

15. EOCENE TO PLIOCENE ARCHAEMONADS, EBRIDIANS, AND ENDOSKELETAL DINOFLAGELLATES FROM THE NORWEGIAN SEA, DSDP LEG 38

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ABSTRACT

Eocene to Pliocene archaeomonads, ebridians, endoskeletal dinoflagellates, and some siliceous microfossils of uncertain affinity found in siliceous sequences cored on DSDP Leg 38 in the Norwegian Sea are listed and illustrated. The diversity of forms is highest in the Eocene sequences and decreases in younger sediments. The diversity is generally lower than in the somewhat lower southern latitude material studied from DSDP Leg 29 from the subantarctic southwest Pacific and New Zealand. Six new archaeomonads, three new ebridians, and one new endoskeletal dinoflagellate are described.

INTRODUCTION

Besides the better known and more often studied Radiolaria, diatoms, and silicoflagellates, some smaller groups of siliceous micro- and nannofossils are commonly found in diatom-rich sediments: archaeomonads, ebridians, and endoskeletal dinoflagellates. Their presence is rarely mentioned in DSDP reports, as they do not occur in large enough amounts to be noted by the sedimentologists. However, sediment layers consisting solely of archaeomonads are known to exist.

These groups were studied in Upper Cretaceous to Pleistocene siliceous sediments from the subantarctic southwest Pacific at latitudes of 40° to 55°S (Perch-Nielsen, 1975). Previously, Dumitrica (1973) reported on ebridians and endoskeletal dinoflagellates from the southwestern Pacific (DSDP Leg 21), and Ling (1973, DSDP Leg 19) discussed ebridians from the North Pacific. It was therefore of great interest to study these groups from high northern latitude sites in the Atlantic and to compare the findings with the results from the high southern latitudes presented in Perch-Nielsen (1975).

Methods of Study

Smear slides were prepared for all samples and studied by light microscope. Samples from Sites 338-341, especially rich in archaeomonads, ebridians, or endoskeletal dinoflagellates or showing one of them in better than average preservation, were treated with diluted HCl and washed several times with water by centrifuging. A drop of the residue was then put on a round cover slide and mounted on a stub for observation in the SEM.

Samples

Samples were studied from the sites listed in Table 1. Cores containing archaeomonads and/or ebridians and/or endoskeletal dinoflagellates are also listed. The

TABLE 1
Cores Studied From Leg 38 Sites for Archaeomonads, Ebridians, or Endoskeletal Dinoflagellates

Site	Cores	Method of Study	Age
338	8-29 (9, 10, 12, 24, 25, 28 not seen)	LM, SEM	L. Eocene to M. Miocene
339	8, 11 (7, 9, 10, 12 not seen)	LM, SEM	L. Eocene or Oligocene
340	2-11 (6 not seen)	LM, SEM	L. Eocene
341	26-34	LM, SEM	M. Miocene
342	3-6	LM	E. Miocene
346	6-9, 11	LM	M. Miocene
348	5-7, 11, 13-16 (10, 12, 17, 18 not seen)	LM	M. Miocene to Pleistocene

fossils were not found at Sites 343, 344, 347, 349, and 350. The site localities are shown in Figure 1.

SPECIFIC RESULTS FOR SITES 346 AND 348

Site 346

Site 346 was located on the Jan Mayen Ridge in a water depth of 732 meters. Cores 5 and 6 belong to the silicoflagellate zone of *Corbisema triacantha* of early to middle Miocene age. Cores below Sample 12, CC could not be assigned to any silicoflagellate zone. The siliceous assemblage contains mainly diatoms. Sponge spicules are often common. The presence of common sponge spicules is often a sign of solution of the other, more delicate siliceous components of the sediment. Thus, no ebridians were found, only few and poorly preserved archaeomonads are present. No endoskeletal dinoflagellates were observed. The archaeomonads include *Archaeomonas dubia* in Samples 346-6-3, 65 cm; 346-7-3, 110 cm; and 346-11-3, 110 cm. *A. cf. A. semplica* is present in the first two of the listed samples, and *Archaeomonas* sp. is found in Sample 346-7-3, 110 cm. *Archaeosphaeridium ornatum* was found only in

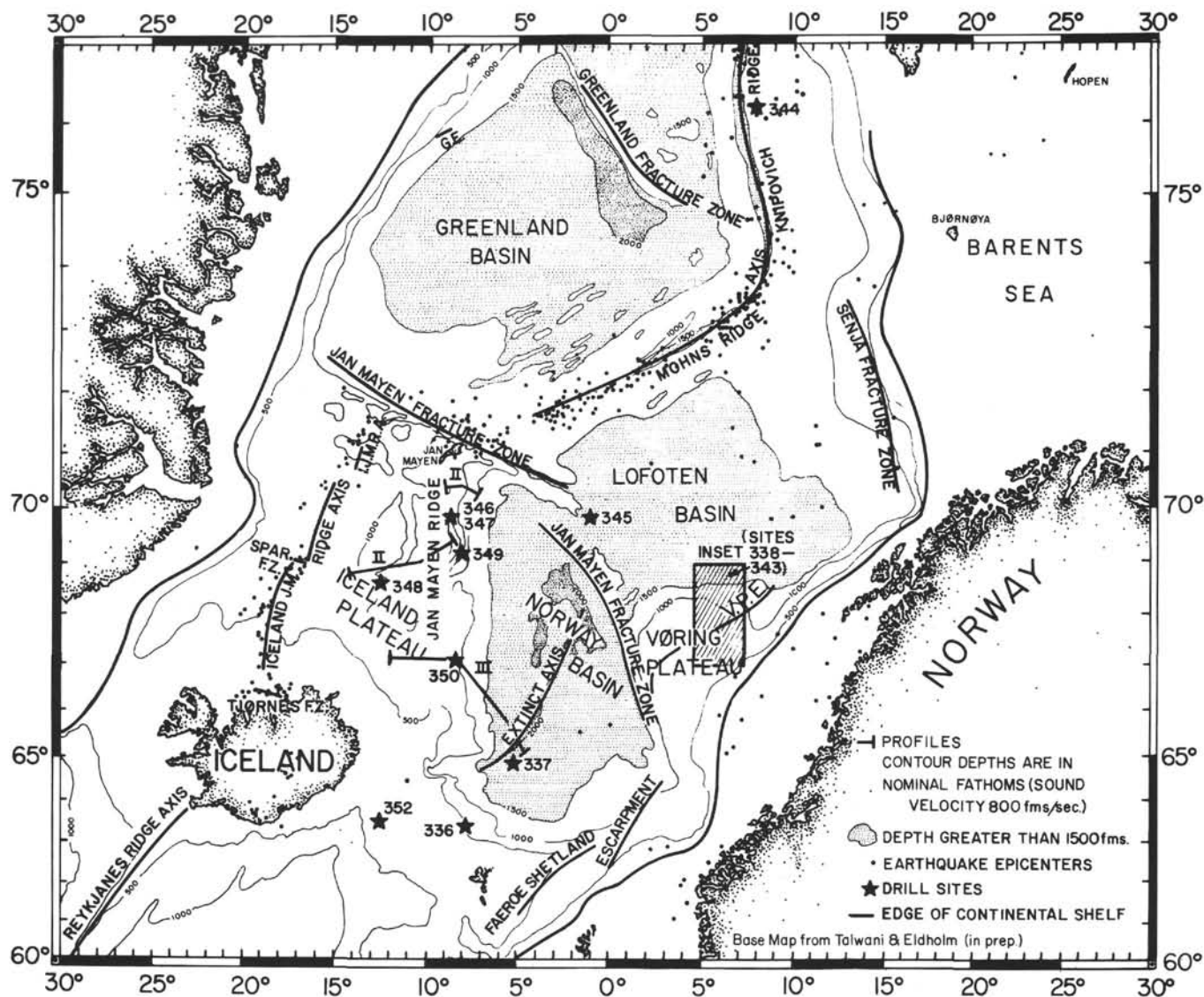


Figure 1. Map showing sites drilled on Deep Sea Drilling Project, Leg 38.

Sample 346-9-3, 145 cm and is the only archaeomonad species in this sample that could survive the apparent solution.

Site 348

Site 348 was located on the Icelandic Plateau in a water depth of 1763 meters. Archaeomonads, ebridians, and endoskeletal dinoflagellates were found in most siliceous samples studied from Cores 5 through 16. The occurrence of common archaeomonads in the two uppermost cores is of special interest, since Core 348-5 is assigned to the *Distephanus speculum* Zone of silicoflagellates which is given a Pliocene or Pleistocene age, and Core 348-6 is assigned to the *Distephanus boliviensis* Zone (uppermost Miocene to lower Pliocene). Except for archaeomonads from questionable Pliocene from DSDP Site 278 in the subantarctic southwest Pacific, no archaeomonads younger than Miocene have been reported. If the age assignment here is correct, the range of archaeomonads can be extended

at least into the Pliocene. Besides *Archaeomonas dubia*, which occurs in most samples, *A. cf. A. simplicia* was found, and *Archaeosphaeridium ornatum* was found in Sample 348-14-3, 80 cm, of middle or late Miocene age.

Ammodochium rectangulare and *Ebriopsis crenulata* occur sporadically and *Pseudammodochium cf. P. dictyoides* was found only in Sample 348-6-3, 15 cm. *Actiniscus pentasterias* is present in all siliceous samples, *A. tetrasterias* only in Sample 348-11-3, 95 cm.

ARCHAEOMONADS

The Archaeomonadaceae are a family of fossil marine chrysomonads which, during their life cycle, formed cysts consisting of SiO_2 . The archaeomonads probably led a planktonic life in the photic zone of the oceans and their cysts had an opening. The form and size of the opening, as well as of the cyst, are used to distinguish genera and species. Archaeomonads occur from the Late Cretaceous through the Miocene and possibly Pliocene (Tynan, 1971; Perch-Nielsen, 1975).

Late Eocene

Siliceous sediments of late Eocene age were recorded at Sites 338, 339, and 340. They yielded rare to common archaeomonads, the assemblage typically including *Archaeomonas striata*, *A. heteroptera*, and *A. ninae*. Six new species are described from the late Eocene to early Oligocene. The late Eocene to early Oligocene (late Eocene and early Oligocene cannot be distinguished by silicoflagellates which were used for the age determination in most cases) archaeomonad assemblages are different and richer than those reported from the subantarctic southwest Pacific (Perch-Nielsen, 1975), although some species are in common.

Oligocene

Oligocene siliceous sediments were cored at Sites 338, 339, and 346 and include less diverse archaeomonad assemblages than the late Eocene or most of the Miocene studied from the Norwegian Sea. The assemblage is especially poor in the interval assigned by silicoflagellates to the middle Oligocene, whereas it is richer in the intervals assigned to "late Eocene to early Oligocene" and "late Oligocene to early Miocene," the latter boundary being comprised within a silicoflagellate zone. Also, the Oligocene archaeomonad assemblage differs from the one described from the subantarctic southwest Pacific. Most conspicuous is the absence of *Archaeosphaeridium tasmaniae* and *A. australensis* in the Oligocene of the Norwegian Sea.

Miocene

The Miocene siliceous sequences of Sites 338, 341, 342, 346, and 348 were studied for this report. Archaeomonads are absent or rare to common, and the diversity is higher than in the Oligocene, but considerably lower than in the late Eocene. Diversity and abundance are highest in the middle Miocene, a fact already observed in most Miocene sequences studied for archaeomonads. In fact, most Miocene archaeomonads described are from the middle Miocene.

Pliocene-Pleistocene

Pliocene-Pleistocene siliceous sediments were cored at Site 348 and dated by silicoflagellate zonation (*Distephanus speculum* Zone). If this age assignment is correct, the archaeomonads found in Cores 348-5 and 348-6 are the youngest yet observed—*Archaeomonas dubia*, and a form very similar to *A. dubia*, but with somewhat more robust spines. These forms could, however, also be reworked since they occur in a sediment with a considerable amount of clastic material.

SYSTEMATIC PALEONTOLOGY

The taxonomy used in this report was proposed by Deflandre (1932a), who also is the author of most species found in the siliceous sediments studied from DSDP Leg 38. It is based mainly 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), and their stratigraphic distribution is compiled in Tynan (1971). A discussion of the Chrysomonad cyst-families Chrysostomataceae and Archaeomonadaceae and their status in paleontology is given by Cornell (1970), who also discusses their biology.

Genus ARCHAEOMONADOPSIS Deflandre, 1938

Archaeomonadopsis lagenula Deflandre, 1938 (Plate 3, Figure 20)

Remarks: *A. lagenula*, an easily recognizable, large form, was described from the upper Eocene diatomite of Oamaru, New Zealand, and was found in the upper Eocene sediments at Site 340 on the Vøring Plateau.

Genus ARCHAEOMONAS Deflandre, 1932a

Archaeomonas areolata Deflandre, 1933 (Plate 1, Figures 5-8, 10; Plate 4, Figures 2, 3)

Remarks: *A. areolata* was originally described from the Mio-Pliocene of Karand, Hungary, and was found in the Miocene at Site 338 on the Vøring Plateau. The SEM pictures on Plate 1 show different states of preservation of this species from the well-preserved specimen in Figure 6 to the poorly preserved form in Figure 10.

Archaeomonas chenevieri Deflandre, 1932e (Plate 3, Figures 11, 12)

Remarks: *A. chenevieri* has an irregular pattern of small ridges on the surface of the cyst. It was originally described from "reworked Eocene" in the Caspian Sea and was found in the upper Eocene sediments at Site 340 on the Vøring Plateau.

Archaeomonas cf. *A. circuligera* Rampi, 1969 (Plate 2, Figure 7)

Remarks: The archaeomonad illustrated by the SEM photograph seems to be close to *A. circuligera* as shown by an LM photograph and drawings by Rampi (1969). *A. circuligera* has, however, relatively smaller circular ornaments than the form illustrated here, which was found in the upper Eocene sediments at Site 340 on the Vøring Plateau. *A. circuligera* was described from the upper Eocene Kreyenhagen diatomite in California.

Archaeomonas deflandrei Rampi, 1948 (Plate 2, Figure 6)

Remarks: *A. deflandrei* is a small archaeomonad with a simple opening and low, but thin ridges. It was described originally from the Miocene diatomite of Sicily and illustrated by a rather schematic drawing. Similar forms are *A. gracilis* Tynan, 1960, which has a collar, and *A. lefeburei* Deflandre, 1933, which also has a collar and a simpler pattern of ridges. *A. deflandrei* occurs in the Miocene of the Vøring Plateau.

Archaeomonas cf. *A. dentata* Deflandre, 1932c (Plate 4, Figures 9, 10)

Remarks: *A. dentata* was described from the lower Eocene diatomite of Fur, Denmark, as an archaeomonad with conical spines of different length. The form illustrated here shows spines more equal in length, and occurs in the Oligocene at Site 338 on the Vøring Plateau.

Archaeomonas dubia Deflandre, 1933 (Plate 2, Figures 8, 9; Plate 3, Figure 10)

Remarks: *A. dubia*, as described from the upper Eocene diatomite of Oamaru, New Zealand, is an archaeomonad with a simple collar and a large number of small spines. Such forms are common in some samples of the Miocene at Site 339 on the Vøring Plateau and in the Miocene and Pliocene of Site 348 on the Icelandic Plateau.

Archaeomonas helminthophora Deflandre, 1933 (Plate 1, Figures 12, 16; Plate 3, Figures 23, 24)

Remarks: The SEM picture of *A. helminthophora* shows the small opening to lie on a small platform. This species was described originally from the Miocene diatomite of Maryland, USA, and was found to occur in the Miocene at Site 338 on the Vøring Plateau.

Archaeomonas heteroptera Deflandre, 1932c (Plate 1, Figures 17-20; Plate 3, Figures 23-26)

Remarks: *A. heteroptera* was described from the lower Eocene diatomite of Fur, Denmark, and was also found in the upper Eocene

Kreyenhagen diatomite in California, and at DSDP Site 283 in the subantarctic southwest Pacific. From the Miocene of Japan, Bachmann (1964) described an *A. heteroptera* with a simpler collar than the one usually seen on Paleogene forms of this species. The same difference could be seen in the forms studied here, between the Eocene and Miocene specimens. The number of ridges, their height, and the size of the specimens vary greatly.

***Archaeomonas japonica* Deflandre, 1933**
(Plate 3, Figure 9)

Remarks: *A. japonica* was originally described from the Miocene of Japan, but also occurs in the Eocene (Kreyenhagen) of California and in the Oligocene to the Miocene at DSDP Site 278 in the subantarctic southwest Pacific. On the Vøring Plateau, it was found in the upper Eocene sediments at Site 340.

***Archaeomonas karinae* n. sp.**
(Plate 2, Figures 15-17)

Holotype: Plate 2, Figure 15.

Diagnosis: *Archaeomonas*, spherical with conical spines. Thin, shallow ridges radiate from the base of the spine, some connecting the spines by a ridge. The opening is small and surrounded by a simple collar.

Remarks: In similar forms, like *A. longispina* Rampi, 1948, there are only the ridges connecting the spines and no other ridges radiating from the spines.

Occurrence: *A. karinae* is rare in the late Eocene at Site 340 on the Vøring Plateau.

***Archaeomonas kreyenhagenensis* Rampi, 1969**
(Plate 3, Figure 17)

Remarks: *A. kreyenhagenensis* was described from the Eocene of Kreyenhagen, California and occurs in the late Eocene at Site 340 on the Vøring Plateau.

***Archaeomonas* cf. *A. lefeburei* Deflandre, 1933**
(Plate 3, Figures 13, 14)

Remarks: *A. lefeburei*, as described from the Eocene diatomite from Oamaru, New Zealand, has less shallow ridges than the form illustrated here from the late Eocene of Site 340 on the Vøring Plateau. Some of the ridges cross at right angles.

***Archaeomonas multipunctata* Rampi, 1969**
(Plate 2, Figures 10, 13)

Remarks: Small archaeomonads with a simple opening and a large number of small conical spines are assigned to *A. multipunctata*, although they are smaller than the holotype of this species. *A. multipunctata* was originally described from the Eocene (Kreyenhagen) diatomite of California and was found in the Eocene at Site 340 and in the Oligocene at Site 338 on the Vøring Plateau.

***Archaeomonas ninae* n. sp.**
(Plate 1, Figures 13-15)

Holotype: Plate 1, Figure 13.

Diagnosis: *Archaeomonas* with wedge-formed ornamentations which are pierced by small holes. The opening is small and is not surrounded by a collar.

Remarks: *A. ninae* is similar to *A. helminthophora*, but differs from the latter by the consistent presence of small holes in the ornamentations.

Occurrence: *A. ninae* is not rare in the upper Eocene sediments at Site 340 on the Vøring Plateau.

***Archaeomonas norvegiensis* n. sp.**
(Plate 3, Figures 21, 22)

Holotype: Plate 3, Figures 21, 22.

Diagnosis: *Archaeomonas* with high, slender ridges which are longer than the cyst itself including the collar.

Remarks: *A. norvegiensis* is similar to *A. heteroptera*, but differs from the latter by the longer ridges.

Occurrence: *A. norvegiensis* was found only in one sample of late Eocene age at Site 340 on the Vøring Plateau.

***Archaeomonas oamaruensis* Deflandre, 1933**
(Plate 2, Figures 18-21; Plate 3, Figure 8)

Remarks: In *A. oamaruensis*, as described from the diatomite of late Eocene age at Oamaru, New Zealand, the collar also bears spines which are somewhat smaller than the spines on the cyst itself. Such forms were found in the Eocene at Site 340 and the Miocene at Site 338 on the Vøring Plateau. In some specimens, low ridges connect the spines.

***Archaeomonas* cf. *A. ornata* Rampi, 1969**
(Plate 1, Figure 11)

Remarks: *A. ornata* was described from the Eocene Kreyenhagen diatomite of California and has an ornamentation consisting of small spines surrounded by round depressions. In the specimen illustrated here, the small spines are surrounded by pentagonal and hexagonal depressions. This form was found in the Eocene at Site 339 on the Vøring Plateau.

***Archaeomonas ovoidea* Deflandre, 1933**
(Plate 4, Figures 14, 15)

Remarks: *A. ovoidea*, a large and easily recognizable archaeomonad, was described from the middle Miocene diatomite of San Pedro, California and was found in the middle or late Miocene at Site 341 on the Vøring Plateau.

***Archaeomonas* cf. *A. ovoidea* Deflandre, 1933**
(Plate 4, Figures 12, 13)

Remarks: The form illustrated here is similar to *A. ovoidea* in size and ornamentation. It has, however, an elliptical rather than an egg-shaped outline and its collar bears spines, whereas *A. ovoidea* is egg-shaped and has no spines on the collar. *A. cf. ovoidea* occurs in the Miocene at Site 338 on the Vøring Plateau.

***Archaeomonas paucispinosa* Deflandre, 1938**
(Plate 2, Figure 3; Plate 3, Figure 15)

Remarks: *A. paucispinosa* is a small archaeomonad with few short spines and a simple opening. It was found in the late Eocene of Site 340 on the Vøring Plateau.

***Archaeomonas robusta* Rampi, 1969**
(Plate 2, Figure 14)

Remarks: *A. robusta* is a relatively large form with a collar and many short, but thick, spines. It was described from the Kreyenhagen diatomite of Eocene age of California and occurs in the Eocene at Site 339 on the Vøring Plateau.

***Archaeomonas simplicia* Rampi, 1940**
(Plate 2, Figure 5)

Remarks: *A. simplicia* as described from the Upper Cretaceous diatomite of Moreno, USA, has a smooth surface and a slightly conical collar. It was found in the upper Eocene sediments at Site 340 on the Vøring Plateau.

***Archaeomonas speciosa* Deflandre, 1932c**
(Plate 4, Figure 1)

Remarks: *A. speciosa* from the Miocene diatomite of Maryland, shows a somewhat irregular net-like ornamentation. As in the specimen illustrated here, the meshes of the net are large. It was found also in the Miocene of Hungary and occurs in the Miocene at Site 338 on the Vøring Plateau.

***Archaeomonas sphaerica* Deflandre, 1932c**
(Plate 2, Figure 4)

Remarks: *A. sphaerica*, a relatively large form consisting of a sphere with a smooth surface and an opening without a collar, occurs in the Miocene of Site 338 on the Vøring Plateau. It was originally described from the lower Eocene diatomite of Fur, Denmark, but has been found also in the Miocene of Hungary and Yugoslavia.

***Archaeomonas sphaeroidea* Deflandre, 1938**
(Plate 3, Figure 18)

Remarks: Like *A. sphaerica*, *A. sphaeroidea* has a smooth surface and an opening without a collar. Around the opening, the sphere is

flattened. The species was described from the upper Eocene diatomite of Oamaru, New Zealand, and was also found at DSDP Site 281 in the subantarctic southwest Pacific in upper Eocene samples. On the Vøring Plateau, it occurs in the Miocene at Site 341.

Archaeomonas striata Deflandre, 1933
(Plate 1, Figures 1-4; Plate 3, Figures 1-6)

Remarks: The holotype of *A. striata* shows five parallel ridges parallel to the plane of the opening and five parallel ridges in an angle of about 45° to this plane. *A. striata*'s holotype was illustrated by a drawing and later a photograph of it was given in Deflandre and Deflandre-Rigaud (1970), who also published SEM pictures of the species, taken from the same material as the holotype. These pictures show specimens with about 15 very thin and low ridges. The variation is not so considerable in the material from the Miocene of Site 338 and the late Eocene of Site 340 from the Vøring Plateau as in the diatomite from Fur, Denmark, from where the holotype was described. The opening is surrounded by a low collar. The species was also found in the Miocene at DSDP Site 278 in the subantarctic southwest Pacific.

Archaeomonas vermiculosa Deflandre, 1932c
(Plate 1, Figure 9)

Remarks: The specimen illustrated here has a somewhat larger collar than the holotype of *A. vermiculosa* which was described from the Miocene diatomite of Maryland. It was found in the Miocene at Site 341 on the Vøring Plateau.

Archaeomonas sp. 1
(Plate 3, Figure 7)

Remarks: The form illustrated here has a simple opening and an ornamentation consisting of a pattern of hexagonal and pentagonal ridges. It occurs only in one sample of Oligocene age at Site 338 on the Vøring Plateau.

Archaeomonas sp. 2
(Plate 3, Figure 19)

Remarks: *Archaeomonas* with a smooth surface and spines with parallel sides and of different length. It was found only in one sample of late Eocene age at Site 340 on the Vøring Plateau.

Archaeomonas sp. 3
(Plate 4, Figures 11, 16)

Remarks: A large archaeomonad similar to *A. ovoidea*, but almost spherical and with a finer ornamentation. It occurs in the Miocene at Site 341 on the Vøring Plateau.

Genus **ARCHAEOSPHAERIDIUM** Deflandre, 1932a

Archaeosphaeridium cf. A. dangeardianum Deflandre, 1932c
(Plate 2, Figure 1)

Remarks: The holotype of *A. dangeardianum*, which was described from the Miocene diatomite of Maryland, shows a rough surface, a large collar, and a small opening. The specimen illustrated here has a much lower collar and has less small spines. It is closer to forms assigned to *A. dangeardianum* by Deflandre (1938) from the lower Eocene diatomite of Mors, Denmark, and occurs in the upper Eocene sediments at Site 340 on the Vøring Plateau. Forms with a smooth surface have also been attributed to *A. dangeardianum*.

Archaeosphaeridium ornatum Deflandre, 1932a
(Plate 4, Figures 17-21)

Remarks: *A. ornatum* is a very large archaeomonad described from the Miocene diatomite of New Jersey. It has a somewhat rough surface and short, wedge-shaped spines. The collar is large with a large opening. It was here found in the Miocene at Site 341 on the Vøring Plateau. It seems to be a typical Miocene species.

Archaeosphaeridium cf. A. pachyceros Deflandre, 1933
(Plate 2, Figure 2)

Remarks: *A. pachyceros* is a large archaeomonad with long conical spines and was described from the Miocene diatomite of New Jersey

and also found in the Miocene of Japan. The form illustrated here, on the contrary, is very small and occurs only in the late Eocene at Site 340 on the Vøring Plateau.

Genus **LITHARCHAEOCYSTIS** Deflandre, 1932b

Litharchaeocystis costata Deflandre, 1932b
(Plate 3, Figure 37)

Remarks: The cyst of *L. costata* is decorated with low longitudinal ridges extending into spines below the cyst, thus forming "legs" to the cyst which has an elliptical outline. It was described from the Paleocene-Eocene diatomite of Kusnetz, USSR. It was here found in the late Eocene of Site 340 on the Vøring Plateau.

Litharchaeocystis glabra Rampi, 1948
(Plate 3, Figure 27)

Remarks: *L. glabra* has a smooth surface and only few, small spines around the bottom of the bottle-shaped form. It was originally described from the upper Eocene diatomite of Oamaru, New Zealand, and here occurs in the upper Eocene at Site 340 on the Vøring Plateau.

Litharchaeocystis oamaruensis Deflandre, 1938
(Plate 3, Figures 28, 29, 32)

Remarks: *L. oamaruensis* from the upper Eocene diatomite of Oamaru, New Zealand, is oval to bottle-shaped and has longitudinally oriented ridges extending into prominent spines at the bottom of the form. It was found in the upper Eocene at Site 340 on the Vøring Plateau.

Litharchaeocystis taiwanii n. sp.
(Plate 3, Figures 34-36)

Holotype: Plate 3, Figures 35, 36.

Diagnosis: A bottle-shaped form of *Litharchaeocystis* with prominent longitudinal ridges extending into vertical spines.

Remarks: *L. taiwanii* differs from the other species of *Litharchaeocystis* by the very prominent ridges and the vertical spines. *L. glabra* has a smooth surface and the ridges on all other thus far described species are finer and lower, and the spines usually not vertical.

Occurrence: *L. taiwanii* is not rare in the late Eocene at Site 340 on the Vøring Plateau.

Litharchaeocystis udintsevii n. sp.
(Plate 3, Figures 30, 31, 33)

Holotype: Plate 3, Figures 30, 31.

Diagnosis: A bottle to cone shaped form of *Litharchaeocystis* with low, fine ridges extending into spines around the flat bottom of the form.

Remarks: *L. udintsevii* is broader than all other species of this genus.

Occurrence: *L. udintsevii* is not rare in the late Eocene at Sites 338 and 340 on the Vøring Plateau.

Genus **LITHEUSPHAERELLA** Deflandre, 1932a

Litheusphaerella spectabilis Deflandre, 1932a
(Plate 2, Figures 11, 12)

Remarks: The illustrated specimens of *L. spectabilis* show two different states of preservation of this species. It was found in the upper Eocene sediments at Site 340 on the Vøring Plateau and was originally described from the lower Eocene diatomite of Fur, Denmark. It has also been found in the Eocene diatomite of Isenski, USSR, and the Late Cretaceous at DSDP Site 275 in the subantarctic southwest Pacific.

Litheusphaerella sp. 1
(Plate 4, Figures 6-8)

Remarks: The specimens illustrated here seem to belong to *Litheusphaerella*, but they have more and smaller T-shaped spines than the species of this genus thus far described. They are the first *Litheusphaerella* reported from the Neogene and occur in the Miocene at Sites 338 and 341 on the Vøring Plateau.

Genus PARARCHAEOMONAS Deflandre, 1932c

Pararchaeomonas challengerii n. sp.

(Plate 3, Figure 16)

Holotype: Plate 3, Figure 16.**Diagnosis:** *Pararchaeomonas*, almost spherical and with a "turtleneck" around the opening. The surface is smooth, or covered with tiny spines.**Remarks:** *P. challengerii* differs from the other species of the genus by its turtleneck-shaped collar around the opening. *P. colligera* Deflandre, 1932d, has a holotype with a simple collar, and a paratype which shows a turtleneck similar to the one of *P. challengerii*.**Occurrence:** *P. challengerii* was only found in the late Eocene at Site 340 on the Vøring Plateau.**EBRIDIAN**

Ebridians are marine, planktonic organisms secreting silica. They are 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 Eocene

Relatively rich ebridian assemblages were found in some of the samples from the siliceous upper Eocene sequences at Sites 339 and 340. Preservation varies from very poor to moderate. The assemblages include many of the forms found in the subantarctic southwest Pacific (Perch-Nielsen, 1975), but lack completely *Micromarsupium* and *Craniopsis*. On the other hand, *Ammodoichium complexum*, *A. novum*, and *Parebriopsis symmetrica* are new species from the Eocene of the Norwegian Sea.

Oligocene

Ebridians are only present in one sample of definite (middle) Oligocene age (338-21-1, 145 cm). *Hermesinum geminum*, one of the few species also found in the Oligocene (and late Eocene) of DSDP Site 280, south of Tasmania, is also present.

Miocene

Miocene ebridian assemblages were found at Sites 338, 341, 342, and 348. They are poorer than those of the late Eocene, but ebridians are more common and diverse than in the Oligocene. At Site 346, no ebridians were found despite the abundance of other siliceous microfossils. The Miocene assemblage includes *Parathranium*, a genus which was not represented in the Miocene of the subantarctic southwest Pacific, whereas *Ammodoichium rectangulare* and *Ebriopsis crenulata* are relatively common in both areas.

Pliocene-Pleistocene

Pliocene-Pleistocene siliceous sediments were recovered at Site 348. *E. crenulata* and *Pseudammodoichium* cf. *P. dictyoides* are very rare in Cores 348-5 and 348-6.

SYSTEMATIC PALEONTOLOGY

In the following, an inventory of the ebridians found in samples from Leg 38 is given. No attempt was made to present the synonymy for each species or to discuss its architecture or history. The morphologic terms used are those commonly employed and summarized by Deflandre (1951).

The holotypes of *Ammodoichium complexum* n. sp. and *Parebriopsis symmetrica* n. sp. are designed in Sample Vema 43/28-220 cm, a piston core from the Vøring Plateau, because of the better preservation there than in the Leg 38 material where these species also occur. The age assigned to the Vema sample by diatoms and silicoflagellates was (?) late Eocene (Bjørklund and Kellogg, 1972), the same age as the samples in which they occur in Leg 38 material.

Genus AMMODOICHUM Hovasse, 1932d

Ammodoichium complexum Dumitrica and Perch-Nielsen, n. sp.

(Plate 8, Figures 15, 16; Plate 10, Figure 11)

Holotype: Plate 10, Figure 11.

Description: Skeleton inflate, with one end—supposedly the nuclear one—wider than the opposite end. Three equal proclades and three opisthoclades approximately similar to the proclades. They all have, commonly, three large pores, one oriented towards the triode, two to the nuclear and the antapical ring, respectively. Thus, both rings are generally surrounded by six pores. The nuclear ring is larger than the antapical one. The proclades and opisthoclades are connected by an H-shaped mesoclade which gives rise to three pores: a lateral pore between the mesoclade and the proximal ends of the proclade and the opisthoclade, and two outer pores which have their distal wall in common with that of the unpaired pore of the proclade and the opisthoclade. The scaffolding of the skeleton seems to suggest that the three actines of the triode fork in a vertical plane, giving rise to the proclades and opisthoclades, which fork at their turn in a perpendicular plane, each branch being connected with the nearest branch of the adjoining pro- or opisthoclade.

A superficial ornamentation is visible on the relatively well-preserved specimen Plate 8, Figure 16, and consists of a network of crests. A small hole occurs at the meeting points of the crests. This is in contrast to the occurrence of knobs at meeting points of crests in the ornamentation found on silicoflagellates. The internal parts of the skeleton show no ornamentation.

Sample: Vema 43/28-220 cm.

Remarks: This species is the most complex species of the genus *Ammodoichium* so far known. It resembles *A. speciosum* Deflandre, from which it differs by a greater complexity. It differs from *A. novum* by the lack of mesoclades in the latter.

Occurrence: *A. complexum* is rare in Samples Vema 43/28-220 cm and 330 cm (late Eocene?) and was found in the late Eocene and early Oligocene at Sites 340 and 338 on the Vøring Plateau.

Ammodoichium novum n. sp.

(Plate 8, Figures 13, 14)

Holotype: Plate 8, Figure 14.

Description: Skeleton with one end, supposedly the nuclear one, wider than the opposite one. The three proclades are similar to the three opisthoclades and each bear three large, usually round pores. Two are oriented towards the nuclear and the antapical ring, the third towards the triode. An extra pore of the same form and size lies between the two pores oriented towards the triode.

A superficial ornamentation is visible on well-preserved specimens such as those illustrated on Plate 8 and consists of a network of crests. Where the crests meet, they form a short spine with a small hole in the middle. The internal parts of the skeleton show no ornamentation.

Sample: DSDP 339-11-1, 100 cm.

Remarks: This species is very similar to *A. complexum*, but differs from it by the lack of mesoclades and the presence of an extra pore between the opisthoclade and the proclade.

Occurrence: *A. novum* was found in the late Eocene at Site 339 on the Vøring Plateau, where it is rare.

Ammodoichium cf. A. prismaticum Hovasse, 1932a

(Plate 8, Figure 20)

Remarks: *A. prismaticum* was originally described from the Paleocene/Eocene from Denmark. In the specimen illustrated here, the apical structure is smaller than the central tripod, while it is the other way around in the *A. prismaticum*. Also, the apical structure in the double skeleton shown on Plate 8 is nearly round, whereas it is triangular in *A. prismaticum* from Denmark and rhombohedral in *A. prismaticum paradoxum* Hovasse from the upper Eocene of New Zealand.

Occurrence: *A. cf. A. prismaticum* was only found in Cores 338-8 to 338-18 of (?) late Oligocene to (?) late Miocene age.

***Ammodochium rectangulare* (Schulz) Deflandre, 1933**
(Plate 8, Figures 17-19)

Remarks and Occurrence: *A. rectangulare* occurs from the late Eocene through the Miocene in many samples from the Vøring Plateau sites. Well-preserved specimens show an ornamentation consisting of knobs connected by crests. The internal parts of the skeleton show no ornamentation.

Genus EBRIOPSIS Hovasse, 1932a

***Ebriopsis cornuta* Dumitrica and Perch-Nielsen, 1975**
(Plate 9, Figures 1-5; Plate 10, Figure 13)

Remarks: *E. cornuta* was originally described from a *Vema* sample (43/28-520 cm) from the Vøring Plateau and was also found to occur very rarely in the Eocene at Site 277 in the subantarctic southwest Pacific. On well-preserved specimens, an ornamentation consisting of ridges can be observed on the external part of the skeleton.

Occurrence: Besides the occurrence at Site 277 in the subantarctic southwest Pacific and the *Vema* sample from the Vøring Plateau, *E. cornuta* was also found at Sites 338 and 340 in the late Eocene, where it is not rare.

***Ebriopsis crenulata* Hovasse, 1932b**
(Plate 9, Figures 6-8)

Remarks and Occurrence: *E. crenulata* occurs in the late Eocene at Sites 338 and 340. It was originally described from the upper Eocene of New Zealand and was found, more or less consistently, in the late Eocene and in the Oligocene of Sites 277, 280, 281, and 283 in the subantarctic southwest Pacific. The surface ornamentation also consists of crests forming small holes at their meeting points.

Genus FALSEBRIA Deflandre, 1951

"Falsebria" sp.
(Plate 8, Figures 9-11)

Remarks and Occurrence: Deflandre (1951) created the genus *Falsebria* for forms that differed from *Ebriopsis* only by the absence of synclades and sometimes reduced or absent opisthoclares. No attempt was made here to assign the specimens shown on Plate 8 to Deflandre's species of *Falsebria*, since these forms are here considered to be initial stages of other ebridians rather than belonging to a genus of their own. "*Falsebria*" occur in many samples of Eocene to Miocene age, which include other ebridians.

Genus HAPLOHERMESINUM Hovasse, 1943

***Haplohermesinum simplex* (Schulz) Hovasse, 1943**
(Plate 9, Figures 10-19, 20?, 21?)

Remarks and Occurrence: The ornamentation on the outer side of the skeleton consists of ridges showing holes at their meeting points in well, but not excellently preserved specimens. The inner part of the skeleton shows no ornamentation. *H. simplex* occurs in the late Eocene or Oligocene to Miocene at Site 338.

Genus HERMESINOPSIS Deflandre, 1934

***Hermesinopsis caulleryi* Deflandre, 1934**
(Plate 10, Figures 1-8)

Remarks and Occurrence: More or less well-preserved specimens of *H. caulleryi* show a fine ornamentation consisting of crests which show small holes at their meeting points on the outer side of the skeleton. *H. caulleryi* was originally described from the Eocene of Barbados and was found in the late Eocene to Miocene of Sites 338 and 339.

Genus HERMESINUM Zacharias, 1906

***Hermesinum geminum* Dumitrica and Perch-Nielsen, 1975**
(Plate 10, Figure 12)

Remarks and Occurrence: Only one broken specimen of *H. geminum* was found in the middle Oligocene at Site 338. *H. geminum*

was described from the late Eocene and Oligocene at Site 280 south of Tasmania, and was also found in Sample *Vema* 43/28-520 cm on the Vøring Plateau. Also the specimen found in Sample 338-21-1, 145 cm is a double skeleton, as all the other specimens thus far reported of this species.

Genus PARATHRANIUM Hovasse, 1932d

***Parathranium intermedium* Hovasse, 1932d**
(Plate 7, Figures 1-16, Plate 10, Figures 15-17)

Remarks and Occurrence: Ling and McPherson (1974) have recently commented on the status of the genus *Parathranium* versus *Diadadia*. The specimens illustrated on Plate 7 have opisthoclares of varying length, mainly due to breaking off of the slender tips of the opisthoclares. Some specimens, like those shown on Plate 7 Figures 10 and 11, have two spines on the synclades like those described for *Parathranium hispinum* Deflandre, 1951, whereas spines are less prominent in others. Double skeletons occur frequently in most samples where *P. intermedium* was found: in the late Oligocene or early Miocene to early or middle Miocene at Site 338, and in the mid or late Miocene at Site 341. The ornamentation of the outer part of the skeleton consists of crests forming a network with short spines at the meeting points of the crests.

Genus PAREBRIA Hovasse, 1932c

***Parebria valida* Deflandre, 1934**
(Plate 9, Figure 9)

Remarks and Occurrence: *P. valida* was originally described from the late Paleocene/early Eocene of Denmark. The Danish specimens are somewhat shorter than the specimen illustrated on Plate 9, which was found in the Eocene at Site 340.

Genus PAREBRIOPSIS Hovasse, 1932d

***Parebriopsis symmetrica* Dumitrica and Perch-Nielsen n. sp.**
(Plate 10, Figures 10, 14)

Description: Convex, disc-shaped skeleton consisting of two equal "triodes" opposite one another by their concavity and symmetrically superposed as against the equatorial plane. The two "triodes" are connected to one another by the three branches of each arm, two of which are parallel to the surface of the disc, and a third one pillar-shaped and perpendicular to the equatorial plane. All these skeletal elements are inscribed in an equatorial ring consisting of three synclades and three mesoclares. The skeleton thus has six large windows, three on each side of the disc, which are limited by the three arms of the "triodes" and the synclades of the equatorial ring, and six small windows, one at each distal end of the arms, situated between the two external branches of the arms and the short mesoclares lying in the equatorial ring. There are also other six inner windows, two for each pair of arms, situated between the inner pillars and the two external branches of the arms.

Double skeletons were also found (Plate 10, Figure 10), but are rare. A superficial ornamentation is barely visible on the somewhat better preserved specimens. It consists of a network of crests with small holes forming where the crests meet. This pattern is observed in many ebridians on the outer side of their skeletons.

Holotype: Plate 10, Figure 10.

Sample: *Vema* 43/28-220 cm, ?late Eocene Vøring Plateau, Norwegian Sea.

Remarks: *Parebriopsis* is the only genus to which this species could be assigned. *P. symmetrica* shows the following morphological resemblances with *P. fallax* Hovasse, the genotype of *Parebriopsis* and thus far the only species of the genus: skeleton consisting of two opposite "triodes"; connection between these "triodes" made by short pillars; and bifurcation of the arms of the "triodes" and small windows between these distal branches. *P. symmetrica* differs from *P. fallax* by: (1) the very regular skeleton; (2) the superimposed position of the two opposite "triodes," while they are turned with about 60° in *P. fallax*; (3) the presence of the three connecting pillars, while there are only two in *P. fallax*; (4) the number of the small windows at the distal ends of all arms, while there are only two small windows, one at the distal ends of a1, the other of sa12, and possibly other two at the distal ends of a3 and sa23 in *P. fallax*.

By its morphology, *P. symmetrica* has the same relation to *P. fallax* as *Ebriopsis crenulata* to *E. valida*. A nomenclature problem arises

concerning the various elements of the skeleton of *P. symmetrica*. Deflandre (1951, fig. 80-87) interpreted *P. fallax* as consisting of an initial triaene, with the actine a2 missing, so that the initial skeleton is a false triode. One arm of this "triode" would be the rhabde r, the other two the actines a1 and a3. The opposite "triode" would consist of the opisthoclad o2, and the anterior synclades sa23 and sa12. While it is easy to make these distinctions in *P. fallax*, it is very difficult in *P. symmetrica* because of its perfect triradial symmetry. It could, however, be supposed, that the "triode" with the tricostate arms could be a remain of the initial triaene. One arm of this "triode" would represent the rhabde, the other two the actines a1 and a3, but due to the perfect symmetry it is not possible to establish which of the elements should be assigned as rhabde and which as actines.

Occurrence: *P. symmetrica* is not rare in Samples Vema 43/28-177 cm, 220 cm, and 520 cm, and was also found very rare in the late Eocene to early Oligocene Sample 339-11-1, 100 cm.

Genus PSEUDAMMODUCHIUM Hovasse, 1932d

Pseudammodochium sp.
(Plate 6, Figures 17-20)

Remarks and Occurrence: *P. dictyoides* was described from the Eocene of New Zealand, as was *P. sphaericum*, while *P. robustum* was described from the Miocene of Japan. The specimens illustrated on Plate 6 have more and smaller pores than any previously described species of *Pseudammodochium*. They occur in the Eocene at Sites 338 and 340 and in the Miocene at Site 339.

ENDOSKELETAL DINOFLAGELLATES

Endoskeletal dinoflagellates were recorded from DSDP Leg 21 (Dumitrica, 1973) and Leg 29 (Perch-Nielsen, 1975). Besides few of the previously described species, one new species, *Foliactiniscus atlanticus*, was found in the Miocene at Sites 338 and 342. The assemblages are essentially similar to those found on Leg 29, with the diversity only slightly higher in the Neogene of the Norwegian Sea than in the subantarctic southwest Pacific, but considerably lower than on Leg 21 in lower southern latitudes.

SYSTEMATIC PALEONTOLOGY

Dumitrica (1973) has discussed the systematical considerations relating to the assignment of the genera found here to the family *Actiniscidae*.

Family ACTINISCIDAE Kützing

Genus ACTINISCUS Ehrenberg, 1854

Actiniscus elongatus Dumitrica, 1968
(Plate 5, Figures 13, 14)

Remarks and Occurrence: *A. elongatus* shows an ornamentation consisting of crests oriented perpendicular to the elongation of the body. It is rare in the Miocene at Site 341.

Actiniscus pentasterias Ehrenberg, 1840
(Plate 5, Figures 1-7, 9-11; Plate 6, Figures 9, 13-16)

Remarks and Occurrence: *A. pentasterias* is found with five to seven or eight arms and a high variety of ornamentation. Also the height and the length of the arms differ considerably. *A. pentasterias* was found consistently in the Oligocene and Miocene at Site 338, and in the Miocene at Site 341.

Abnormal forms of *A. pentasterias* show two alveolar structures (Plate 6, Figure 13) and/or a bifurcation at the end of one arm (Plate 6, Figures 13-16). The latter forms occur only in the early to middle Miocene at Site 338.

Actiniscus tetrasterias Ehrenberg, 1854
(Plate 5, Figures 17-19)

Remarks and Occurrence: The ornamentation on *A. tetrasterias* is not so well developed as on *A. pentasterias*. *A. tetrasterias* is rare in the Miocene at Sites 338 and 341.

Actiniscus sp.

(Plate 5, Figures 8, 12, 15)

Remarks and Occurrence: *Actiniscus* sp. resembles *A. pentasterias*, but has longer arms and more pronounced spines on the apical part without reaching the extreme forms of *A. radícula* Dumitrica (1973). The median crest on the arm is also armed with few, but prominent spines. *Actiniscus* sp. is rare in the Miocene at Sites 338 and 341.

Genus CALCIPEDINIUM Dumitrica, 1973

Calcipedinium quadripes Dumitrica, 1973
(Plate 5, Figure 16)

Remarks and Occurrence: Dumitrica (1973) described *C. quadripes* as a "spicule with star-shaped basal plate consisting of four, exceptionally three or five, three-bladed arms." The few specimens found in the Miocene at Site 338 show five arms. *C. quadripes* was described originally from the middle Miocene of Rumania.

Genus CARDUIFOLIA Hovasse, 1932d

Carduifolia gracilis Hovasse, 1932d
(Plate 5, Figure 20)

Remarks and Occurrence: Specimens of *C. gracilis* found in the material studied here all only show small spines on two of the three crests of the arms. *C. gracilis* was found in small numbers in Eocene to Miocene samples containing siliceous microfossils.

Genus FOLIACTINISCUS Dumitrica, 1973

Foliactiniscus atlanticus n. sp.
(Plate 6, Figures 1-8)

Holotype: Plate 6, Figure 6.

Sample: DSDP 338-18-1, 140 cm.

Description: Siliceous skeleton with usually six tricostate arms. The central plate shows three or more alveoli. The arms bear no ornaments and are usually paired.

Remarks: *F. atlanticus* differs from other species in this genus by the paired arms and the high number of alveoli on the central plate.

Occurrence: *F. atlanticus* occurs in the Miocene of Site 338.

Foliactiniscus folia (Hovasse) Dumitrica, 1973
(Plate 6, Figures 10-12)

Remarks and Occurrence: A tendency of the crests of the arms to form an alveola could be observed on some specimens from the Miocene of Site 338. Typical for this species is also the ornamentation of the arms which consists of crests oriented perpendicular to the main crest along the arm.

Siliceous dinoflagellate?
(Plate 10, Figures 18, 19)

Remarks: In the late Eocene Sample 340-2-1, 85 cm and in late Eocene samples from Vema 43/28 from the Vøring Plateau, few specimens of siliceous forms similar to usually organic-walled dinoflagellates were found.

OTHER SILICEOUS MICROFOSSILS

Some siliceous microfossils which traditionally are treated together with silicoflagellates or the groups treated here are included in this report: *Clathropyxidella similis* and *Pseudorocella barbadiensis*.

Genus CLATHROPYXIDELLA Deflandre, 1938

Clathropyxidella similis Deflandre, 1938
(Plate 7, Figures 17, 18)

Remarks and Occurrence: *C. similis* was originally described from the Eocene of Barbados. The forms found in the Eocene at Site 340 have usually the same number of windows and the same size as those illustrated by Deflandre (1938). Unlike on silicoflagellates or ebridians, there is no ornamentation observable on the skeleton. The basal ring is doubled by the frame of the vertical windows. *C. similis* was found only in the Eocene at Site 340.

Genus *Pseudorocella* Deflandre, 1938

Pseudorocella barbadiensis Deflandre, 1938
(Plate 7, Figures 19, 20)

Remarks and Occurrence: *P. barbadiensis* includes a variety of simple siliceous forms with a round to more or less elliptical outline and a varying number of windows of different form and size. It was originally described from the Eocene of Barbados and was here found in the late Eocene to early Oligocene at Site 339. On Plate 7, the two sides are shown: one has a smooth surface, the other shows a rim around the smooth center of the body

ACKNOWLEDGMENTS

Above all, I would like to thank the Leg 38 shipboard party for sampling yet another set of samples for a special investigation. Dr. P. Dumitrica, Bukarest, has described two of the new ebridians. H. Franz, Zürich, has assisted in my work at the SEM of the Federal Technical Institute of Technology, and I. Nyegaard, Copenhagen, prepared the photographs and made up most plates.

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PLATE 1

- Figures 1-4 *Archaeomonas striata* Deflandre; Sample 340-9-4, 100 cm; magnification 5000 \times .
- Figures 5-8, 10 *Archaeomonas areolata* Deflandre; Sample 338-11-1, 130 cm and Sample 338-8-4, 120 cm (fig. 5); magnification 5000 \times .
- Figure 9 *Archaeomonas vermiculosa* Deflandre; Sample 341-34-3, 101 cm; magnification 5000 \times .
- Figure 11 *Archaeomonas* cf. *A. ornata* Rampi; Sample 339-11-1, 100 cm; magnification 5000 \times .
- Figures 12, 16 *Archaeomonas helminthophora* Deflandre; Samples 338-11-1, 130 cm and 338-14-1, 100 cm; magnification 5000 \times and 4500 \times .
- Figures 13-15 *Archaeomonas ninae* n. sp.; Samples 340-10-4, 70 cm (fig. 13) and 340-9-4, 100 cm; magnification 4000 \times , 3700 \times , and 5000 \times . (Fig. 13 is the holotype.)
- Figures 17-20 *Archaeomonas heteroptera* Deflandre; Samples 340-9-4, 100 cm; 339-11-1, 100 cm; 340-2-1, 85 cm; and 340-9-4, 100 cm.

PLATE 1

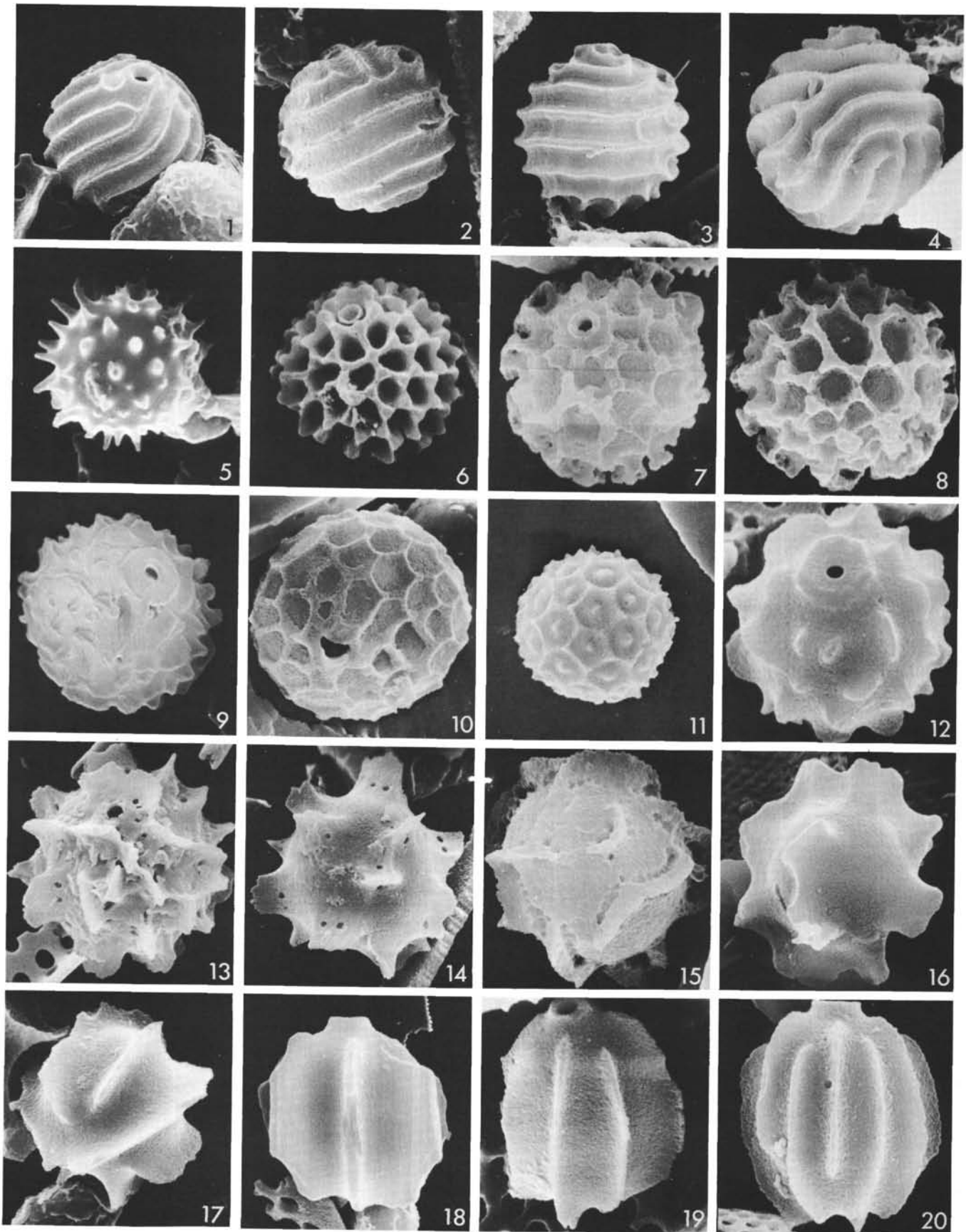


PLATE 2

- Figure 1 *Archaeosphaeridium* cf. *A. dangeardianum* Deflandre; Sample 340-9-4, 100 cm; magnification 3000 \times .
- Figure 2 *Archaeosphaeridium* cf. *A. pachyceros* Deflandre; Sample 340-10-4, 70 cm; magnification 5000 \times .
- Figure 3 *Archaeomonas paucispinosa* Deflandre; Sample 340-11-4, 100 cm; magnification 5000 \times .
- Figure 4 *Archaeomonas sphaerica* Deflandre; Sample 338-11-1, 130 cm; magnification 3000 \times .
- Figure 5 *Archaeomonas simplicia* Rampi; Sample 340-9-4, 100 cm; magnification 5000 \times .
- Figure 6 *Archaeomonas deflandrei* Rampi; Sample 339-11-1, 100 cm; magnification 5000 \times .
- Figure 7 *Archaeomonas* cf. *A. circuligera* Rampi; Sample 340-9-4, 100 cm; magnification 5000 \times .
- Figures 8, 9 *Archaeomonas dubia* Deflandre; Sample 339-11-1, 100 cm; magnification 5000 \times and 3500 \times .
- Figures 10, 13 *Archaeomonas multipunctata* Rampi; Samples 338-19-4, 110 cm and 340-4-4, 50 cm; magnification 5000 \times .
- Figures 11, 12 *Litheusphaerella spectabilis* Deflandre; Sample 340-2-1, 85 cm; magnification 5000 \times .
- Figure 14 *Archaeomonas robusta* Rampi; Sample 339-11-1, 100 cm; magnification 4500 \times .
- Figures 15-17 *Archaeomonas karinae* n. sp.; Samples 340-4-4, 50 cm (fig. 15, holotype) and 340-2-1, 85 cm; magnification 5000 \times .
- Figures 18-21 *Archaeomonas oamaruensis* Deflandre; Samples 340-9-4, 100 cm (fig. 18, 19); 340-10-4, 70 cm; and 338-8-4, 120 cm; magnification 5000 \times and 4000 \times (fig. 20).

PLATE 2

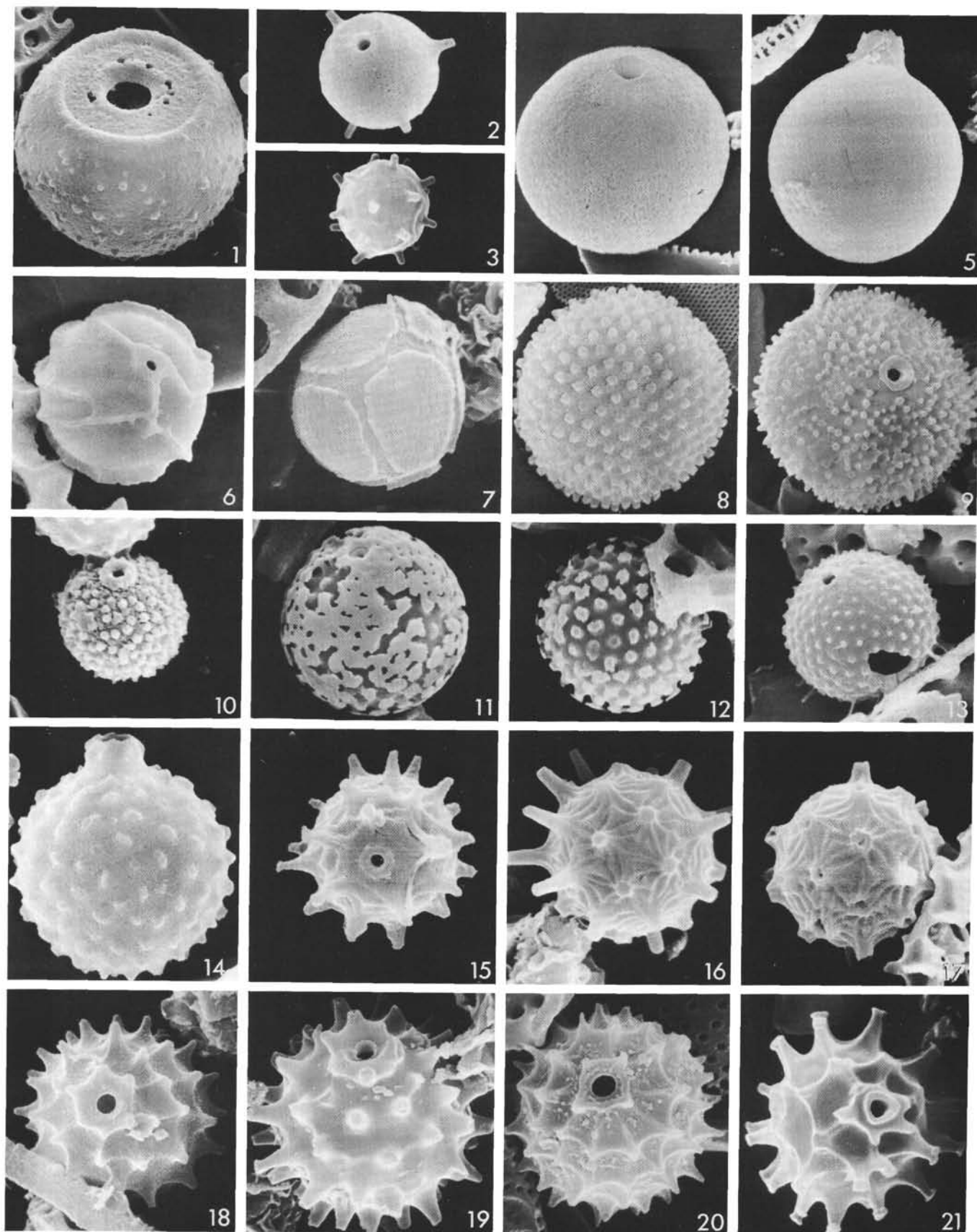


PLATE 3
Magnification (LM photographs) 2000×

- Figures 1-6 *Archaeomonas striata* Deflandre; Samples 338-26-4, 140 cm (fig. 1, 2) and 340-9-4, 100 cm.
- Figure 7 *Archaeomonas* sp. 1; Sample 338-21-1, 145 cm.
- Figure 8 *Archaeomonas oamaruensis* Deflandre; Sample 340-9-4, 100 cm.
- Figure 9 *Archaeomonas japonica* Deflandre; Sample 340-11-4, 110 cm.
- Figure 10 *Archaeomonas dubia* Deflandre; Sample 340-5-1, 80 cm.
- Figures 11, 12 *Archaeomonas chenevieri* Deflandre; Sample 340-3-4, 110 cm.
- Figures 13, 14 *Archaeomonas* cf. *A. lefeburei* Deflandre; Sample 340-9-1, 120 cm.
- Figure 15 *Archaeomonas paucispinosa* Deflandre; Sample 340-11-4, 110 cm.
- Figure 16 *Pararchaeomonas challengerii* n. sp.; Sample 340-9-4, 100 cm; holotype.
- Figure 17 *Archaeomonas kreyenhagenensis* Rampi; Sample 340-11-4, 100 cm.
- Figure 18 *Archaeomonas sphaeroidea* Deflandre; Sample 341-33-4, 116 cm.
- Figure 19 *Archaeomonas?* sp. 2; Sample 340-9-4, 100 cm.
- Figure 20 *Archaeomonadopsis lagenula* Deflandre; Sample 340-11-4, 110 cm.
- Figures 21, 22 *Archaeomonas norvegiensis* n. sp.; Sample 340-2-1, 85 cm; holotype.
- Figures 23, 24 *Archaeomonas heteroptera* Deflandre; Samples 340-9-4, 100 cm and 338-29-1, 94 cm.
- Figures 25, 26 *Archaeomonas* cf. *heteroptera* Deflandre; Sample 341-33-4, 116 cm.
- Figure 27 *Litharchaeocystis glabra* Rampi; Sample 340-10-4, 70 cm.
- Figures 28, 29, 32 *Litharchaeocystis oamaruensis* Deflandre; Sample 340-11-4, 110 cm. Magnification fig. 32 2500×
- Figures 30, 31, 33 *Litharchaeocystis udintsevii* n. sp.; Samples 340-10-4, 70 cm and 338-27-4, 111 cm. Fig. 30 and 31 show the holotype. Magnification fig. 33 2000×
- Figures 34-36 *Litharchaeocystis talwanii* n. sp.; Sample 340-9-4, 100 cm. Fig. 35 and 36 show the holotype. Magnification fig. 34 2500×
- Figure 37 *Litharchaeocystis costata* Deflandre; Sample 340-11-4, 110 cm.

PLATE 3

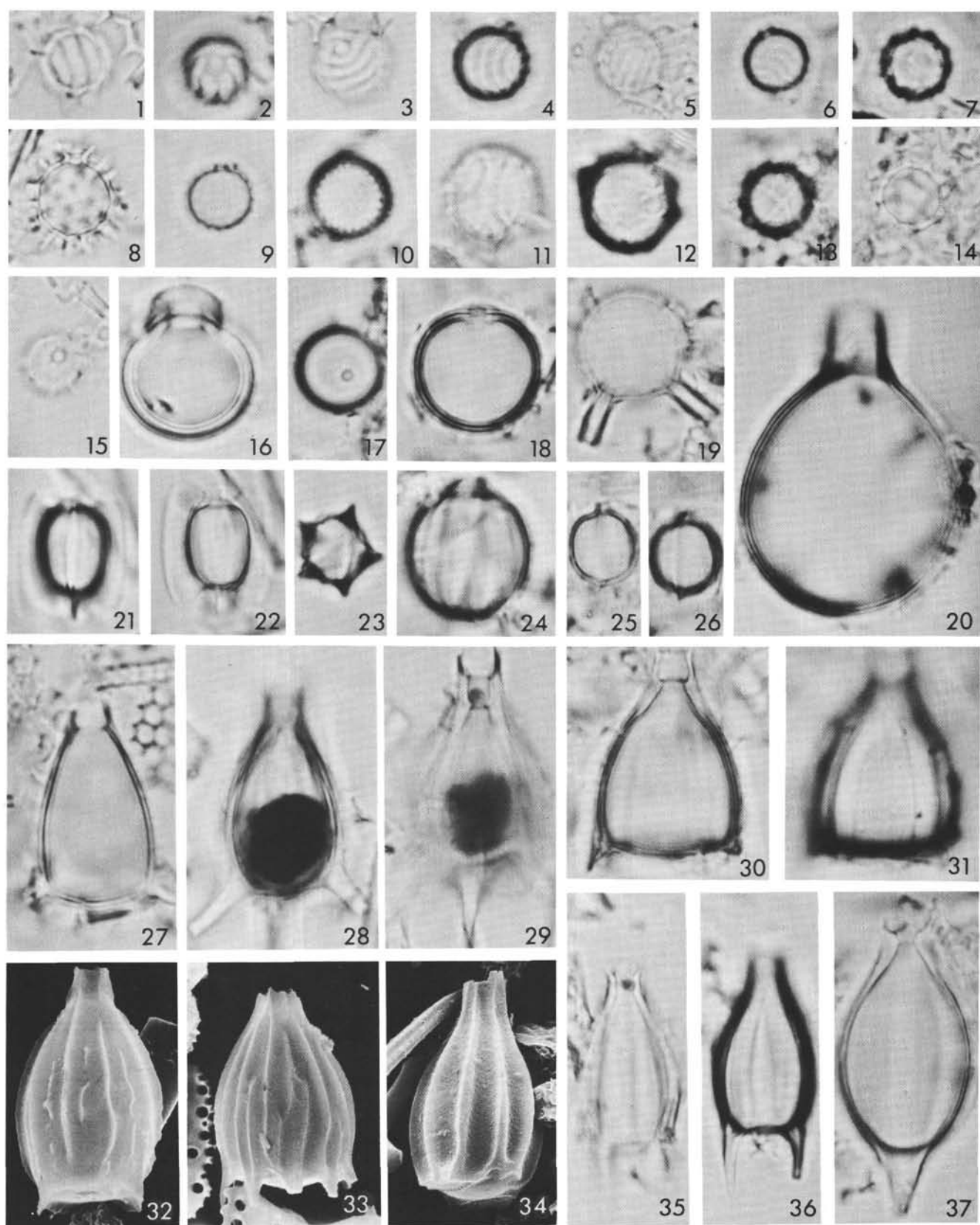


PLATE 4
Magnification 2000×

- | | |
|-----------------|---|
| Figure 1 | <i>Archaeomonas speciosa</i> Deflandre; Sample 338-11-1, 130 cm. |
| Figures 2, 3 | <i>Archaeomonas areolata</i> Deflandre; Sample 338-11-1, 130 cm. |
| Figures 4, 5 | <i>Archaeomonas helminthophora</i> Deflandre; Sample 338-11-1, 130 cm. |
| Figures 6, 7, 8 | <i>Litheusphaerella</i> sp. 1; Samples 338-13-4, 90 cm and 341-34-3, 101 cm (fig. 8). |
| Figures 9, 10 | <i>Archaeomonas</i> cf. <i>A. dentata</i> Deflandre; Sample 338-20-4, 120 cm. |
| Figures 12, 13 | <i>Archaeomonas</i> cf. <i>A. ovoidea</i> Deflandre; Sample 338-8-4, 120 cm. |
| Figures 14, 15 | <i>Archaeomonas ovoidea</i> Deflandre; Sample 341-32-4, 127 cm. |
| Figures 11, 16 | <i>Archaeomonas</i> sp. 3; Sample 341-27-4, 89 cm. |
| Figures 17-21 | <i>Archaeosphaeridium ornatum</i> Deflandre; Samples 341-33-4, 116 cm (fig. 17, 18); 341-31-4, 127 cm (fig. 19); and 341-27-4, 89 cm. |

PLATE 4

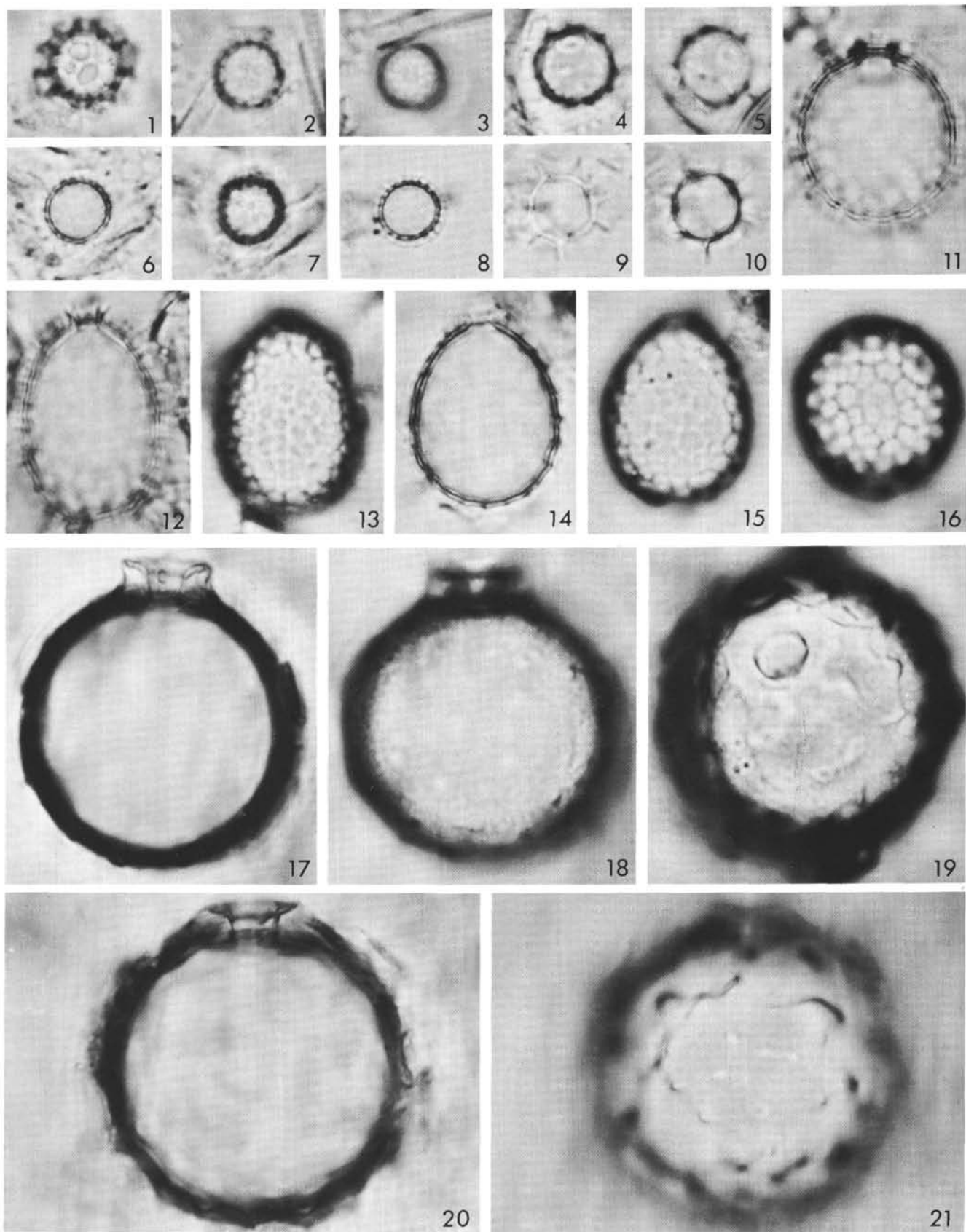


PLATE 5

- Figures 1-7, 9-11 *Actiniscus pentasterias* Ehrenberg; Samples 341-34-3, 101 cm (fig. 1, 2, 5) and 341-27-4, 89 cm (fig. 3, 6, 7, 9-11); magnification 1800 \times (fig. 1, 3, 5); 2000 \times (fig. 2); 1500 \times (fig. 6); 2500 \times (fig. 4, 7, 9); 1300 \times (fig. 10, 11).
- Figures 8, 12, 15 *Actiniscus* sp.; Sample 338-8-4, 120 cm; magnification 750 \times and 1500 \times (fig. 12, 15).
- Figures 13, 14 *Actiniscus elongatus* Dumitrica; Sample 341-30-4, 90 cm; magnification 2500 \times .
- Figure 16 *Calcipedinium quadripes* Dumitrica; Sample 338-8-4, 120 cm; magnification 1800 \times .
- Figures 17-19 *Actiniscus tetrasterias* Ehrenberg; Samples 341-27-4, 89 cm (fig. 17) and 338-14-1, 100 cm; magnification 2000 \times (fig. 17, 18) and 2500 \times .
- Figure 20 *Carduifolia gracilis* Hovasse; Sample 340-9-4, 100 cm; magnification 1500 \times .

PLATE 5

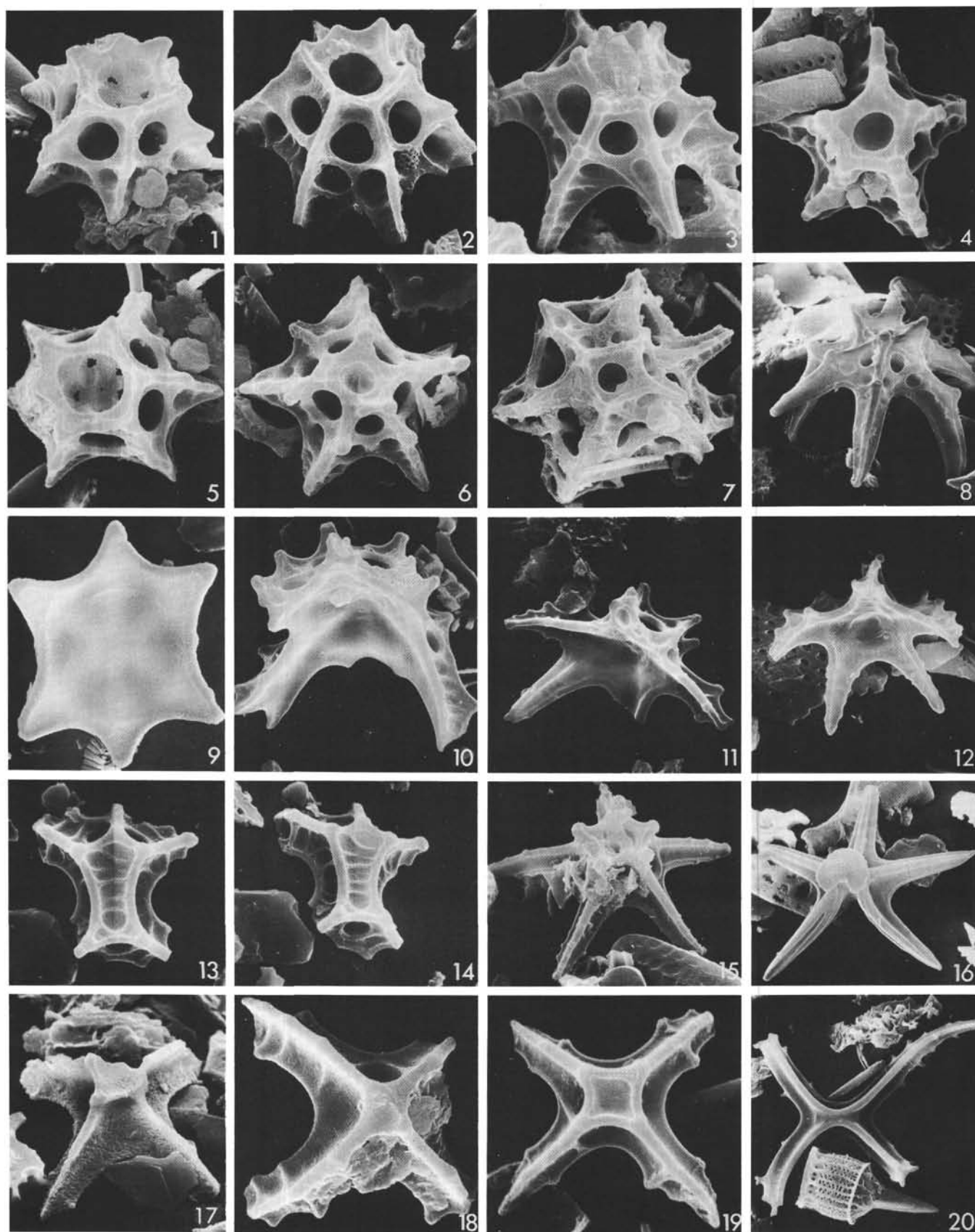


PLATE 6

- Figures 1-8 *Foliactiniscus atlanticus* n. sp.; Samples 338-18-1, 140 cm and 338-14-1, 100 cm (fig. 2, 3); magnification 2500 \times (fig. 1, 3, 5-7), 2200 \times (fig. 4, 8). Fig. 6 is the holotype.
- Figures 9, 13-16 *Actiniscus pentasterias* Ehrenberg; Samples 338-11-1, 130 cm, 338-13-4, 90 cm (fig. 13-15) and 338-14-1, 100 cm (fig. 16); magnification 1500 \times .
- Figures 10-12 *Foliactiniscus folia* (Hovasse) Dumitrica; Samples 338-14-1, 100 cm, 338-13-4, 90 cm and 338-18-1, 140 cm; magnification 1500 \times and 1300 \times (fig. 11).
- Figures 17-20 *Pseudammodochium* sp.; Samples 340-9-4, 100 cm (fig. 17) and 339-11-1, 100 cm; magnification 1500 \times , 1300 \times , 1800 \times , 1000 \times , respectively.

PLATE 6

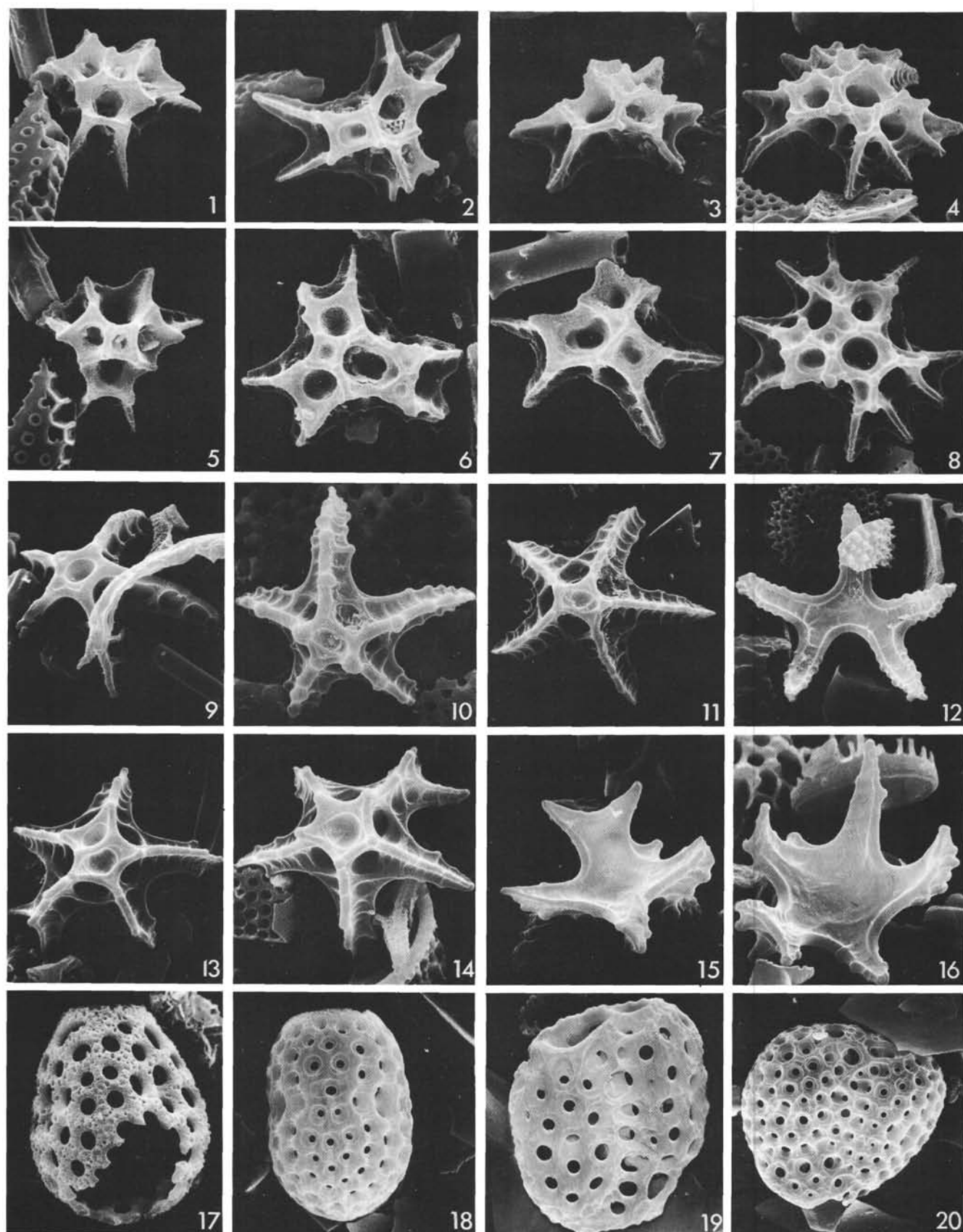


PLATE 7

- Figures 1-16 *Parathranium intermedium* Hovasse; Samples 341-27-4, 89 cm (fig. 1, 5); 338-18-1, 140 cm (fig. 2, 3, 7, 10, 11); 338-11-1, 130 cm (fig. 4, 6, 8, 9, 12, 13); 338-8-4, 120 cm (fig. 14-16); magnification 2000 \times (fig. 1, 4-8, 10); 2500 \times (fig. 2, 11); 2300 \times (fig. 3); 1500 \times (fig. 9, 12, 13), 1400 \times (fig. 14-16).
- Figures 17, 18 *Clathropyxidella similis* Deflandre; 340-3-4, 110 cm; magnification 4500 \times
- Figures 19, 20 *Pseudorocella barbadiensis* Deflandre; Sample 339-11-1, 100 cm; magnification 3000 \times and 2500 \times .

PLATE 7

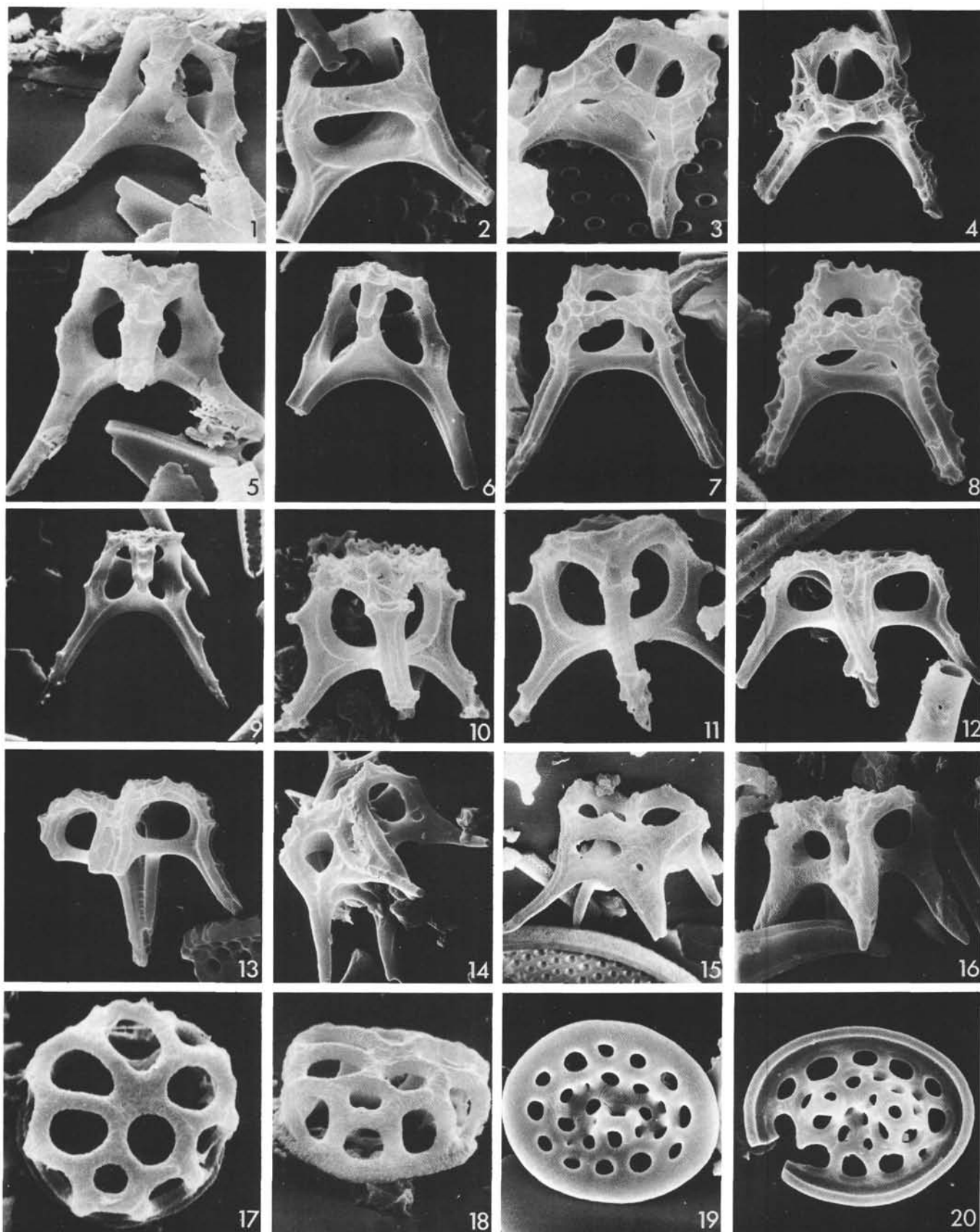


PLATE 8

- Figures 1-8, 12 Ebridians. Gen. et sp. indet.; Samples 338-13-4, 90 cm (fig. 1, 3, 5, 7); 338-14-1, 100 cm (fig. 2, 6); 338-27-4, 111 cm (fig. 4, 8); and 340-9-4, 100 cm (fig. 12); magnification 650 \times (fig. 1, 5); 800 \times (fig. 2, 6); 1500 \times (fig. 3, 7, 12); 1600 \times (fig. 4); and 2000 \times (fig. 8).
- Figures 9-11 "*Falsebria*" sp.; Samples 338-18-1, 140 cm; 338-11-1, 130 cm; and 339-11-1, 100 cm; magnification 1000 \times (fig. 9, 10) and 2000 \times (fig. 11).
- Figures 13, 14 *Ammodochium novum* n. sp.; Sample 339-11-1, 100 cm; magnification 1500 \times . Fig. 14 is the holotype.
- Figures 15, 16 *Ammodochium complexum* Dumitrica and Perch-Nielsen n. sp.; Samples 340-9-4, 100 cm and 338-27-4, 111 cm; magnification 1500 \times and 1200 \times (fig. 16).
- Figures 17-19 *Ammodochium rectangulare* (Schulz) Deflandre; Samples 340-11-4, 110 cm (fig. 17) and 341-27-4, 89 cm; magnification 1500 \times (fig. 17) and 2000 \times .
- Figure 20 *Ammodochium* cf. *A. prismaticum* Hovasse; Sample 338-11-1, 130 cm; magnification 1500 \times .

PLATE 8

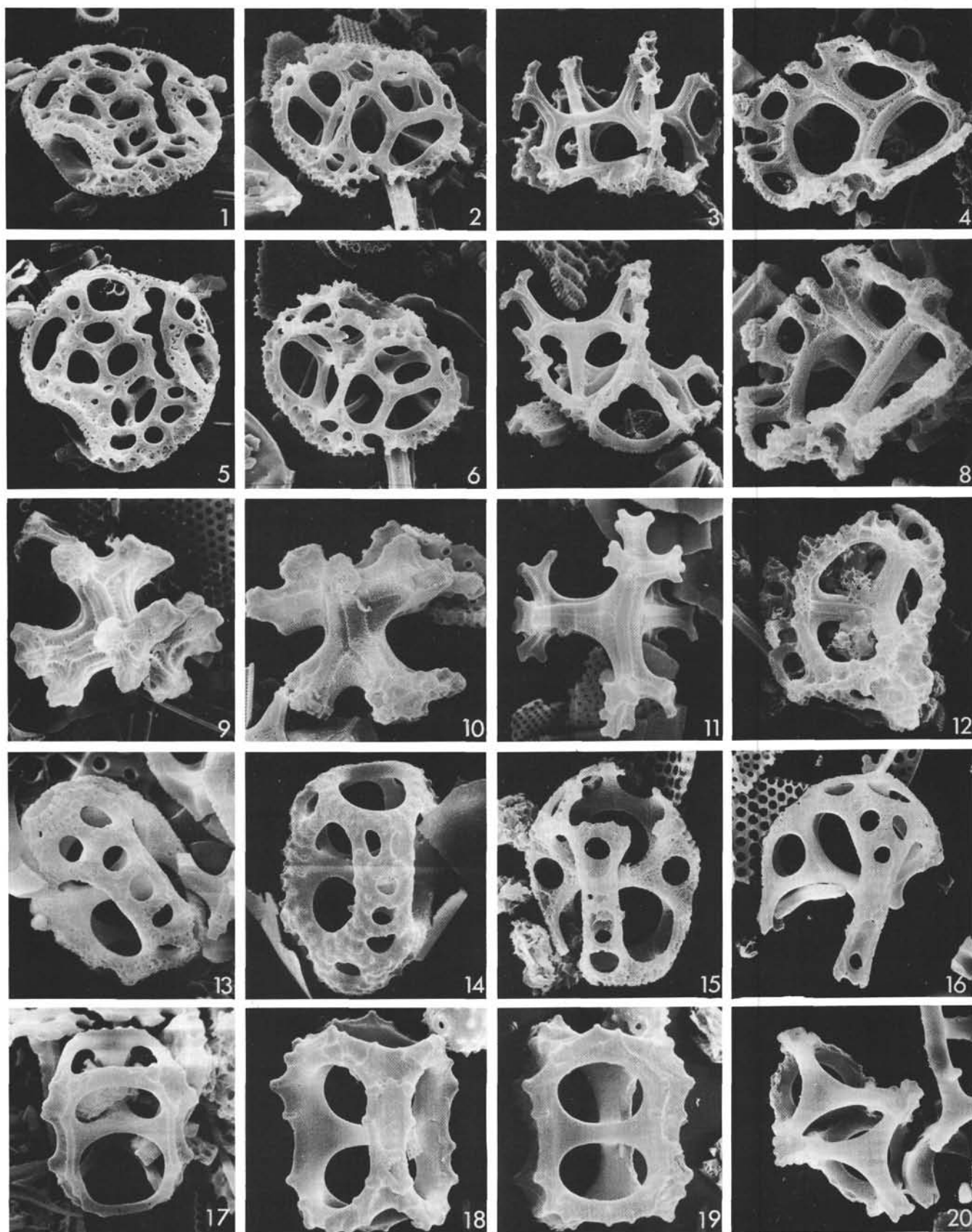


PLATE 9

- Figures 1-5 *Ebriopsis cornuta* Dumitrica and Perch-Nielsen; Samples 340-2-1, 85 cm (fig. 1); 340-9-4, 100 cm (fig. 2, 3); and 340-10-4, 70 cm (fig. 4, 5); magnification 1500 \times (fig. 1-3) and 1000 \times (fig. 4, 5).
- Figures 6-8 *Ebriopsis crenulata* Hovasse; Samples 340-2-1, 85 cm; 340-9-4, 100 cm; and 338-27-4, 111 cm; magnification 1500 \times , 1000 \times , and 1200 \times , respectively.
- Figure 9 *Parebria valida* Deflandre; Sample 340-9-4, 100 cm; magnification 1500 \times .
- Figures 10-19
20? 21? *Haplohermesinum simplex* (Schulz) Hovasse; Samples 338-14-1, 100 cm (fig. 10, 14); 338-11-1, 130 cm (fig. 11, 15, 18-21); 338-13-4, 90 cm (fig. 12, 16); and 338-27-4, 111 cm (fig. 13, 17); magnification 1300 \times (fig. 10, 14); 1500 \times (fig. 11, 15, 12, 16, 17); 2000 \times (fig. 13); and 2200 \times (fig. 20, 21).

PLATE 9

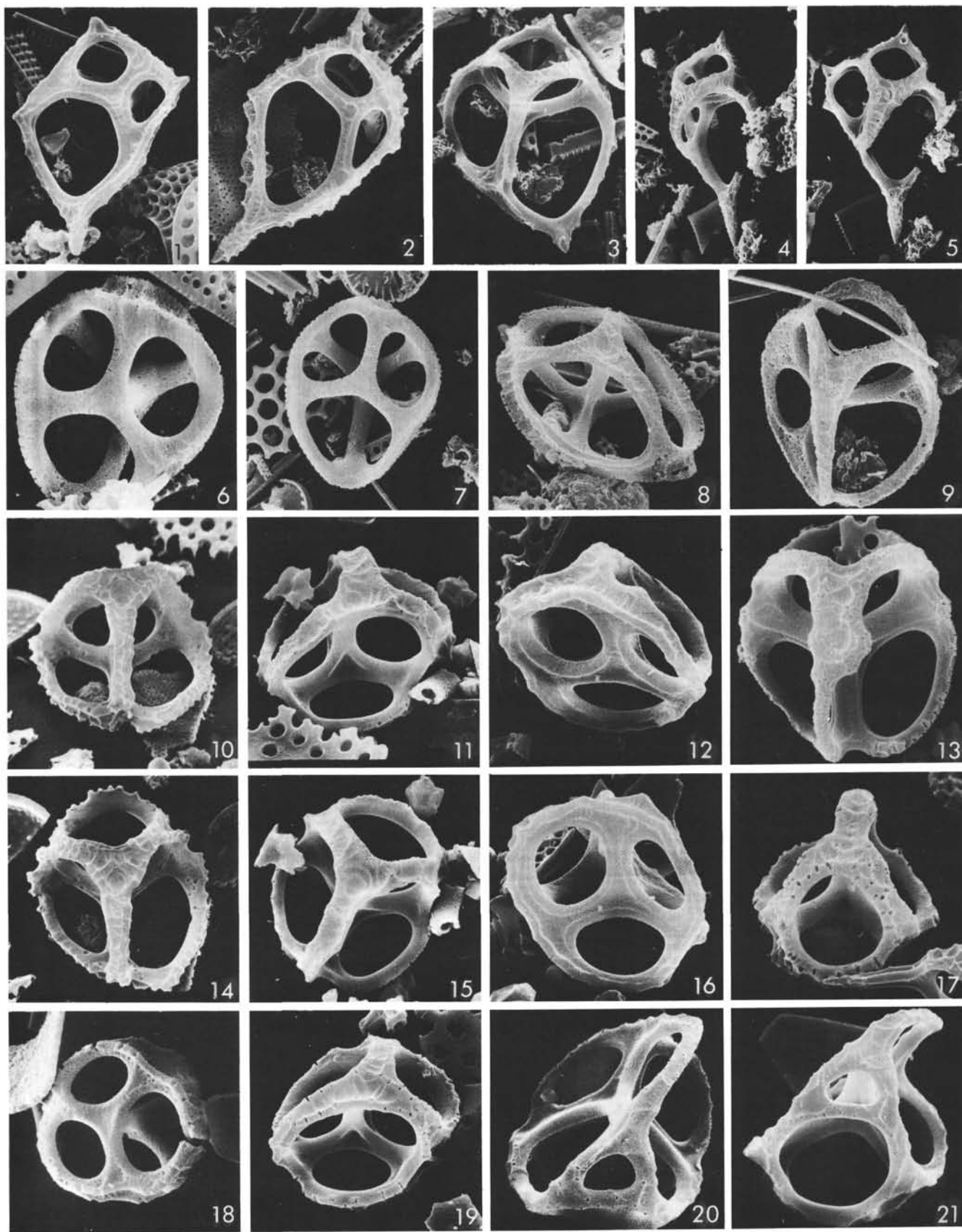


PLATE 10

- Figures 1-8 *Hermesinopsis caulleryi* Deflandre; Samples 338-27-4, 111 cm (fig. 1, 2); 338-18-1, 140 cm (fig. 3, 4); and 339-11-1, 100 cm (fig. 5-8).
- Figure 9 Ebridian. Gen. et sp. indet.; Sample 338-13-4, 90 cm; magnification 800 \times .
- Figures 10, 14 *Parebriopsis symmetrica* Dumitrica and Perch-Nielsen n. sp.; Sample *Vema* 43/28-220 cm; magnification 2000 \times (Holotype, fig. 10), 800 \times .
- Figure 11 *Ammodochium complexum* Dumitrica and Perch-Nielsen n. sp.; Sample *Vema* 43/28-220 cm; magnification 3000 \times . Holotype.
- Figure 12 *Hermesinum geminum* Dumitrica and Perch-Nielsen, broken specimen; Sample 338-21-1, 145 cm; magnification 800 \times .
- Figure 13 *Ebriopsis cornuta* Dumitrica and Perch-Nielsen; Sample 338-21-1, 145 cm; magnification 800 \times .
- Figures 15-17 *Parathranium intermedium* Hovasse; Samples 341-27-4, 89 cm; 338-8-4, 120 cm; and 341-33-4, 116 cm; magnification 800 \times .
- Figures 18, 19 Siliceous dinoflagellate?; Sample 340-2-1, 85 cm; magnification 2000 \times .

PLATE 10

