeomonadopsis* cf. *A. elegante* Rampi; Sample 280A-1, CC.
Figure 21	*Archaeomonas* cf. *A. nebulosa* Deflandre; Sample 283-3-1.
Figure 22	*Archaeomonas sphaeroidea* Deflandre; Sample 271-16, CC.
Figure 23	*Archaeomonas cratera* Deflandre; Sample 281-16, CC.
Figure 24	*Archaeomonas edwardsii* n.sp.; Sample 283-3-1.
Figure 25	*Archaeomonas heteroptera* Deflandre; Sample 283-6-2, 117 cm.
Figure 26	*Archaeomonas americana* Rampi; Sample 281-14, CC.
Figure 27	*Archaeomonas cylindropora* Deflandre; Sample 280A-4-3, 110 cm.
Figure 28	*Archaeomonas reticulosa* Deflandre; Sample 283-3-1.
Figure 29	*Archaeomonas* cf. *A. japonica* Deflandre; Sample 283-3-1.
Figure 30	*Archaeomonas dubia* Deflandre; Sample 283-6-2, 117 cm.
Figure 31	*Archaeomonas glabra* Rampi; Sample 275-1-1, 130 cm.
Figure 32	*Archaeomonas semplica* Rampi; Sample 275-2-4, 50 cm.
Figure 33	*Archaeomonas kreyenhagensis* Rampi; Sample 275-1-1, 130 cm.
Figures 34, 35	*Archaeomonas mirabilis* n.sp.; Sample 275-1-1, 130 cm.
Figures 36, 37 38(?)	*Archaeomonas mangini.* Sample 275-1-1, 130 cm.
Figure 39	*Litheusphaerella cretacea* n.sp.; Sample 275-1-1, 130 cm.
Figures 40, 41	*Litheusphaerella spectabilis* Deflandre; Sample 275-1-1, 130 cm.
Figures 42-45	*Archaeomonas rampii* n.sp.; Sample 275-1-1, 130 cm.
Figure 46	*Archaeomonas cretacea* Rampi; Sample 275-2-4, 50 cm.
Figure 47	*Pararchaeomonas* sp.; Sample 275-2-4, 50 cm.
Figures 48, 49	*Archaeomonas* cf. *A. heteroptera* Deflandre; Sample 275-1-1, 130 cm.
Figures 50, 51	*Archaeomonas ambigua* Rampi; Sample 275-2-4, 50 cm.
Figures 52, 53	*Archaeomonas transversa* n.sp.; Sample 275-1-1, 130 cm.
Figure 54	*Archaeomonas* cf. *A. membranosa* Rampi; Sample 275-2-4, 50 cm.
Figures 55, 56	*Pararchaeomonas* cf. *P. colligera* Deflandre; Sample 275-1-3, 50 cm.
Figure 57	*Archaeomonas* cf. *A. scabratula* Deflandre; Sample 275-1-4, 50 cm.
Figure 58	*Archaeomonas paucispinosa* Deflandre; Sample 275-2-4, 50 cm.
Figures 59, 60, 61	*Litheusphaerella frenguelli* Deflandre; Sample 275-2-2, 50 cm.

PLATE 1

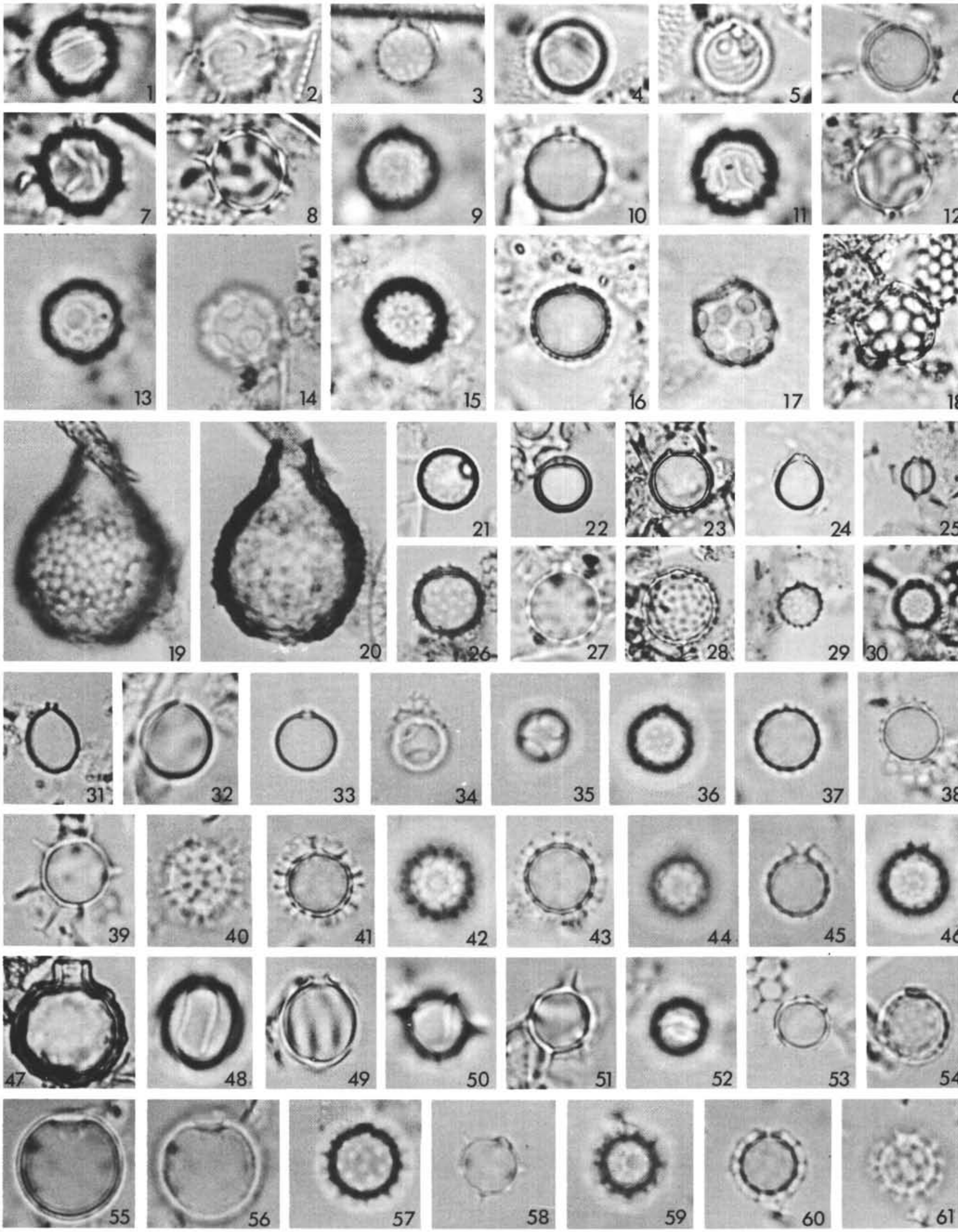
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PLATE 2

Archaeomonads; magnification ca. 800×.

Figures 1-10 *Archaeosphaeridium australensis* n.sp.
1. Sample 283-6-2, 117 cm.
2. Sample 283-3-1.
3. Sample 280A-3-3, 110 cm.
4. Sample 280A-4, CC.
5. Sample 280A-3-3, 110 cm.
6. Sample 281-16, CC.
7. Sample 281-15, CC.
8. Sample 283-5-2, 117 cm.
9. Sample 283-3-1.
10. Sample 283-3-1.

Figures 11-17 *Archaeosphaeridium dumitricae* n.sp.
11. Sample 283-6-2, 117 cm.
12. Sample 281-14, CC.
13. Sample 281-15, CC.
14. Sample 281-16, CC.
15. Sample 281-16, CC.
16. Sample 281-16, CC.
17. Sample 281-16, CC.

Figures 18-23 *Archaeosphaeridium tasmaniae* n. sp.
18. Sample 280A-1-2, 120 cm.
19. Sample 280A-1-2, 120 cm.
20. Sample 280A-4, CC.
21. Sample 280A-1, CC.
22. Sample 280A-1, CC.
23. Sample 280A-6-2, 110 cm.

PLATE 3

Archaeomonads; magnification ca. 800×.

Figures 1-10 *Archaeosphaeridium tasmaniae* n.sp.
1. Sample 280A-5-1, 110 cm.
2. Sample 280A-2, CC.
3. Sample 280A-4, CC.
4. Sample 280A-4, CC.
5. Sample 280A-4, CC.
6. Sample 280A-4, CC.
7. Sample 280A-4, CC.
8. Sample 280A-4, CC.
9. Sample 280A-4, CC.
10. Sample 280A-2, CC.

(See p. 890)

PLATE 2

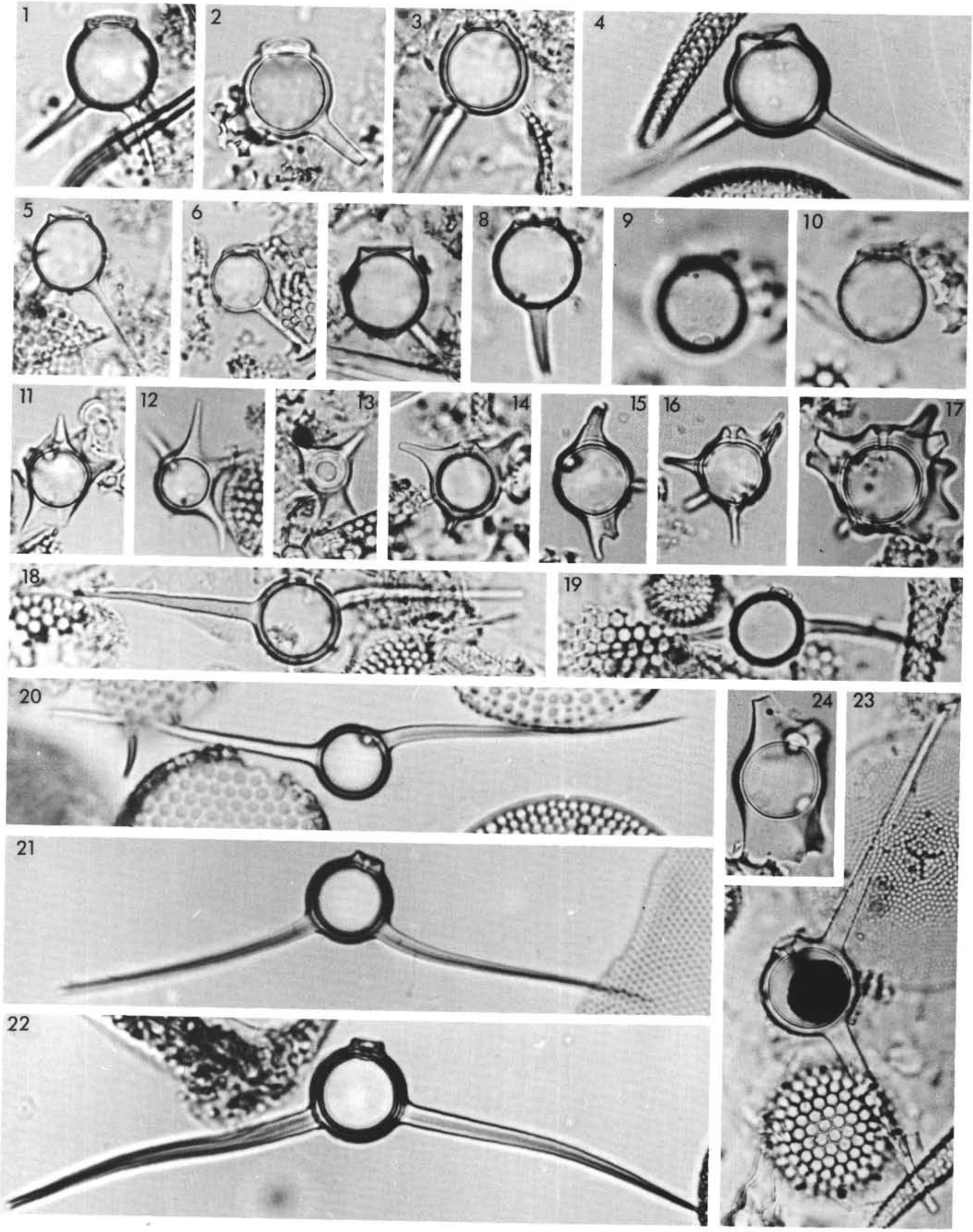

PLATE 3

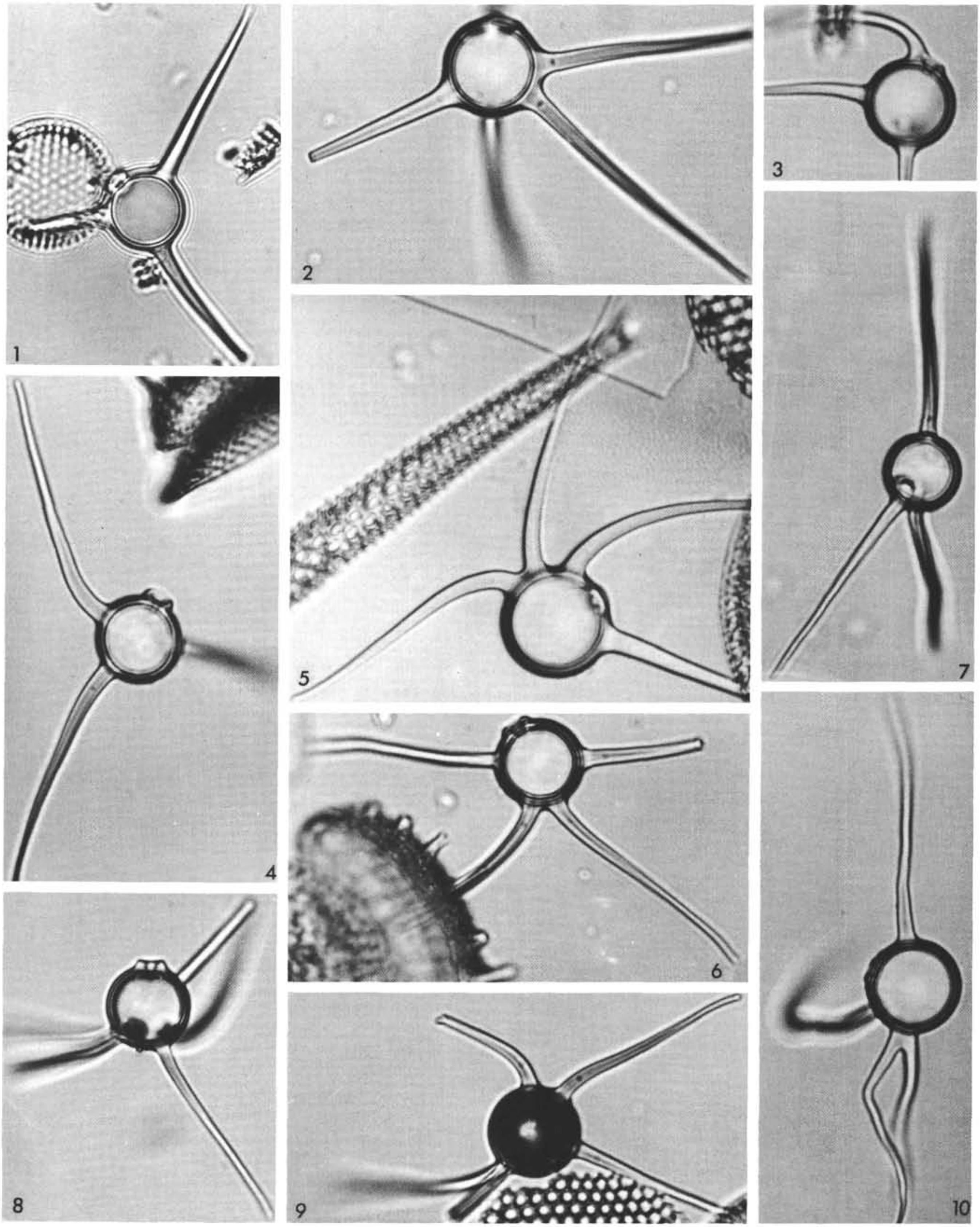

PLATE 4

Ebridians; magnification ca. 800×.

Figures 1-10 — *Craniopsis octo* Hovasse.
1. Sample 277-21-2, 110 cm.
2. Sample 277-21-2, 110 cm.
3. Sample 277-21-2, 110 cm.
4. Sample 277-21-2, 110 cm.
5. Sample 277-21-2, 110 cm.

6, 7. Sample 283-3-1, high and low focus.
8, 9. Sample 283-5-2, 117 cm, high and low focus.
10. Sample 283-5-2, 117 cm.

Figures 11-14 — *Ebriopsis crenulata* Hovasse.
11. Sample 277-12-4, 110 cm.
12. Sample 277-12-4, 110 cm.
13. Sample 277-15-4, 110 cm.
14. Sample 277-18-2, 110 cm.

Figure 15 — *Ebriopsis antiqua* (Schulz); Sample 281-14, CC.

Figure 16 — *Hermesinum geminum* n.sp.; Sample 280A-4, CC.

Figures 17, 18, 29 — *Ammodochium ampulla* Deflandre.
17. Sample 283-5-2, 117 cm.
18. Sample 283-5-2, 117 cm.
29. Sample 277-21-2, 110 cm.

Figures 19-28, 30-32 — *Ammodochium rectangulare* (Schulz).
19. Sample 283-6-2, 117 cm.
20. Sample 277-5-4, 110 cm.
21. Sample 283-5-2, 117 cm.
22. Sample 280A-1-2, 120 cm.
23. Sample 277-6-4, 110 cm.

24, 28. Sample 280A-6-2, 110 cm, high and low focus.
25. Sample 280A-2-3, 110 cm.
26. Sample 283-3-1.
27. Sample 277-8-4, 110 cm.
30. Sample 283-3-1.
31. Sample 280A-7, CC.
32. Sample 280A-1-2, 110 cm.

Figures 33-35 — *Parebriopsis fallax* Hovasse, with hypersilicified crest.
33. Sample 283-5-2, 117 cm.
34. Sample 281-16, CC.
35. Sample 283-6-2, 117 cm.

(See p. 892)

PLATE 4

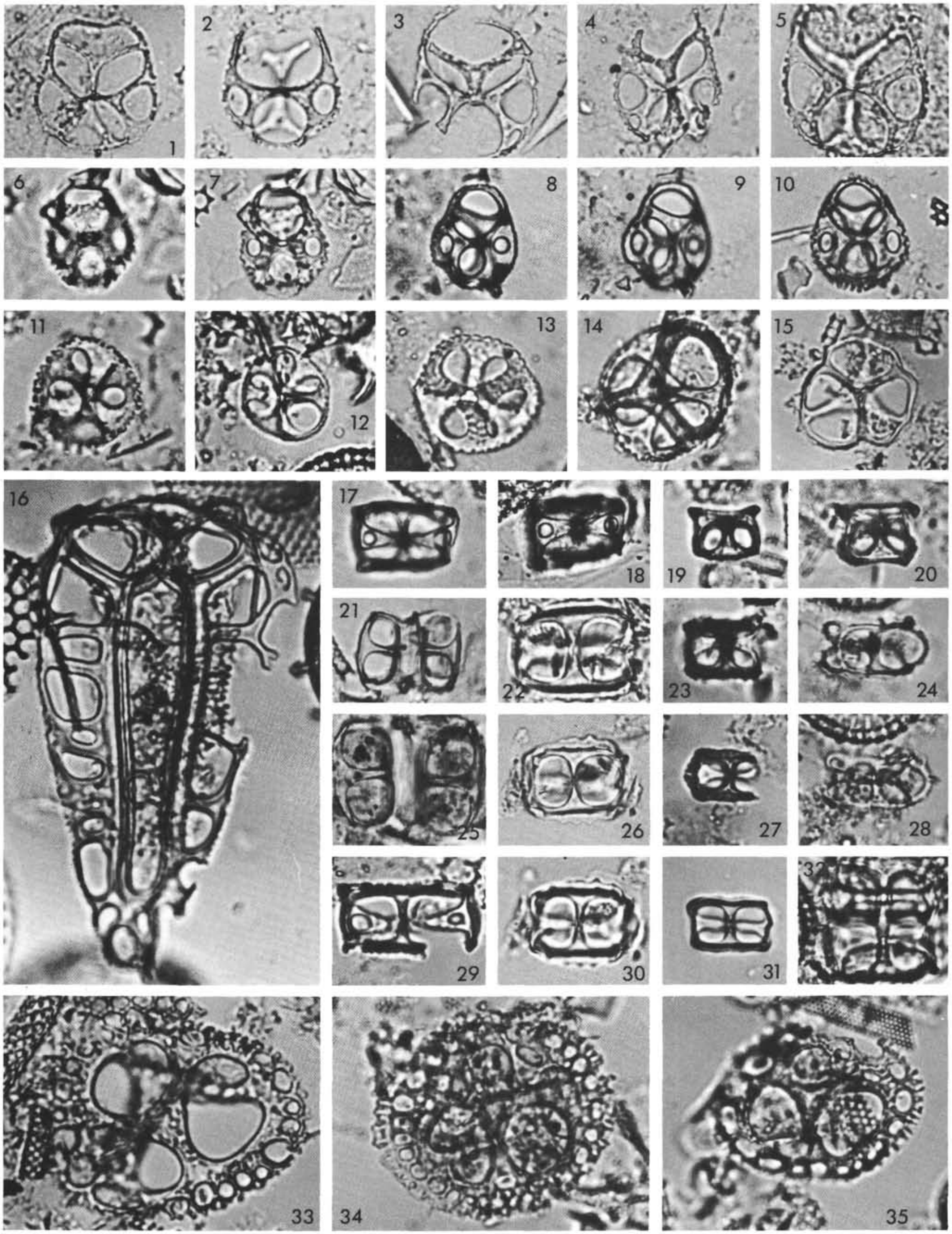
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PLATE 5

Ebridians; magnification ca. 800×.

Figures 1, 2	*Ammodochium speciosum* Deflandre; high and low focus; Sample 277-21-2, 110 cm.
Figures 3, 4	*Ammodochium* cf. *A. danicum curtum* Deflandre; Sample 281-8, CC, high and low focus.
Figures 5, 6	*Ammodochium rectangulare* (Schulz), apical or basal view; Sample 277-23-2, 110 cm.ure 7
Figure 7	*Hermesinella transversa* Deflandre; Sample 281-14, CC.
Figures 8-12	*Parebriopsis fallax* Hovasse. 8. Sample 277-21-2, 110 cm. 9. Sample 283-5-2, 117 cm. 10. Sample 281-14, CC. 11. Sample 277-21-2, 110 cm. 12. Sample 283-4, CC.
Figures 13-17	*Ammodochium rectangulare* (Schulz), double skeletons. 13, 14. Sample 278-32-1, CC; high and middle focus. 15. Sample 283-3-1. 16. Sample 280A-4-3, 110 cm. 17. Sample 277-17-4, 110 cm.
Figures 18-21	*Ebriopsis crenulata* Hovasse. 18. Sample 281-16, CC. 19. Sample 281-16, CC. 20. Sample 283-3-1. 21. Sample 283-3-1.
Figure 22	*Ammodochium rectangulare* (Schulz); Sample 281-8, CC.
Figures 23-26	*Ammodochium ampulla* Deflandre. 23. Sample 283-5-2, 117 cm. 24, 25. Sample 281-16, CC, high and low focus. 26. Sample 281-14, CC.

(See p. 894)

PLATE 5

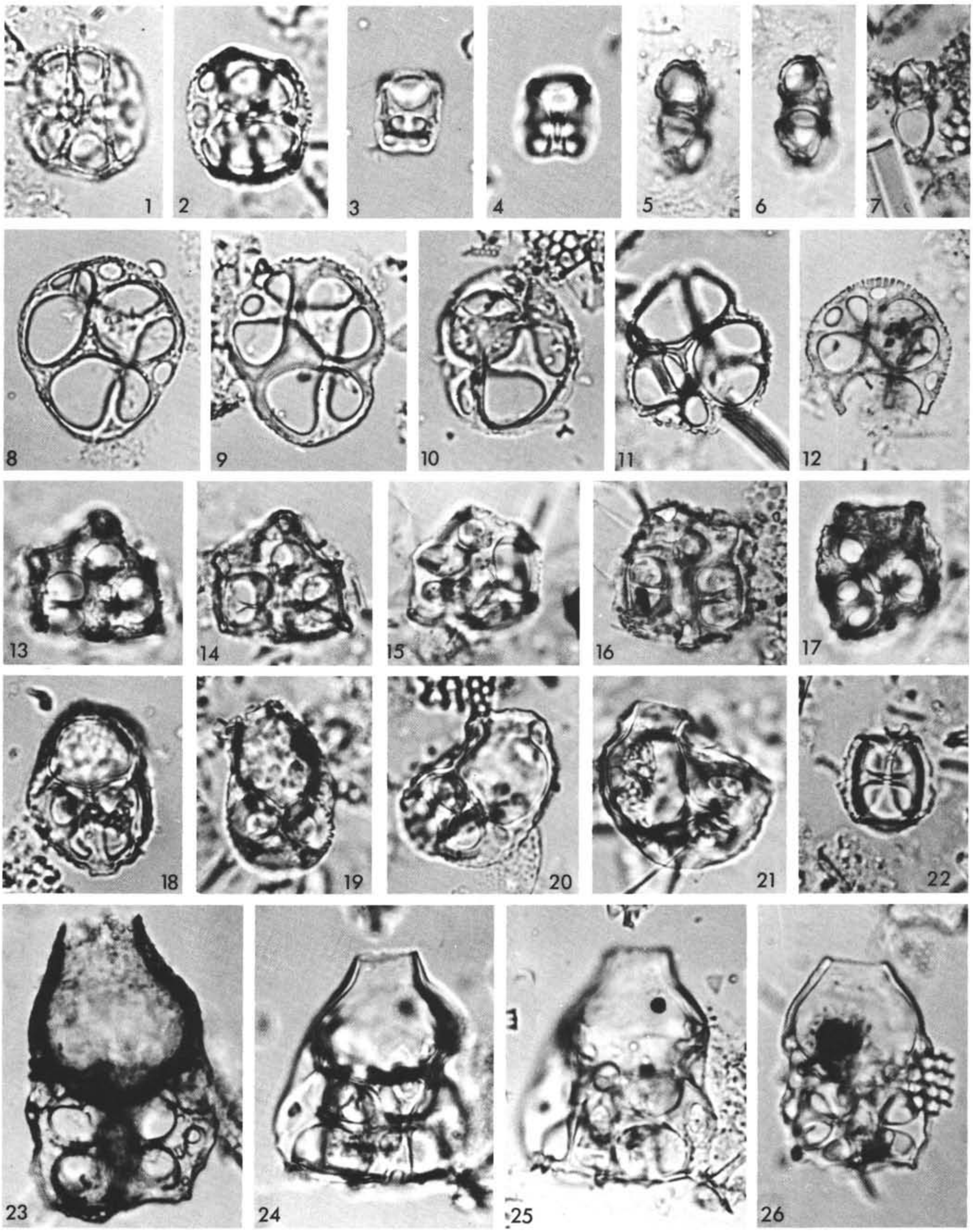

PLATE 6

Ebridians; magnification ca. 800×.

Figures 1-11 *Micromarsupium anceps* Deflandre.
1. Sample 283-5-2, 117 cm.
2. Sample 283-5-2, 117 cm.
3. Sample 283-5-2, 117 cm.
4. Sample 283-5-2, 117 cm.
5. Sample 280A-3-3, 110 cm.
6. Sample 283-6, CC.
7. Sample 283-6,18.
8. Sample 283-6, CC.
9. Sample 283-6, CC.
10. Sample 283-6, CC.
11. Sample 283-6, CC.

(See p. 896)

PLATE 7

Ebridians; magnification 800×.

Figures 1-7, 10, 11, 13 *Micromarsupium anceps* Deflandre.
1, 2. Sample 283-7, CC; different focus.
3. Sample 283-6, CC.
4, 5. Sample 283-6, CC; different focus.
6, 7. Sample 280A-5-1, 110 cm.
10. Sample 280A-7-3, 110 cm.
11. Sample 283-5-2, 117 cm.
13. Sample 281-15, CC.

Figures 8, 9 *Ebriopsis cornuta* Dumitrica and Perch-Nielsen, n. sp.
8, 9. Sample 277-21-2, 110 cm.

Figure 12 *Ebriopsis* cf. *E. aplanata* Deflandre; Sample 280A-4-3, 110 cm.

(See p. 897)

PLATE 6

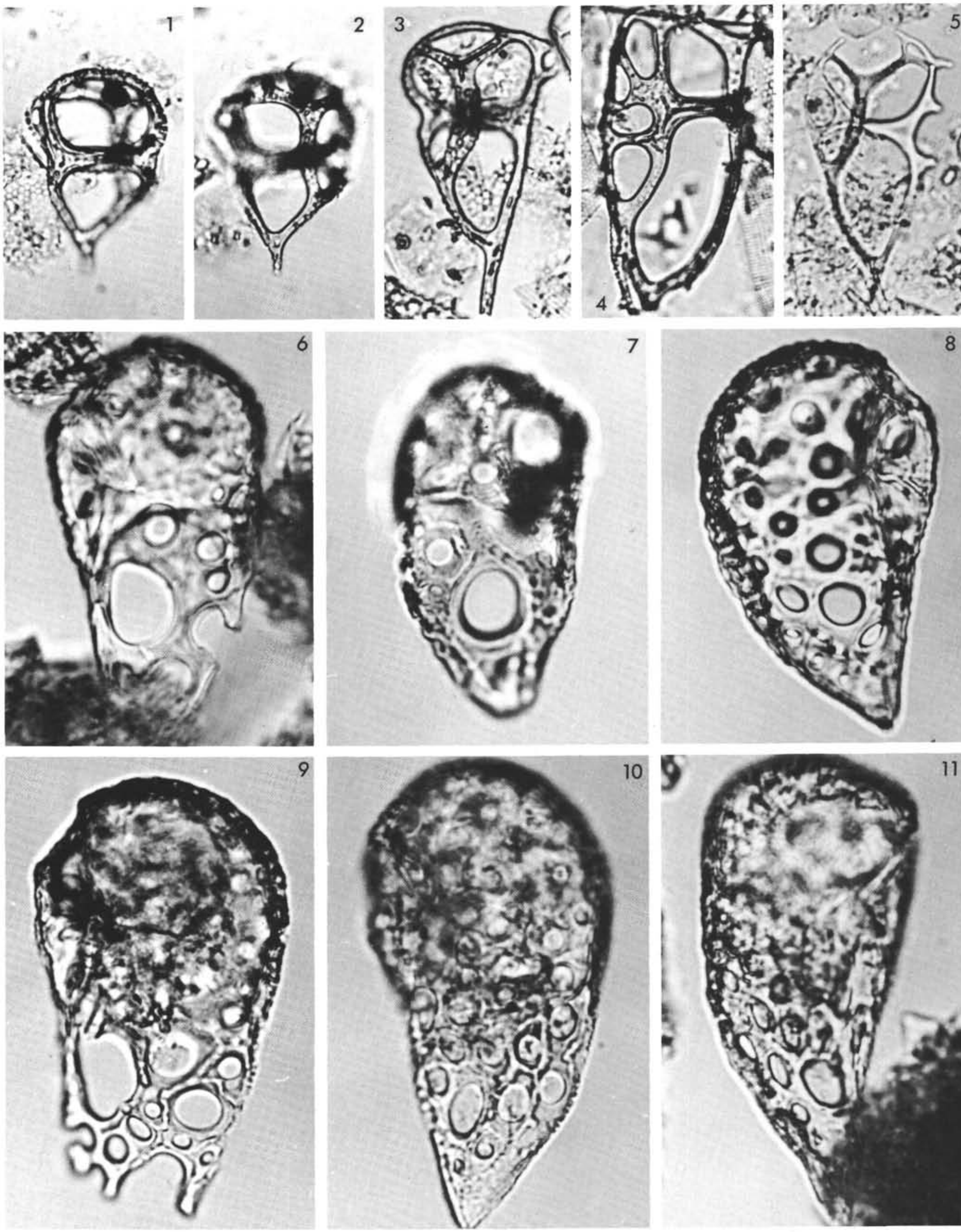

PLATE 7

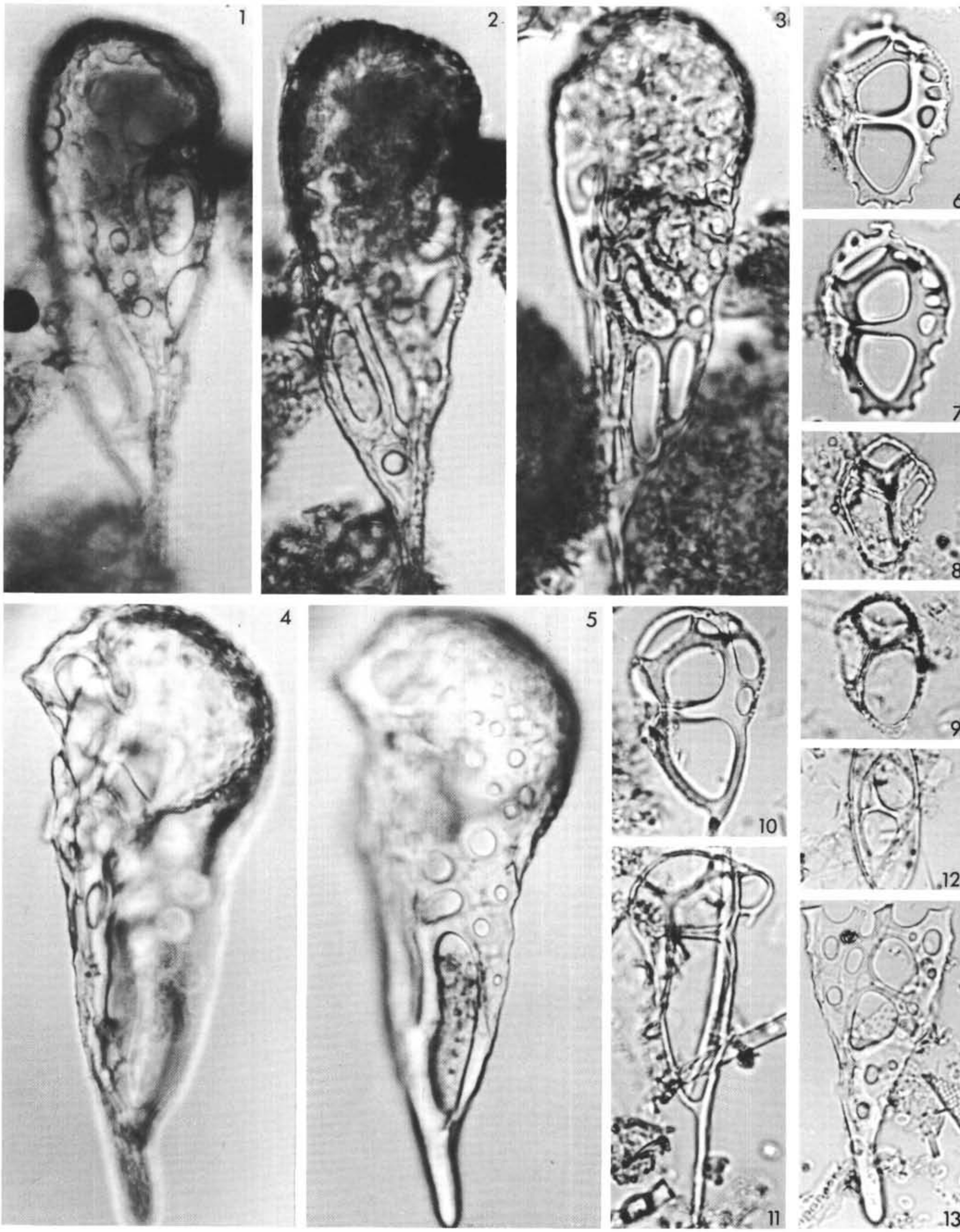

PLATE 8

Ebridians; magnification ca. 600×.

Figures 1-16	*Hermesinum geminum* n.sp. 1, 2. Sample 278-31, CC; different focus. 3. Sample 278-31, CC. 4. Sample 278-31, CC. 5. Sample 280A-1, CC. 6. Sample 280A-2, CC. 7. Sample 280A-3, CC. 8. Sample 280A-3, CC. 9, 10. Sample 280A-4, CC; turned in the plane of the opisthoclade 01. 11. Sample 280A-4, CC. 12. Sample 280A-4, CC. 13. Sample 280A-4, CC. 14. Sample 280A-4, CC. 15. Sample 280A-5, CC. 16. Sample 280A-5, CC.

PLATE 9

Ebridians from Sample 280A-5-1, 110 cm, early Oligocene; silicoflagellate (Figure 4) from Sample 275-2-5, 40 cm; Late Cretaceous.

Figures 1, 2, 4, 6	*Ammodochium rectangulare* (Schulz) 1. 2400×, 0°. 2. 2350×, 50°. 4. 3360×, 0°. 6. 2250×, 25°.
Figure 3	*Vallacerta* cf. *V. tumidula* Glezer; 1050×, 45°.
Figures 5, 7, 8	*Parebriopsis fallax* Hovasse. 5. 2350×, 45°. 7. 2500×, 25°. 8. 2400×, 0°.

(See p. 900)

PLATE 8

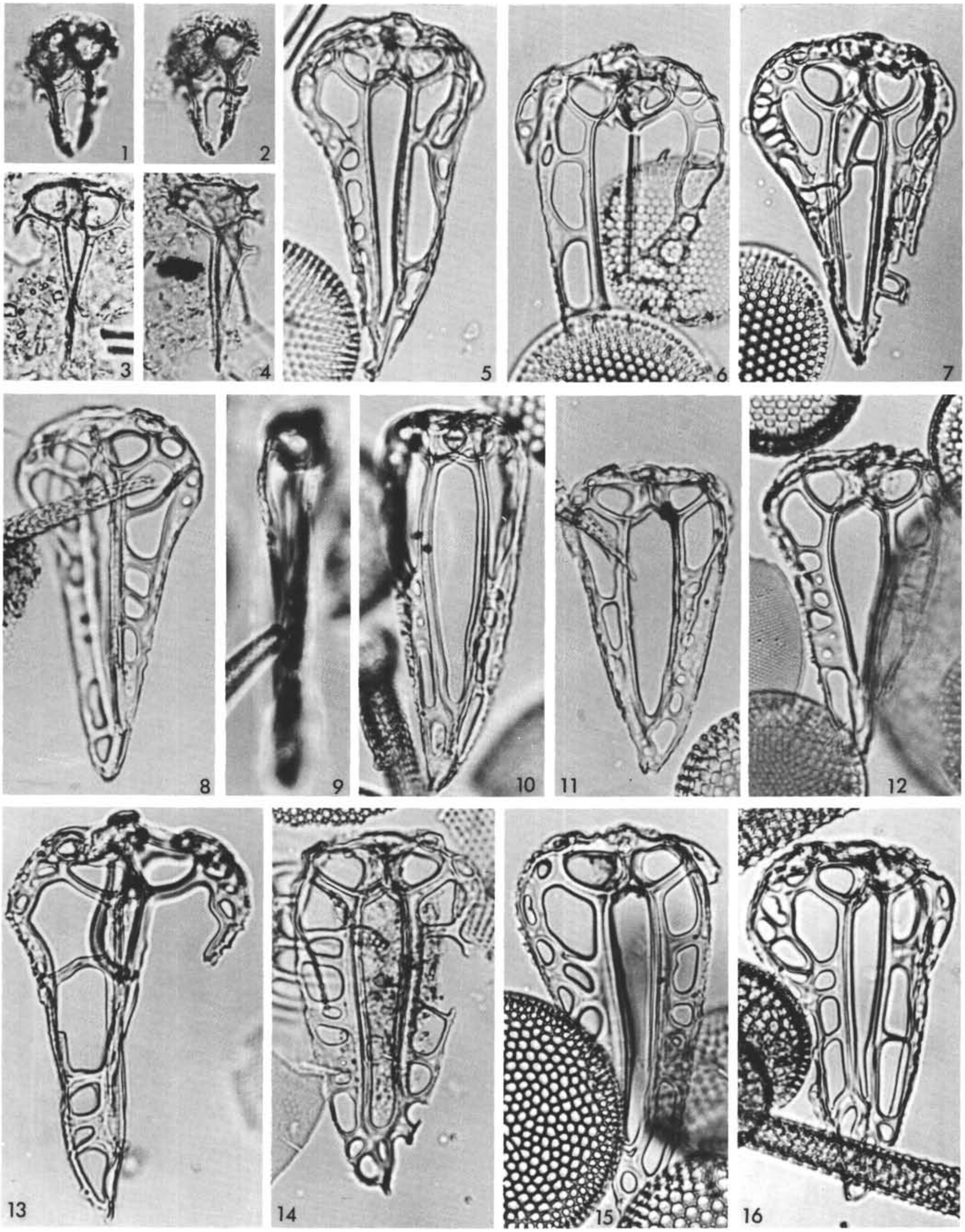

PLATE 9

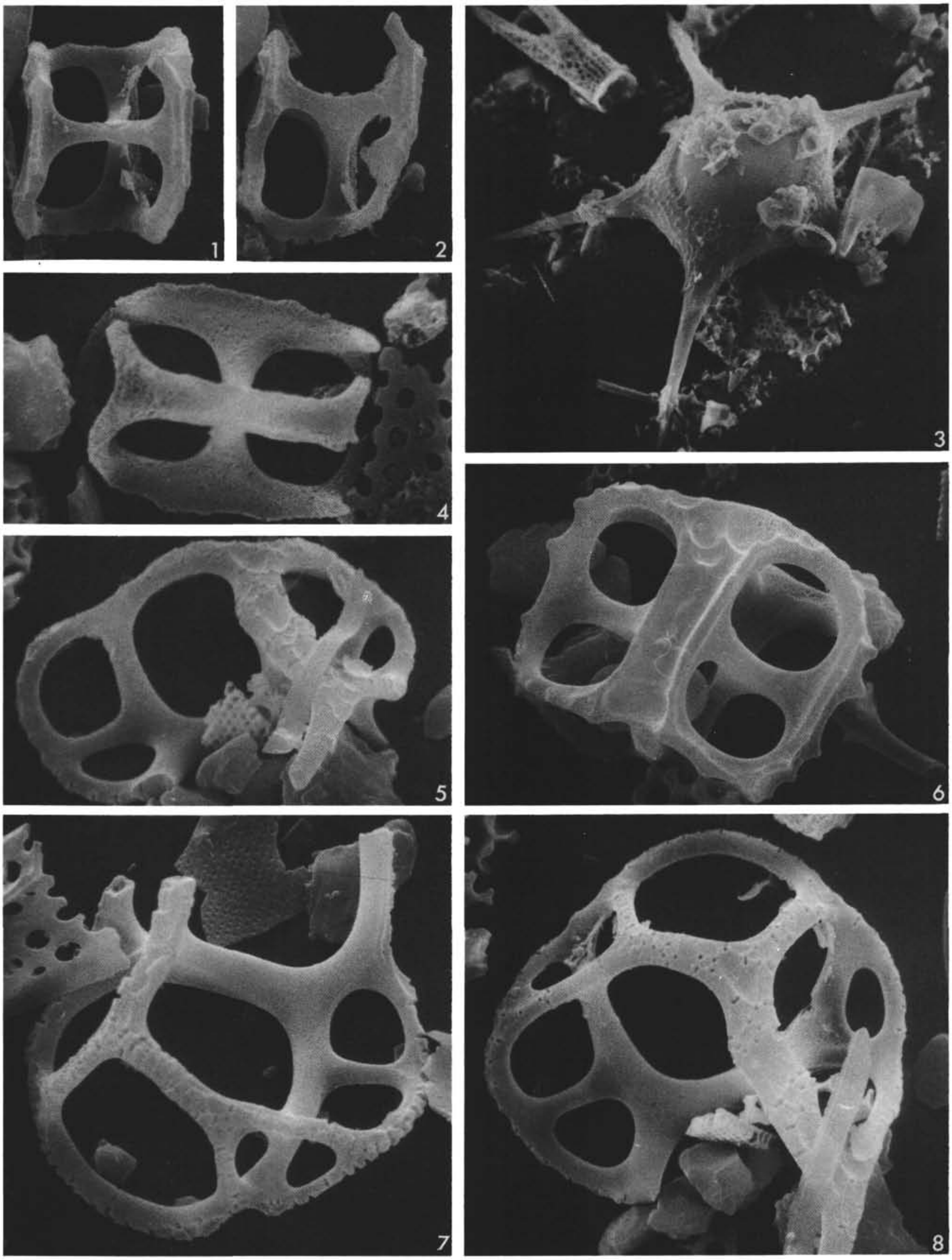

PLATE 10

Endoskeletal dinoflagellates; magnification ca. 800× (Figure 30, 2000×).

Figure 1 — *Actiniscus tetrasterias* Ehrenberg; Sample 278-9-3, 110 cm.

Figures 2-10, 16 — *Actiniscus pentasterias* Ehrenberg.
2. Sample 278-1-3, 118 cm.
3. Sample 278-10-1, 110 cm.
4. Sample 278-11, CC.
5. Sample 278-14, CC.
6. Sample 278-14, CC.
7. Sample 278-26, CC.
8. Sample 277-6-4, 110 cm.
9. Sample 277-8-4, 110 cm.
10. Sample 278-20-4, 110 cm.
16. Sample 278-31, CC.

Figures 11-13 — *Actiniscus elongatus* Dumitrica.
11. Sample 278-11-5, 110 cm.
12. Sample 278-19, CC.
13. Sample 277-21-2, 110 cm.

Figures 14, 15 — *Foliactiniscus* cf. *F. mirabilis* Dumitrica.
14. Sample 277-6-4, 110 cm.
15. Sample 277-6-4, 110 cm.

Figure 17 — *Carduifolia?* sp.; Sample 277-18-2, 110 cm.

Figure 18 — *Carduifolia lata* Hovasse, basal view; Sample 277-23-2, 110 cm.

Figures 19-25 — *Carduifolia gracilis* Hovasse.
19. Sample 280A-3-3, 110 cm.
20. Sample 280A-5-1, 110 cm.
21. Sample 280A-5-1, 110 cm.
22. Sample 280A-4, CC.
23. Sample 280A-1, CC.
24. Sample 280A-1, CC.
25. Sample 280A-4, CC.

Figures 26-30 — *Carduifolia cf. C. onoporoides* Hovasse.
26. Sample 275-1-1, 136 cm.
27. Sample 275-2-4, 50 cm.
28. Sample 275-2-4, 50 cm.
29. Sample 275-2-4, 50 cm.
30. Sample 275-2-4, 50 cm.

PLATE 10

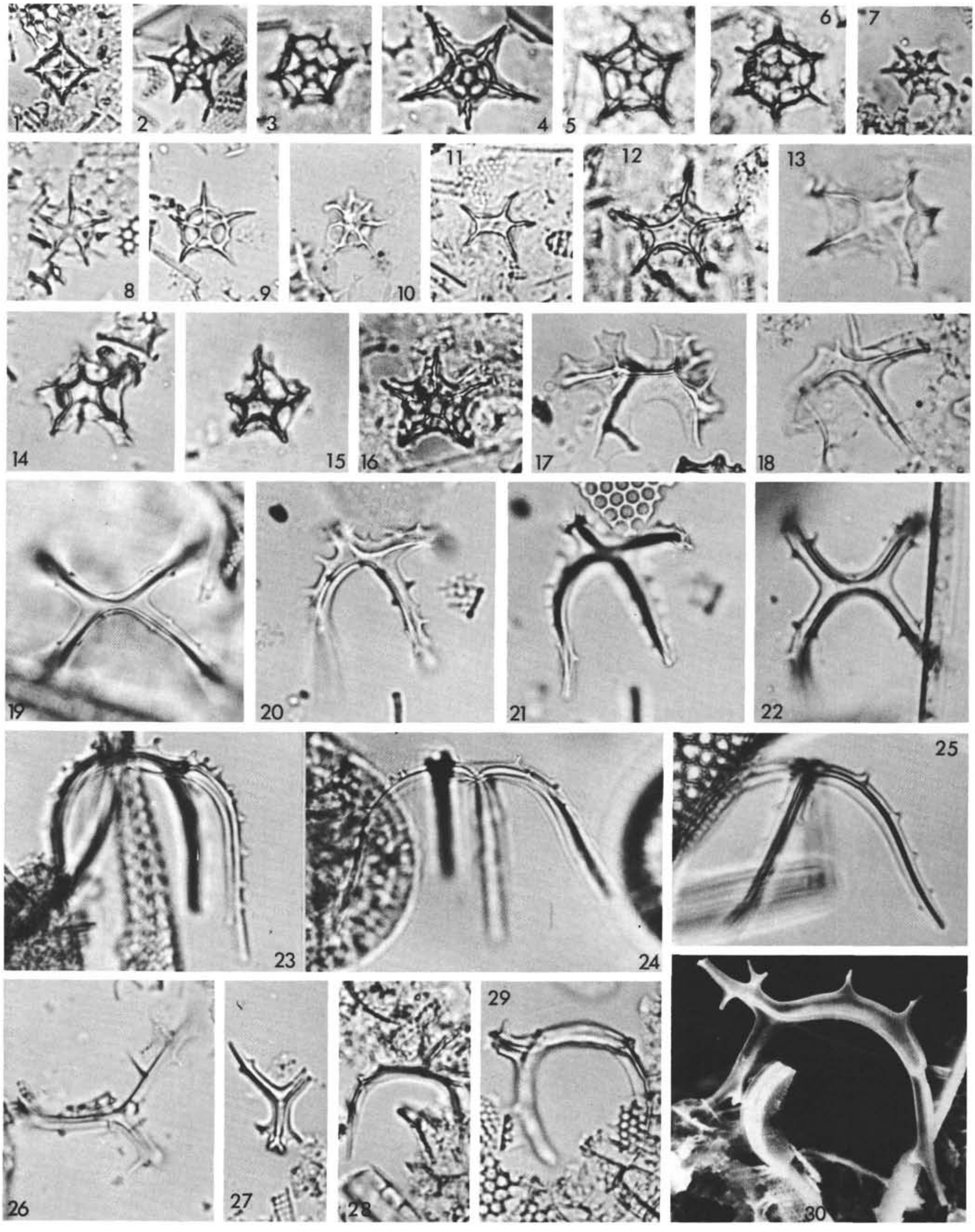
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PLATE 11

Diatoms?; magnification ca. 800×.

Figures 1-10 *Rocella gemma* Hanna.
1. Sample 278-31-2, 110 cm.
2. Sample 278-31-2, 110 cm.
3. Sample 278-31-2, 110 cm.
4. Sample 278-31-2, 110 cm.
5. Sample 278-31-2, 110 cm.
6. Sample 278-20-6, 130 cm.
7. Sample 278-27, CC.
8. Sample 278-31-2, 110 cm.
9. Sample 278-27, CC.
10. Sample 278-29, CC.

Figure 11 *Pseudorocella corona* Deflandre; Sample 277-6-4, 110 cm.

Figures 12, 13 *Rocella ?* sp.1.
12. Sample 277-7-4, 110 cm.
13. Sample 280A-1-2, 120 cm.

(See p. 904)

PLATE 12

Archaeomonads.

Figures 1-3 *Archaeosphaeridium tasmaniae* n.sp.; Sample 280A-5-1, 110 cm.
1,3. Magnification 1150×.
2. Magnification 2300×.

Figure 4 *Archaeomonas* sp.; Sample 280A-5-1, 110 cm; magnification 11,550×.

Figure 5 *Archaeomonas paucispinosa* Deflandre Sample 275-2-1, 130 cm; magnification 11,200×.

Figure 6 *Archaeomonas* cf. *A. scabratula* Deflandre; Sample 275-2-5, 40 cm; magnification 10,500×.

(See p. 905)

PLATE 11

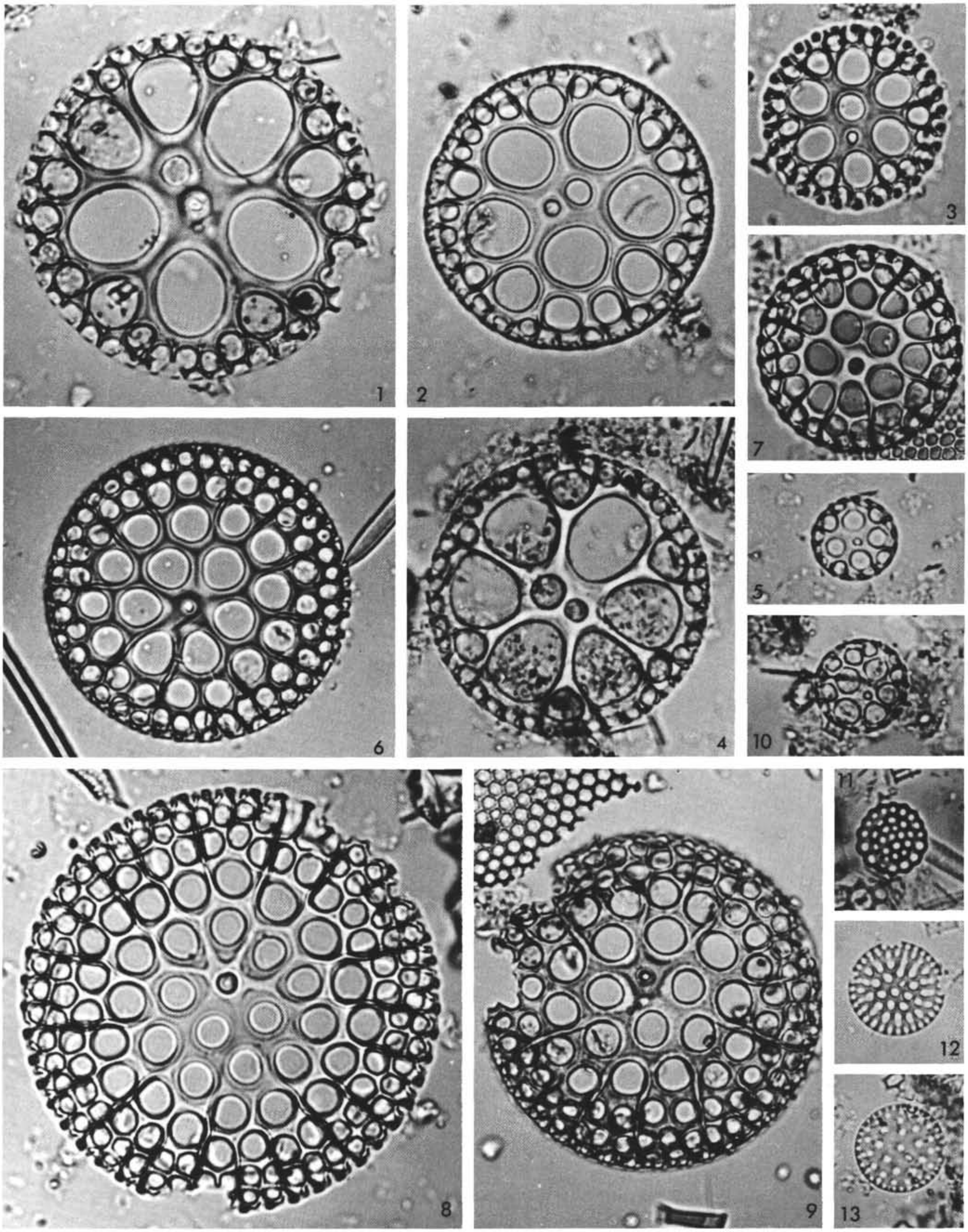

PLATE 12

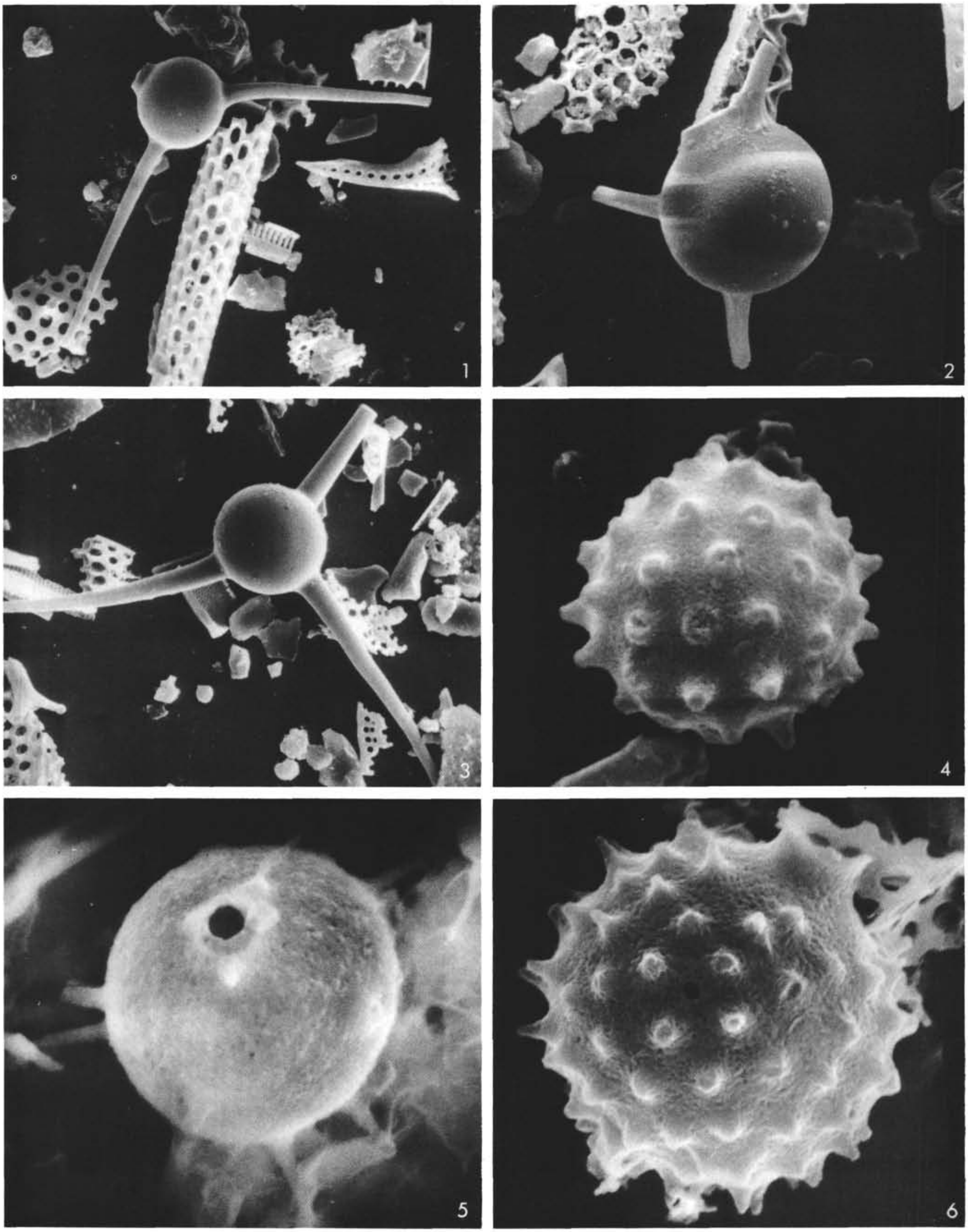

PLATE 13

Diatoms(?) from the Late Cretaceous at Site 275; magnification ca. 800×; Figures 24-27 ca. 2000×.

Figures 1-4, 10-14, 16-27	*Micrampulla parvula* Hanna.
Figures 5-8, 15	*Micrampulla* ? sp.
Figure 9	Diatom.

PLATE 13