23. MIDDLE EOCENE DIATOMS FROM THE SOUTH ATLANTIC[1]

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ABSTRACT

The biostratigraphic distribution of nearly 60 diatom species in a 67.1-meter, continuously piston cored middle Eocene (Lutetian) section is documented. The first and last appearance datums of nine stratigraphically important species are illustrated. These datums may be of use in regional correlations of Lutetian sediments in the South Atlantic Ocean.

INTRODUCTION

This report presents data on the stratigraphic distribution of fossil marine diatoms in a 67.1-meter, continuously cored middle Eocene section recovered at DSDP Site 512 on the Falkland Plateau in the Southwest Atlantic Ocean. The section represents the longest diatomaceous middle Eocene section yet cored in the South Atlantic; it therefore provides important new biostratigraphic and biogeographic information on fossil marine diatoms for a time interval and geographic region from which they were previously not well known.

Prior to the recovery at Site 512 of a long middle Eocene section, the only available data on high-latitude South Atlantic middle Eocene diatoms were those derived from *Islas Orcadas* piston core 1678–43 (author's notes), which is only 188 cm long. The core includes a 128-cm interval assigned to the *Globigerapsis index* Zone of Jenkins (1971) (see Site 511 site chapter), but it is so short it as to be of little value in determining the biostratigraphic succession of middle Eocene diatoms.

The long section at Site 512 was continuously cored using the newly developed hydraulic piston corer (HPC), so that core disturbance and microfossil mixing are minimal. Moreover, foraminifers and radiolarians which are present in the sediment allow independent dating of the core, which is thus an excellent data source for middle Eocene diatom biostratigraphy in the South Atlantic.

Background

Hole 512 is located at 49°52.194′S; 40°50.713′W on the northeastern part of the Maurice Ewing Bank at the eastern extremity of the Falkland Plateau. Hole 512A is located nearby at 49°52.170′S; 40°50.710′W. Water depth at the drill site is 1844 meters. Hole 512 was continuously cored with the HPC for 77.9 meters or a total of 19 cores. One conventional (rotary-drilled) core was recovered from Hole 512A in the interval from 81.5–89.3 meters sub-bottom, or just below the deepest penetration of Core 19 in Hole 512.

Stratigraphic Summary

An unconformity is present in Hole 512 between Cores 5 and 6; it separates middle Miocene diatomaceous nannofossil ooze of the *Nitzschia denticuloides* Zone of Weaver and Gombos (1981) from middle Eocene siliceous nannofossil ooze. According to F. M. Weaver (pers. comm.) Cores 6 through 19 of Hole 512 and the upper part of Core 2 of Hole 512A fall within the *Globigerapsis index index* Zone of Jenkins (1971) and the lower part of Core 2 of Hole 512A is within the *Pseudoglobaquadrina primitiva* Zone of Jenkins (1971). According to F. M. Weaver (pers. comm.) Cores 6 through 19 of Hole 512 and Core 2 of Hole 512A contain elements of the middle Eocene *Podocyrtis mitra* and *P. ampla* zones (radiolarian) of Riedel and Sanfilippo (1978). Both the foraminifer and radiolarian zones indicate that the middle Eocene section from Site 512 corresponds to the upper part of the Lutetian Stage (Fig. 2).

MATERIAL AND METHODS

All samples used in this study were collected by shipboard scientists during Deep Sea Drilling Project Leg 71. Slides of core catcher samples used in this study were prepared aboard the *Glomar Challenger* by Dr. F. M. Weaver.

Samples were prepared and examined according to the procedure described in Gombos and Ciesielski, (this volume). Table 1 summarizes the method of recording relative abundances for the distribution chart (Table 2) for Holes 512 and 512A.

MIDDLE EOCENE DIATOMS

Observations

The occurrence and relative abundance of nearly 60 diatom species have been determined for the middle Eocene section of Site 512 (Fig. 1). Sixteen diatom species are considered to be characteristic of the middle Eocene section of Site 512 because of their abundance, distinctive characteristics, or limited stratigraphic range (Fig. 1).

Of the 16 characteristic species, 7 range throughout the section; these are the *Pyxilla prolongata* group, *Melosira architecturalis, Triceratium unguiculatum, Trinacria simulacrum, Tubaformis unicornis, Asterolampra uraster*, and *Craspedodiscus moelleri.*

Coscinodiscus oligocenicus group, *Pseudotriceratium chenevieri*, and *Trinacria excavata* f. *inflata* range

[1] Ludwig, W. J., Krasheninnikov, V. A., et al., *Init. Repts. DSDP*, 71: Washington (U.S. Govt. Printing Office).

Table 1. Abundance categories used in this chapter.

Specimen Counts[a]	Category	Symbol
1	Very rare	VR
2–5	Rare	R
6–10	Frequent	F
11–50	Common	C
51–100	Abundant	A
101–500	Very abundant	VA
501–1000	Dominant	D

[a] Based on counts per field of view during two traverses of 22 × 22 mm cover slip at ×400 of one slide of unsieved material and one slide of Fraction 2 (38–63 μm) (see Gombos and Ciesielski, this volume, for discussion).

from Hole 512, Core 6 through Cores 14, 12, and 11, respectively.

The highest occurrence of *T. excavata* f. *tetragona* is in Hole 512, Core 9, of *Rylandsia biradiata* in Hole 512, Core 10. Both species range down through Hole 512A, Core 2.

Bergonia angelica ranges from Hole 512, Core 10 through Core 18. *Brightwellia imperfecta* exhibits a short range from Hole 512, Core 15 through Core 16. *Rhizosolenia* sp. ranges from the middle of Hole 152, Core 17 down through Hole 512A, Core 2. *Craspedodiscus ellipticus* appeared only in Hole 512A, Core 2.

DISCUSSION

At present, continuous core data on the stratigraphic distribution of middle Eocene diatoms from high-latitude regions of the South Atlantic are not available for comparison with data from Holes 512 and 512A, and no high-latitude South Atlantic diatom zonation can be proposed at this time.

The only reports available on low- and mid-latitude middle Eocene diatoms of the South Atlantic are those by Gleser and Jousé (1974), who described the diatom assemblage in one core from Hole 13 in the tropical Atlantic, and by Fenner (1979), who studied a longer but discontinuous section in Hole 356 in the subtropical Atlantic. Because of the many coring gaps in Hole 356, Fenner did not attempt to construct a zonal scheme.

As part of her study, Fenner (1979) reviewed all available literature on Eocene diatoms and found that most Eocene diatom species are widely distributed geograph-

Table 2. Stratigraphic distribution and relative abundances of diatom species in middle Eocene samples from Holes 512 and 512A.

Sample (interval in cm)	*Asterolampra acutiloba*	*A. affinis*	*A. distincta*	*A. grevillei*	*A. insignis*	*A. marginata*	*A. marylandica*	*A. transmarginata*	*A. uraster*	*A. vulgaris*	*A.* sp.	*Bergonia angelica*	*Brightwellia elaborata*	*B. imperfecta*	*Coscinodiscus bulliens*	*C. marginatus*	*C. oligocenicus* group	*C. praenitidus*	*Craspedodiscus* cf. *C. coscinodiscus*	*C. ellipticus*	*C. moelleri*	*C. splendidus*	*Ethmodiscus rex* (fragments)	*Goniothecium odontella*	*Hemiaulus claviger*	*H. incurvus*	*H. reflexispinosus*	Genus and species uncertain #1	Genus and species uncertain #2	*Melosira architecturalis*'	*Odontotropis* sp.	*Praecymatosira monomembranacea*
Hole 512																																
6-1, 56–58		VR			R				R	R						C	A	R	VR		VR		C			R	R		F		R
6-2, 10–12	VR	R		VR	F		R		R	R					VR	C	C	F			VR		C	R		VR	R	VR		C		
7-1, 105–107	VR	VR		VR	C				R	VR						C	C	R			R		A	VR			R	R		C		R
7-3, 63–65		VR		VR	R				R						VR	C	F	F			R		C	R			R			R	VR	R
8-1, 69–71		R		VR	R				VR	R						C	F	F			R		C		VR		R	R		C	R	F
9-1, 96–98	R	R			R				R	VR					VR	C	R	F			R			VR				R		C		R
9-3, 64–66		R		VR	F				R	R					VR	C	F	F			R		C	VR		VR	VR	C	R	C		C
10-2, 32–34		VR			R				R	R		VR			R	VA	VR	R					C		VR		R	F		C	R	VA
11-1, 78–80		R			F				R			F			R	C	C	F			F		A			VR	R	F	R	C		C
11-3, 60–62		R		VR	F				R	VR	R	R			VR	C	C	R			F		C				R	R	R	C		C
12-2, 58–60		F			R				R			R				C	C	R			R		C		R		R	R		C	VR	C
12-3, 66–68		R			VR				R							C	F	R			R		A	R	R			R		C		F
13-1, 33–35		R	R		VR				R	R	VR	R				A	C	F			R		C		VR		VR	R		C	R	A
14-1, 68–70		R			VR				R	VR					VR	C	R	F		VR	F		A	VR	VR			R		R	R	C
14-3, 49–51		VR			R			VR	R			R			VR	R		R	VR	VR	VR	VR	A	R	VR		R			VR		C
15-1, 71–73		VR			R				R	VR				VR		R		F			R		C					R		F	VR	C
15-3, 15–17		R			R				R				R	R		R		R			R		C	VR				R		C		C
16-2, 19–21		R			R				R			VR	VR	F		R		R			VR	R	C	R			VR	F	R	A	VR	A
17-1, 42–44		R			VR											R		F			VR		R	R				R		A		C
17-3, 23–25		R							R							C		F	VR		R		C	VR			R	R		A	VR	C
18-1, 41–43		R	VR		R					R		R	VR		VR	R		R			VR		C	VR			VR	F	R	C		C
18-2, 106–108		F			R				R			R	VR			C					R		C	VR				R		F		C
19-7, 9–11		VR			R							VR				F		R			VR						VR	VR		F		F
19-2, 80–82		R			R				R							C		R			R		F		VR		VR	R		C		R
Hole 512A																																
2,CC					R											C				F	VR	VR	A				VR	VR				

Note: Miocene (Samples 512-1-1, 89–90 cm to 512-5-2, 74–76 cm) not studied. For explanation of letters, see Table 1.

ically. Comparison of the middle Eocene diatom assemblage of Site 512 with Fenner's (1979) data from Site 356 and other areas tends to confirm this observation. Exceptions include the presence of species such as *Bergonia angelica, Trinacria excavata* f. *inflata, Asterolampra uraster*, and *Rhizosolenia* sp. in the middle Eocene of Site 512 but not in lower-latitude sites in the Atlantic. The distribution of these species may be restricted to the higher latitudes.

Eleven discrete diatom datums observed in the middle Eocene section of Site 512 may be useful for correlation, at least locally in the region of the Falkland Plateau. All 11 datums occur within the *Globigerapsis index index* Zone of Jenkins (1971) and are illustrated in Figure 1. The datums include, in ascending order, the lowest stratigraphic occurrence of *Bergonia angelica, Brightwellia imperfecta, Coscinodiscus oligocenicus* group, *Pseudotriceratium chenevieri*, and *Trinacria excavata* f. *inflata*; and, in descending order, the highest stratigraphic occurrence of *Trinacria excavata* f. *tetragona, Bergonia angelica, Rylandsia biradiata, Brightwellia imperfecta, Rhizosolenia* sp., and *Craspedodiscus ellipticus*. The highest occurrence of *C. ellipticus* occurs very near the boundary between the *G. index index* Zone and the *Pseudogloboquadrina primitiva* Zone of Jenkins (1971).

Evidence for reworking of older diatoms into the middle Eocene of Site 512 is indicated by the sporadic occurrence of the late Paleocene species *Hemiaulus incurvus* in Hole 512, Cores 6 through 11 (see Table 2).

CONCLUSIONS

At present the Eocene diatoms of the high-latitude South Atlantic are not well known. The recovery of a 67.1-meter, continuously piston cored middle Eocene (Lutetian) section from DSDP Site 512 on the Falkland Plateau provides the best available record of diatom biostratigraphy during that time in the high-latitude South Atlantic. The recovered section provides important new data on the occurrence of nearly 60 diatom species in upper Lutetian sediments. Eleven appearance and extinction datums of nine species have been identified in the section. These datums may be of use in correlating middle Eocene sections in the Falkland Plateau region.

Table 2. (Continued).

Pseudorutilaria monile	*Pterotheca aculeifera*	*P. danica*	*P. danica* (elongate form)	*P. major*	*P. spada*	*Pyxilla prolongata* group	*Rhizosolenia interposita*	*R.* sp.	*Rylandsia biradiata*	*Sceptroneis* cf. *S. ligulatus*	*S. pesplanus*	*Stephanopyxis grunowii* s.l.	*S. turris* s.l.	*Triceratium capitatum*	*Pseudotriceratium chenevieri*	*Triceratium inconspicum* v. *trilobata*	*T. macroporum*	*T.* cf. *T. russlandicum*	*T. unguiculatum* group	*Trinacria excavata*	*T. excavata* f. *tetragona*	*T. excavata* f. *inflata*	*T. simulacrum*	*Tubaformis unicornis*	Radiolarian Zones (Weaver, this volume)	Foraminifer Zones (Basov et al., this volume)	Stage	Age
	R					R	VR			F	VR	F			C	R			VR	VR			R	R				
	R	R		VR		F				R		C			R	VR		VR		VR		VR	C	R				
	VR					C	VR						F		F	R			R				R	R				
VR	R	R	F			F	VR					F			R	C		VR	R	VR		R	F	R				
	R			R		F	VR			VR		C	C		C	C			R	VR		R	C	R				
	R	VR	VR			R	VR					C	F		F	C		VR	R			R	C	R				
VR	R					C	VR			R		C			C	C		VR	R		R	F	R	R				
	R					R						C	C	VR	C	C	VR						R	F	*Podocyrtis mitra* zonal equivalent			
R	R	VR	VR			F	R		R	VR		C	F		F	A	R		R	R	VR		F	R				
	VR					C			R	R	R				C	VA	VR		F	VR	VR	VR	C	R				
	R	R	R			C	VR		R	VR		C			VA	A			R	VR	R		C	F				
	R		VR			C	VR					C			C	A			R	VR	R		C	R				
	R	R	R			F			VR	VR		C			C	VA			R	VR	R		C	R				
	R	R	R	VR		C						C	C			VA		F	R	VR	R		A	R				
	R	VR				F			VR		VR	C			VR	C	R				VR		C	R				
	VR					C			VR			C				VA	R		VR	VR	F		C	R		*Globigerapsis index*	Lutetian	middle Eocene
	R	VR				F	VR		VR			F	F			VA	VR	R		VR	R		A	R				
	R	VR	VR			R			VR			C				C			R				R	R				
	R					R						C	F			A							R	C				
	R	R	R			R	VR	R				C	C			VA			R		R		C	C				
	R	VR				R		R	VR			C				VA		R		VR			F	C				
	R	R	R		VR	C	VR	VR	VR		VR	C		VR		VA	VR				R		F	C				
		R	R	VR		R		R				C				A			F	VR	VR		R	F				
	R	R		VR	VR	R	VR	R	R			C	F			VA		R	VR	VR	R		R	R	*P. mitra* to *P. ampla* zonal equivalent			
		R				R			R							C			R	VR	R		A	VR		*Pseudoglobo-quadrina primitiva*		

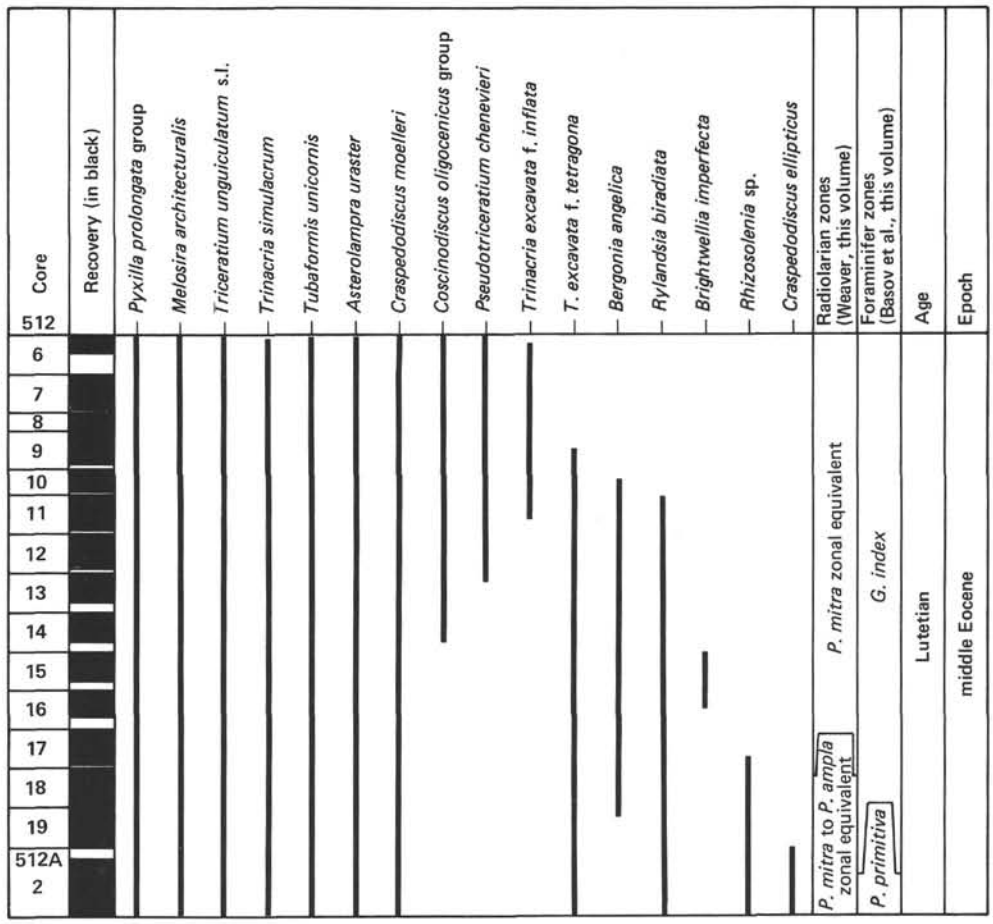

Figure 1. Stratigraphic distribution of selected middle Eocene diatom species in DSDP Holes 512 and 512A on the Falkland Plateau. Miocene (Cores 1–5) not studied.

TAXONOMIC LIST

Genus *ASTEROLAMPRA* Ehrenberg, 1844

Asterolampra acutiloba Forti, 1912
(No illustration)

References. Forti, 1912, *in* Tempère and Peragallo, 1912, p. 337, nos. 696–698; Forti, 1913, p. 1564, pl. 3, figs. 1, 5–6, 9.

Remarks. The occurrence of this Miocene species in the upper part of the middle Eocene section in Hole 512 may be attributable to contamination.

Asterolampra affinis Greville, 1862
(Plate 1, Fig. 1)

References. Greville, 1862, p. 48, pl. 8, figs. 26–27; Schrader and Fenner, 1976, text-figure 40, nos. 4, 10; Gombos, 1980, p. 234.

Asterolampra distincta Barker and Meakin, 1944/45
(Plate 1, Figs. 9–10)

References. Barker and Meakin, 1944/45, p. 18, pl. 3, fig. 3; Gombos, 1980, p. 235, pl. 3, figs. 14–18.

Remarks. This species is extremely rare in Hole 512.

Asterolampra grevillei (Wallich) Greville, 1860
(Plate 1, Fig. 2)

References. Greville, 1860, p. 113, pl. 4, fig. 21; Ralfs *in* Pritchard, 1861, p. 853; Rattray, 1890, p. 644; Wolle, 1890, pl. 81, fig. 15; De Toni, 1894, p. 1405; Peragallo, 1897–1908, p. 405, pl. 110, fig. 3; Hustedt, 1930, p. 489, fig. 274; Gombos, 1975, p. 315, pl. 6, figs. 2, 8, 9; Fenner, 1978, p. 511, pl. 18, fig. 3.

Synonyms. *Asteromphalus grevillei* Wallich, 1860, p. 47, pl. 2, fig. 15; *Asterolampra rotula* Greville, 1860, p. 111, pl. 3, fig. 5; *A. variabilis* Greville, 1860, p. 111, pl. 6, fig. 8; *Asteromphalus variabilis* (Greville) Rattray, 1890, p. 655.

Remarks. Rare, but consistently occurs in the upper part of the middle Eocene section in Hole 512.

Asterolampra insignis Schmidt, 1888
(No illustration)

References. Schmidt, 1888, pl. 137, figs. 1–3; Schrader and Fenner, 1976, p. 965, pl. 21, fig. 15; Gombos, 1977, p. 592, pl. 25, figs. 2, 4; Fenner, 1979, p. 511; Gombos, 1980, pp. 235–236, pl. 10, fig. 48; pl. 13, fig. 52.

Remarks. This is the most common species of *Asterolampra* in Hole 512.

Asterolampra marginata (Brightwell) Greville, 1862
(No illustration)

References. Greville, 1862, p. 50, pl. 8, fig. 30; Gombos, 1980, p. 237, pl. 1, figs. 1–3; pl. 9, figs. 44–45.

Synonyms. *Craspedodiscus marginatus* Brightwell, 1860, p. 95, pl. 5, fig. 7; *Heterodictyon rylandsium* Greville, 1863, p. 66, pl. 4, fig. 6.

Remarks. Extremely rare in Hole 512.

Asterolampra transmarginata Gombos, 1980
(No illustration)

Reference. Gombos, 1980, p. 238, pl. 1, figs. 5–7.

Remarks. Extremely rare in Hole 512.

Asterolampra marylandica **Ehrenberg, 1844**
(No illustration)

References. Ehrenberg, 1844, p. 76, fig. 10; Hustedt, 1930, p. 485, fig. 271.

Asterolampra uraster **Grove and Sturt, 1887**
(Plate 1, Figs. 4–8)

References. Grove and Sturt, 1887, p. 143, pl. 7, figs. 4–5; Gombos, 1980, p. 239, pl. 3, fig. 19.
Remarks. Rare, but consistently occurs throughout the middle Eocene section in Hole 512.

Asterolampra vulgaris **Greville, 1862**
(No illustration)

References. Greville, 1862, p. 47, pl. 7, figs. 17–20; Schmidt, 1888, pl. 137, figs. 10, 12; pl. 202, figs. 14–16; Schrader and Fenner, 1976, p. 592, pl. 25, figs. 1, 3, 5; Gombos, 1980, pp. 239–240, pl. 4, figs. 20–24.

Asterolampra **sp.**
(Plate 1, Fig. 3)

Remarks. This small species (27 μm in diameter) is characterized by three rays which taken together form an isosceles triangle; the inner margins of the areolated segments are straight, and in the middle of the long side of the isosceles triangle there is one large areola. This species is very rare in Hole 512 and may be a variety of *Asterolampra uraster*, within whose range it occurs.
Age. middle Eocene.

Genus *BERGONIA* Tempère

Bergonia angelica **Gombos, in press**
(Plate 2, Figs. 5–8)

Remarks. This species differs from *Bergonia barbadensis* by having single ray-slits; the rays are situated near each other at one side of the valve. A characteristic middle Eocene diatom.

Genus *BRIGHTWELLIA* Ralfs, 1861

Brightwellia elaborata **Greville, 1861**
(No illustration)

Reference. Greville, 1861, p. 73, pl. 9, fig. 1.
Remarks. Rare in the lower part of the middle Eocene section in Hole 512.

Brightwellia imperfecta **Jousé, 1974**
(Plate 3, Fig. 5)

Reference. Jousé, 1974, p. 56, pl. 2, figs. 5–7.
Remarks. A distinctive species with a short range in Hole 512.

Genus *COSCINODISCUS* Ehrenberg, 1838

Coscinodiscus bulliens **Schmidt, 1886**
(No illustration)

Reference. Schmidt, 1886, pl. 61, fig. 11.

Coscinodiscus marginatus **Ehrenberg, 1841**
(Plate 4, Fig. 14)

Reference. Hustedt, 1930, pp. 416–418, fig. 223.

Coscinodiscus oligocenicus **Jousé, 1974**
(Plate 2, Figs. 1–4)

Reference. Jousé, 1974, p. 348, pl. 1, figs. 6–8, 16.
Remarks. There seems to be quite a bit of variation in this species. For this study I have included all forms similar to those illustrated by Jousé (1974) within a *Coscinodiscus oligocenicus* group.

Coscinodiscus praenitidus **Fenner, 1976**
(No illustration)

Reference. Fenner *in* Schrader and Fenner, 1976, p. 972, pl. 14, figs. 7–9, 12; pl. 27, fig. 8; pl. 35, fig. 24; pl. 36, fig. 5.

Genus *CRASPEDODISCUS* Ehrenberg, 1844

Craspedodiscus coscinodiscus **Ehrenberg, 1844**
(No illustration)

References. Ehrenberg, 1844, p. 266; Kolbe, 1954, p. 36, pl. 1, fig. 4; Gombos, 1975, p. 316, pl. 4, figs. 5–6, 11–12; Schrader and Fenner, 1976, p. 974.
Remarks. Very rare and sporadic in Hole 512.

Craspedodiscus ellipticus **(Greville) Gombos, in press**
(No illustration)

References. Gombos (in press), pl. 3, figs. 13–14.
Synonyms. *Coscinodiscus oblongus* Greville, 1866, p. 4, pl. 1, figs. 9, 10; Schmidt, 1886, pl. 66, figs. 10–11; Walker and Chase, 1886–1887, p. 4, pl. 5, fig. 4; Rattray, 1890, p. 537; De Toni, 1894, p. 1260; Kanaya, 1957, p. 89–90, pl. 6, figs. 2–5; Proschkina-Lavrenko et al., 1974, pl. 32, fig. 1; Schrader and Fenner, 1976, p. 970, pl. 36, figs. 11–12; Fenner, 1979, p. 515; *Craspedodiscus oblongus* (Greville) Hanna, 1931, p. 194, pl. B, figs. 1–2; Jouse, 1977, pl. 63, fig. 7; Dzinoridze et al., 1979, pl. 5, fig. 5.
Remarks. This species is characteristic of the middle Eocene of California (Kanaya, 1957). Its highest occurrence at Site 512 is in Hole 512A, Core 2. This is a very important stratigraphic marker species; it is large, often well preserved, and common and it is easy to identify.

Craspedodiscus moelleri **Schmidt, 1893**
(Plate 3, Fig. 2–4)

References. Schmidt, 1893, pl. 184, fig. 3; Benda, 1972, p. 255, pl. 1, fig. 1; Gombos, 1977, p. 593, pl. 27, fig. 6.

Craspedodiscus splendidus **(Greville) Gombos, in press**
(Plate 3, Figs. 6–7)

References. Gombos (in press), pl. 2, figs. 9, 11.
Synonyms. *Porodiscus splendidus* Greville, 1865, p. 46, pl. 5, fig. 5; Walker and Chase, 1886–1887, p. 2, pl. 5, fig. 5; Rattray, 1890, p. 671; De Toni, 1894, p. 1195; Schutt, 1896, p. 65, fig. 83a; Van Heurck, 1896, p. 516, fig. 270; Karsten, 1928, p. 111, fig. 213A; Laporte and Lefebure, 1930, pl. 23, fig. 163; *P. splendens* (misspelling?) Jousé et al., 1977, pl. 61, fig. 18; *Craspedodiscus ovalis* Grunow, 1881 in Schmidt, 1886, pl. 66, fig. 6.
Remarks. Very rare in Hole 512.

Genus *ETHMODISCUS* Castracane, 1886

Ethmodiscus rex **(Wallich) Hendey, 1953**
(No illustration)

References. Hendey *in* Hendey and Wiseman, 1953, p. 51, pls. 1–2.
Synonym. *Coscinodiscus rex* Wallich *in* Rattray, 1890, p. 568.
Remarks. Common to abundant throughout the middle Eocene of Holes 512 and 512A.

Genus *GONIOTHECIUM* Ehrenberg, 1841

Goniothecium odontella **Ehrenberg, 1844**
(No illustration)

References. Karsten, 1928, p. 301, fig. 419A; Schrader and Fenner, 1976, p. 983, pl. 6, figs. 1–2, 4; Fenner, 1979, p. 520, pl. 26, fig. 7; pl. 27, fig. 1.

Genus *HEMIAULUS* Ehrenberg, 1844

Remarks. This large and complex genus is represented by a great number of species in the material from Holes 512 and 512A. I have not attempted to differentiate all species since that would involve a revision of the genus. Such a study is beyond the scope of this initial report.

Hemiaulus claviger **Schmidt, 1889**
(No illustration)

Reference. Schmidt, 1889, pl. 143, figs. 5–6.

Hemiaulus incurvus **Schibkova, 1959**
(No illustration)

References. Schibkova *in* Krotov and Schibkova, 1959, p. 124, pl. 4, fig. 8; Gombos, 1977, p. 549, pl. 16, figs. 6–7; pl. 17, figs. 1–3.

Remarks. This species is typical of the upper Paleocene of the Falkland Plateau (Gombos, 1977). Its presence in the middle Eocene sediment of Hole 512 suggests that it has been reworked from another locality on the Falkland Plateau.

Genus *MELOSIRA* Agardh, 1824

Melosira architecturalis **Brun, 1892**
(No illustration)

References. Brun *in* Schmidt, 1892, pl. 177, figs. 49–50; Hajós, 1976, p. 824, pl. 1, figs. 5–6; Schrader and Fenner, 1976, p. 989, pl. 14, fig. 13; pl. 29, figs. 7–8; pl. 35, figs. 1–4; Gombos, 1977, p. 595, pl. 26, figs. 5–7; Fenner, 1979, p. 524, pl. 16, figs. 7–12.

Synonym. *Cyclotella hannae* Kanaya, 1957, pp. 82–84, pl. 3, figs. 10–11, 14.

Remarks. This species is common throughout the middle Eocene of Holes 512 and 512A.

Genus *ODONTOTROPIS* Grunow, 1884

Odontotropis **sp.**
(No illustration)

Remarks. Sporadic fragments in Hole 512. Possibly fragments of *Odontotropis klavsenii*.

Genus *PRAECYMATOSIRA* Strelnikova, 1979

Praecymatosira monomembranacea **(Schrader) Strelnikova, 1979**
(Plate 4, Figs. 12–13)

References. Strelnikova, *in* Jousé et al., 1979, p. 64, figs. 169–176.

Synonym. *Pseudorutilaria monomembranacea* Schrader *in* Schrader and Fenner, 1976, p. 994, pl. 22, figs. 1–6.

Remarks. Common throughout the middle Eocene of Hole 512.

Genus *PSEUDORUTILARIA* Grove and Sturt, 1886

Pseudorutilaria monile **Grove and Sturt, 1886**
(No illustration)

References. Grove and Sturt, 1886, p. 324, pl. 18, fig. 7; Hajós, 1976, p. 829, pl. 14, figs. 10–12; Gombos, 1977, p. 595, pl. 40, fig. 7.

Remarks. Very rare in the present material.

Genus *PSEUDOTRICERATIUM* Grunow, 1884

Pseudotriceratium chenevieri **(Meister) Gleser, 1975**
(Plate 2, Figs. 10–12)

References. Gleser, 1975, pl. 2, fig. 4; Schrader and Fenner, 1976, p. 994, pl. 11, figs. 7–9; pl. 26, fig. 5; Strelnikova *in* Jousé et al., 1979, p. 51, figs. 152–153.

Synonym. *Triceratium chenevieri* Meister, 1937, p. 261, pl. 5, fig. 2.

Genus *PTEROTHECA* (Grunow) Forti, 1909

Pterotheca aculeifera **Grunow, 1882**
(No illustration)

References. Grunow *in* Van Heurck, 1882, pl. 83, figs. 13–14; Grunow *in* Van Heurck, 1896, p. 430, fig. 151; Kanaya, 1957, pp. 109–110, pl. 8, figs. 1–2; Schrader and Fenner, 1976, p. 994, pl. 43, figs. 1–4; Gombos, 1977, p. 596, pl. 23, figs. 1–2; Fenner, 1979, p. 527, pl. 17, figs. 8–21.

Remarks. Rare, but consistently occurs throughout the middle Eocene of Holes 512 and 512A.

Pterotheca danica **(Grunow) Forti, 1909**
(Plate 3, Fig. 9)

References. Forti, 1909, p. 13; Hanna, 1927, p. 119, pl. 20, fig. 11; Proschkina-Lavrenko, 1949, p. 203, pl. 75, fig. 9.

Pterotheca major **Jousé, 1955**
(No illustration)

Reference. Jousé, 1955, p. 101, pl. 6, fig. 2; text-figure 1.

Remarks. All forms with broadly expanded bases were included in this taxon.

Pterotheca spada **Tempère and Brun, 1889**
(No illustration)

References. Tempère and Brun *in* Brun and Tempère, 1889, p. 50, pl. 1, fig. 17; Forti, 1909, p. 13.

Genus *PYXILLA* Greville, 1865

Pyxilla prolungata **Brun, 1893**
(No illustration)

References. Brun, 1893, p. 176, pl. 24, fig. 7; Laporte and Lefebure, 1929, pl. 7, fig. 46; McCollum, 1975, p. 535, pl. 11, figs. 4–6.

Synonyms. *Pyrgupyxis prolungata* (Brun) Hendey, 1969, p. 5; Gombos, 1977, p. 596, pl. 21, figs. 1–7; pl. 22, fig. 11; Fenner, 1979, p. 528, pl. 19, fig. 8.

Remarks. Hendey (1969) erected the genus *Pyrgupyxis* to accommodate species which are similar to those of the genus *Pyxilla* Greville but which form pairs through attachment of the hornlike apical processes of the valves by inserting small marginal spurs into notches. Hendey (1969, p. 2) did not believe that the type specimen of *Pyxilla* (i.e., *P. barbadensis* Greville) possessed such attachment spurs and notches; thus he believed that the forms with such apparatuses constituted a separate genus. Upon close scrutiny of the type slide, Dr. R. Simonsen (pers. comm.) observed an attachment spur on the type species of *Pyxilla*. It is understandable that previous workers did not observe the spur, because it is located on one side of the hornlike process and may be difficult to see if the valve is oriented with the spur downward.

The taxonomy of the genus is in need of review and revision, for the limits of the various species and varieties are not very clear. In the material from Holes 512 and 512A, the genus is represented, primarily, by broken fragments of valves which are probably *P. prolungata*. Therefore I have included all fragments from the present material in a *P. prolungata* group on the range chart (Fig. 1). The most important stratigraphic aspect of the *P. prolungata* group is its last occurrence in the lower upper Oligocene (see Gombos and Ciesielski, this volume).

Genus *RHIZOSOLENIA* Ehrenberg, 1841

Rhizosolenia praebarboi **Schrader, 1973**
(No illustration)

References. Schrader, 1973, pp. 709–710, pl. 24, figs. 1–3; Schrader and Fenner, 1976, p. 997, pl. 7, fig. 10; pl. 24, figs. 1–3.

Synonyms. *Rhizosolenia* sp. B Gombos, 1977, p. 596, pl. 23, fig. 7; *R. interposita* Hajós, 1976, p. 827, pl. 21, fig. 8; *R.* sp. 1 Strelnikova *in* Dzinoridze et al., 1979, pl. 5, figs. 4, 6.

Remarks. Schrader and Fenner (1976) report this species as ranging from upper Oligocene to middle Miocene in the Norwegian Sea. Hajós (1976) reports it from the lower Oligocene in the south Tasman Sea. In Hole 512 it is rare and sporadic through the middle Eocene.

Rhizosolenia **sp.**
(Plate 3, Fig. 8)

Remarks. This species, which was observed only as incomplete specimens, is characterized by a thick apical extension, 22 μm long and 10 μm in diameter; the surface has parallel hyaline strips which separate areas of minute punctation. The species is characteristic of the Lutetian and lower Bartonian in Hole 512.

Genus *RYLANDSIA* Greville, 1861

Rylandsia biradiata **Greville, 1861**
(Plate 3, Fig. 10)

References. Greville, 1861, p. 67, pl. 8, fig. 1; Gombos, 1980, p. 242, pl. 6, figs. 32–36; pl. 14, figs. 55–56; pl. 15, figs. 57–58.

Genus *SCEPTRONEIS* Ehrenberg, 1844

Sceptroneis cf. *S. ligulatus* Fenner, 1979
(No illustration)

Reference. Fenner, 1979, p. 531, pl. 31, figs. 8–10.
Synonym. Genus and species indeterminate (C) Gombos, 1977, p. 599, pl. 12, fig. 8.
Remarks. Two types of valves were observed in Hole 512—those with and those without a structured surface, as Fenner (1979) also noted in samples from the middle Eocene of Hole 356 on the São Paulo Plateau. Both types are included together on the range chart (Fig. 1). The hyaline valves range throughout the middle Eocene section in Hole 512, whereas the structured valves range from Core 6 to Core 13, Section 1. Both are rare and sporadic.

Sceptroneis pesplanus Fenner and Schrader, 1976
(No illustration)

Reference. Fenner and Schrader *in* Schrader and Fenner, 1976, p. 998, pl. 22, figs. 30–31; pl. 25, figs. 10–11; Fenner, 1979, p. 531, pl. 26, fig. 16; pl. 27, fig. 16.

Genus *STEPHANOPYXIS* Ehrenberg, 1844

Stephanopyxis grunowii Grove and Sturt, 1888
(No illustration)

References. Grove and Sturt *in* Schmidt, 1888, pl. 130, figs. 1–6; Hanna, 1927, p. 33, pl. 4, fig. 12; Hajós, 1976, p. 824, pl. 3, figs. 3–4; pl. 4, figs 1–2; Gombos, 1977, p. 597, pl. 28, figs. 3–5; pl. 31, figs. 1–2, 7; pl. 32, figs. 1–3.
Remarks. Common through the middle Eocene section of Holes 512 and 512A.

Stephanopyxis turris (Greville and Arnott) Ralfs, 1861
(No illustration)

References. Ralfs *in* Pritchard, 1861, p. 826, pl. 5, fig. 74; Hustedt, 1930, pp. 304–307, figs. 140–144.
Remarks. This nondiagnostic species and its varieties are frequent to common through the middle Eocene in Holes 512 and 512A.

Genus *TRICERATIUM* Ehrenberg, 1841

Triceratium capitatum Greville, 1861
(No illustration)

Reference. Greville, 1861, p. 43, pl. 4, fig. 10.
Remarks. One specimen was observed in Sample 512-10-2, 32–34 cm.

Triceratium inconspicuum v. *trilobata* Fenner, 1978
(No illustration)

Reference. Fenner, 1978, p. 534, pl. 30, figs. 23–26.
Synonyms. *Triceratium inconspicuum* Greville (?) *in* Schmidt, 1882, pl. 77, figs. 25–28; Kanaya, 1957, pp. 100–101, pl. 7, figs. 1–4.

Triceratium macroporum Hajós, 1968
(No illustration)

References. Hajós, 1968, pl. 35, figs, 1–10; Jousé, 1974, p. 349, pl. 2, fig. 12.
Remarks. Jousé (1974) observed one specimen in *Vityaz* core 5996/5 from the tropical Pacific Oligocene. Hajós (1968) observed it in the middle Miocene of Hungary. The species is characterized by large, sparse areolae with very small pores interspersed. There is some variation in valve outline from nearly straight sides to rather convex sides; in some specimens the angles are subcapitate. Rare and sporadic in Holes 512 and 512A.

Triceratium cf. *T. russlandicum* Tempère, 1890
(Plate 1, Fig. 12; Plate 2, Fig. 9)

Reference. Tempère, 1890, p. 33, pl. 3, fig. 6.
Remarks. Because the photographic illustration of *Triceratium russlandicum* presented by Tempère (1890) is somewhat indistinct, it was not possible to match the illustrations herein with his. The specimens observed in the present material exhibit considerable variation in prolongation of the angles. The surfaces of the valves are covered with puncta of differing sizes, some quite elliptical in shape.

Triceratium unguiculatum Greville, 1864
(No illustration)

References. Greville, 1864, p. 85, pl. 11, fig. 9; Gombos, 1977, pp. 598–599, pl. 33, figs. 1, 3; pl. 34, figs. 1–6.

Genus *TRINACRIA* Heiberg, 1863

Trinacria excavata Heiberg, 1863
(No illustration)

References. Heiberg, 1863, p. 51, pl. 4, fig. 9; Hustedt, 1930, pp. 887–888, fig. 532.
Remarks. Rare in material from Holes 512 and 512A.

Trinacria excavata f. *tetragona* Schmidt, 1888
(Plate 4, Fig. 11)

Reference. Schmidt, 1888, pl. 152, figs. 26–28.
Synonym. *Solium exsculptum* sensu Witt *in* Schmidt, 1888, pl. 152, figs. 24–25.
Remarks. This very distinctive species is potentially a valuable stratigraphic marker for the middle Eocene. In Hole 512 its highest occurrence is in Core 9, Section 3. Below that level it is rare to frequent.

Trinacria simulacrum Grove and Sturt, 1887
(No illustration)

References. Grove and Sturt, 1887, p. 144, pl. 13, fig. 46; Schmidt, 1888, pl. 127, fig. 14; Hajós, 1976, p. 829, pl. 15, figs. 1–4; Gombos, 1977, p. 599, pl. 35, figs. 1–2, 4; pl. 36, figs. 1–4; Fenner, 1979, p. 536, pl. 29, fig. 2; pl. 31, fig. 2.
Remarks. Rare to abundant in the middle Eocene of Holes 512 and 512A.

INCERTAE SEDIS

Genus and species uncertain #1
(Plate 7, Figs. 1–6)

Remarks. This species is elliptical in outline; the valve surface is covered with fine, subparallel rows of puncta. There are three prominent elevations, one at each end of the valve from which hyaline horns arise and one in the middle of the valve from which an elongate labiate process arises. Spread between the elevations is a hyaline crest through which a variable number of spines project at irregular intervals. No complete examples of this species were observed, only fragments such as those illustrated herein. Formal naming of this species is withheld pending more detailed analysis with the scanning electron microscope and observation of more complete specimens.
Age. Middle Eocene.

Genus and species uncertain #2
(Plate 8, Figs. 1–5)

Remarks. Similar to but somewhat shorter than Genus and species uncertain #1 (see preceding entry), except for the absence of spines in the hyaline crest.
Age. Middle Eocene.

DESCRIPTIONS OF NEW TAXA

A new genus, two new species, and a new form are described in the following section. The new taxa are listed alphabetically in a separate section for easy reference.

Hemiaulus vitreus n. sp.
(Plate 4, Fig. 1–4)

Description. Valves elliptical and hyaline, with scattered puncta; two long, hyaline horns with discontinuous grooves. No complete specimens were observed, so that the nature of the valve margin or the tips of the horns could not be determined. Distance between horns of holotype 27 μm.
Remarks. The hyaline nature of the valves distinguishes this species from most other *Hemiaulus* (cf. *H. caracteristicus* Hajós, 1976).

Holotype. Author's slide D283T3; specimen is circumscribed on slide and is illustrated in Plate 4, Figure 4.

Repository. Hustedt Collection, Bremerhaven, Federal Republic of Germany, catalog number Zu2/75.

Type locality. Deep Sea Drilling Project Site 512 (49°52.19′S; 40°50.71′W), located on the northeastern part of the Maurice Ewing Bank at the eastern extremity of the Falkland Plateau.

Type stratum. Sample 512-11-1, 78–80 cm; 39.10 meters below the sediment surface.

Age. Middle Eocene.

Trinacria excavata Heiberg f. *inflata* n. f.
(Plate 4, Figs. 5–10)

Description. Similar to *Trinacria excavata* Heiberg f. *tetragona* Schmidt, 1888, but differs from that form by having inflated angles; length of one side of holotype measured from tip of one angle to another 52 μm; length of diagonal of holotype 57 μm; surface covered with puncta, not of uniform size, in radial arrangement, 6 in 10 μm.

Remarks. In Hole 512 this form exhibits a different range from *Trinacria excavata* f. *tetragona* (see Fig. 1) and may have evolved from it.

Holotype. Author's slide D283R3; specimen is circumscribed on slide and is illustrated in Plate 4, Figure 10.

Repository. Hustedt Collection, Bremerhaven, Federal Republic of Germany, catalog number Zu2/74.

Type locality. Deep Sea Drilling Project Site 512 (49°52.19′S; 40°50.71′W), located on the northeastern part of the Maurice Ewing Bank at the eastern extremity of the Falkland Plateau.

Type stratum. Sample 512-9-3, 64–66 cm; 34.56 meters below the sediment surface.

Age. Middle Eocene.

Genus *TUBAFORMIS* n. gen.

Definition. Valves subconical or domeshaped with a single, thick, tapering, curved extension emanating from the apex; valve surface partially punctuate. Genotype: *Tubaformis unicornis* n. sp. (see following sp.).

Tubaformis unicornis n. sp.
(Plate 5, Figs. 1–6; Plate 6, Figs. 1–2)

Description. Valves subconical with a single, long, thick, tapering extension emanating from the apex. Margin of valve is punctate, with some of the puncta loosely arranged into radially oriented rows; remainder of puncta are randomly distributed in the marginal area, which is approximately equal in width to one-third the valve radius. Inner two-thirds of valve surface is hyaline and separated from marginal area by a flexure marking its departure from the more or less planar orientation of the marginal flange. From the apex of the valve a hollow, slightly tapering, tubular extension of the valve surface arises and curves back on itself. To one side of the valve, a depression, corresponding in shape to the curved extension, occurs. This depression receives the extension of the next valve in the chain. Diameter of holotype is 63 μm.

Remarks. No similar species could be found in the literature. This species occurs throughout the middle Eocene section in Hole 512, being most common in the lower part of the section. I noticed it also on a slide from Barbados in the British Museum Greville Collection (slide BM 2045), proving its broad distribution during the middle Eocene.

Holotype. Author's slide DSDP 512-10CC; specimen is circumscribed on the slide and is illustrated in Plate 5, Figure 1.

Repository. Hustedt Collection, Bremerhaven, Federal Republic of Germany, catalog number Zu2/73.

Type locality. Deep Sea Drilling Project Site 512 (49°52.19′S; 40°50.71′W), located on the northeastern part of the Maurice Ewing Bank at the eastern extremity of the Falkland Plateau.

Type stratum. Sample 512-10,CC; 38.3 meters below the sediment surface.

Age. Middle Eocene.

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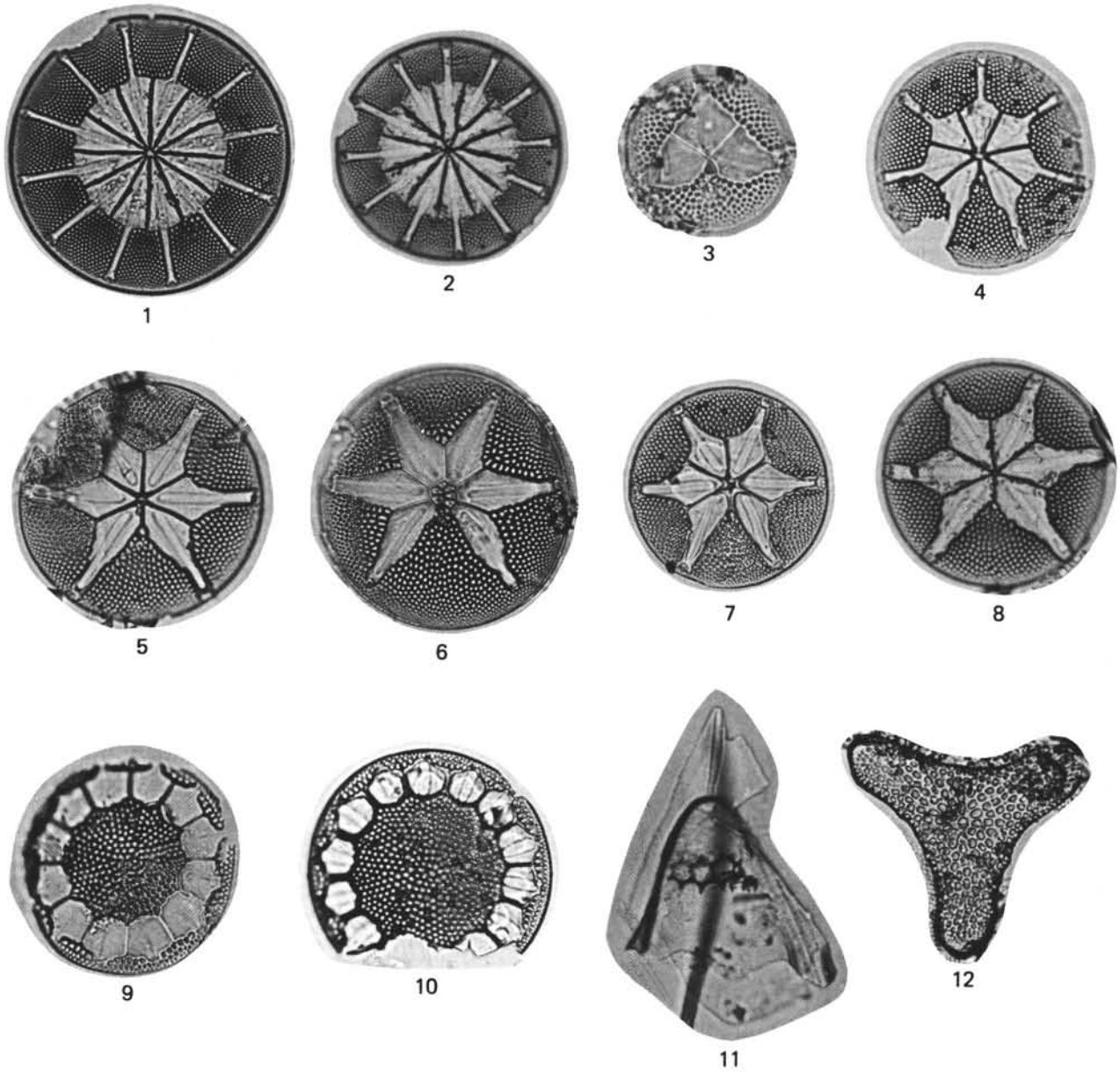


Plate 1. (All magnifications ×500 unless otherwise noted.) 1. *Asterolampra affinis* Greville. Sample 512-9-3, 64–66 cm. 2. *Asterolampra grevillei* Wallich) Greville. Sample 512-9-3, 64–66 cm. 3. *Asterolampra* sp. Sample 512-13-1, 33–35 cm. ×800. 4–8. *Asterolampra uraster* Grove and Sturt (4) Sample 512-18-1, 41–43 cm (5) Sample 512-18-1, 41–43 cm (6) Sample 512-14-1, 68–70 cm (7) Sample 512-18-1, 41–43 cm (8) Sample 512-9-3, 64–66 cm. 9–10. *Asterolampra distincta* Barker and Meakin (9) Sample 512-14-1, 68–70 cm (10) Sample 512-18-1, 41–43 cm. 11. *Odontotropis* sp. Sample 512-13-1, 33–35 cm. 12. *Triceratium* cf. *T. russlandicum* Tempère. Sample 512-14-1, 68–70 cm.

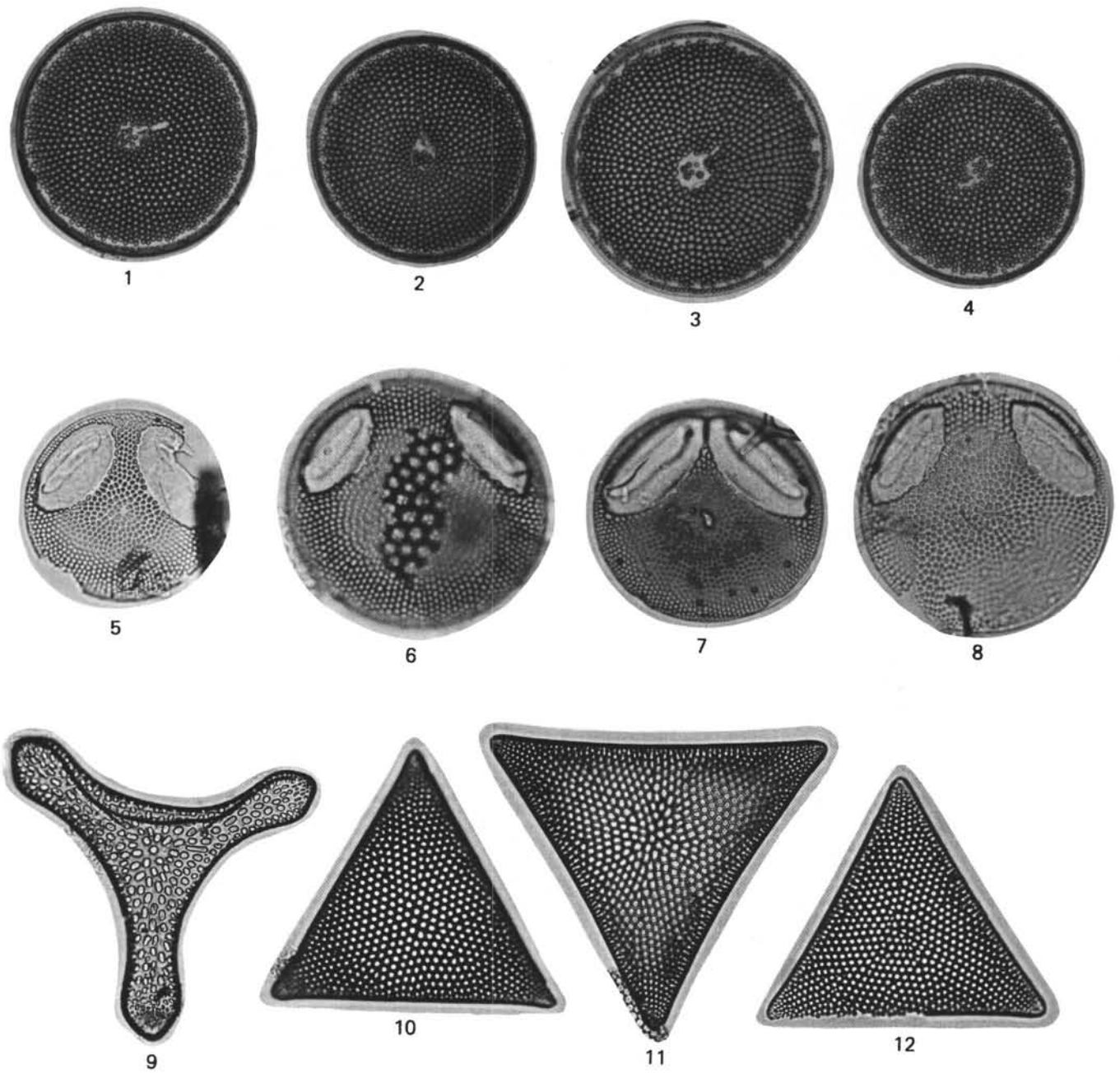


Plate 2. (All magnifications ×500.) 1–4. *Coscinodiscus oligocenicus* Jousé s.l (1) Sample 512-13-1, 33–35 cm (2) Sample 512-11-3, 60–62 cm (3) Sample 512-13-1, 33–35 cm (4) Sample 512-11-3, 60–62 cm. 5–8. *Bergonia angelica* Gombos (5) Sample 512-18-1, 41–43 cm (6) Sample 512-11-3, 60–62 cm (7) Sample 512-11-3, 60–62 cm (8) Sample 512-11-1, 78–80 cm. 9. *Triceratium* cf. *T. russlandicum* Tempère. Sample 512-9-1, 96–98 cm. 10–12. *Pseudotriceratium chenevieri* (Meister) Gleser. Sample 512-9-3, 64–66 cm.

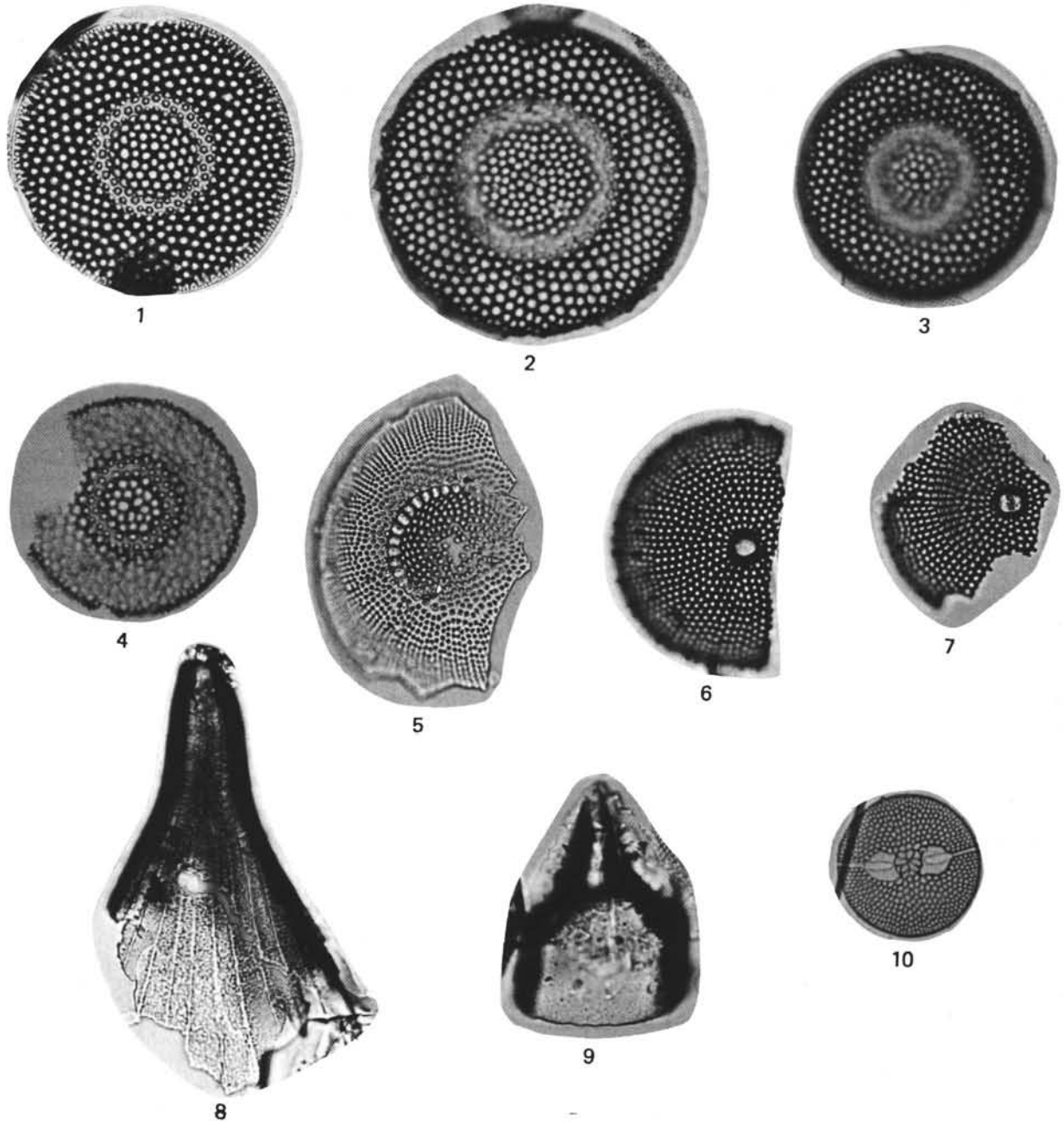


Plate 3. (All magnifications ×500.) 1–4. *Craspedodiscus moelleri* Schmidt (1) Sample 512-8,CC (2–3) Sample 512-11-3, 60–62 cm (4) Sample 512-11-1, 78–80 cm. 5. *Brightwellia imperfecta* Jousé. Sample 512-15-1, 71–73 cm. 6–7. *Craspedodiscus splendidus* (Greville) Gombos (6) Sample 512-16-2, 19–21 cm (7) Sample 512-14-3, 49–51 cm. 8. *Rhizosolenia* sp. Sample 512-18-1, 41–43 cm. 9. *Pterotheca danica* (Grunow) Forti. Sample 512-19-1, 9–11 cm. 10. *Rylandsia biradiata* Greville. Sample 512-11-3, 60–62 cm.

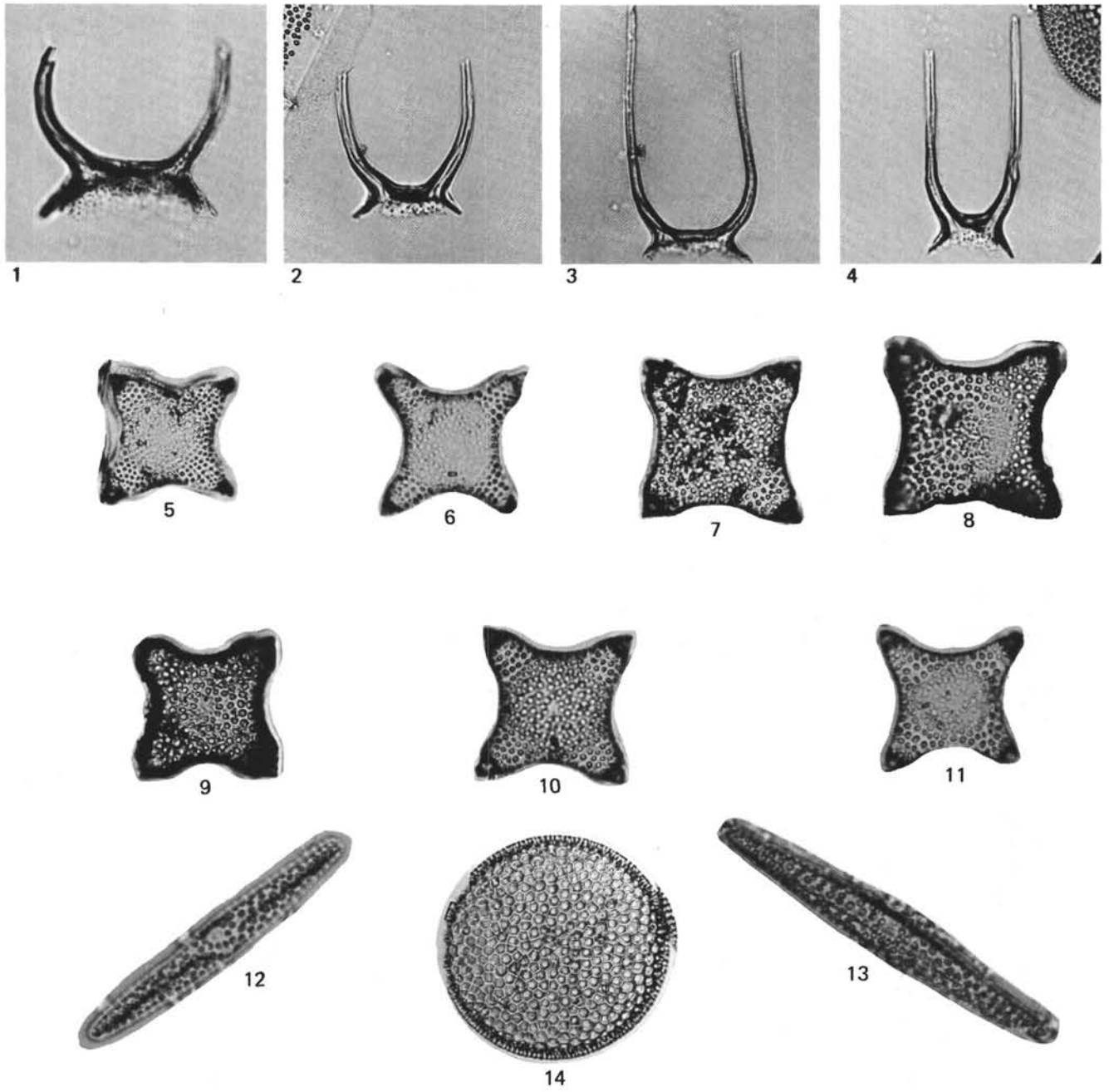
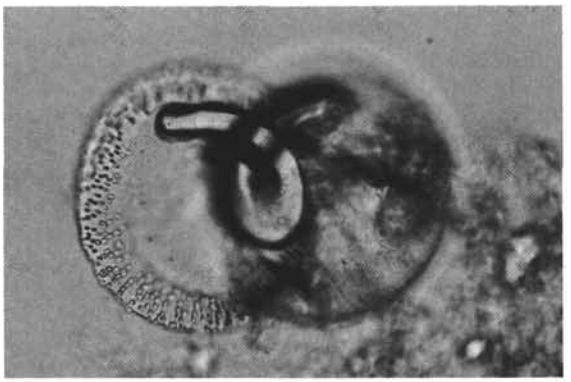


Plate 4. (All magnifications ×500.) 1–4. *Hemiaulus vitreus* n. sp. (1) Sample 512-9-3, 64–66 cm (2–3) Sample 512-11-1, 78–80 cm (4) Holotype Sample 512-11-1, 78–80 cm. 5–10. *Trinacria excavata* f. *inflata* n.f. (5–6). Sample 512-9-3, 64–66 cm (7) Sample 512-8-1, 69–71 cm (8–9) Sample 512-9-1, 96–98 cm (10) Holotype. Sample 512-9-3, 64–66 cm. 11. *Trinacria excavata* f. *tetragona* Schmidt. Sample 512-11-1, 78–80 cm. 12–13. *Praecymatosira monomembranacea* (Schrader) Strelnikova. Sample 512-12-2, 58–60 cm. 14. *Coscinodiscus marginatus* Ehrenberg. Sample 512-9-3, 64–66 cm.



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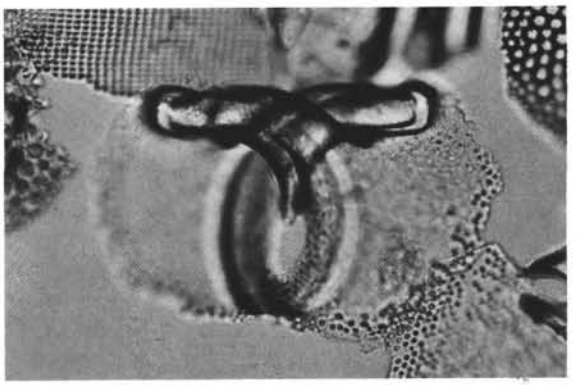

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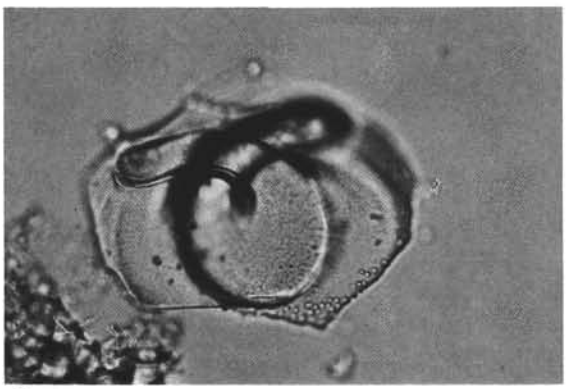

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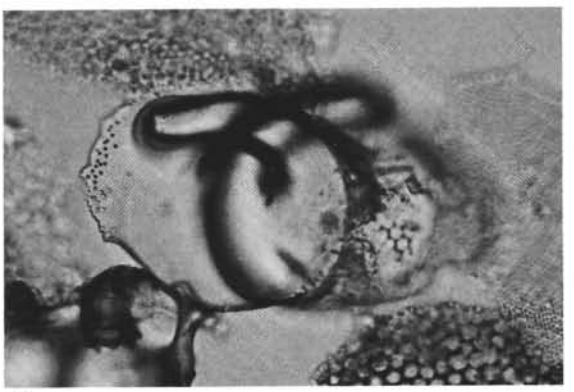

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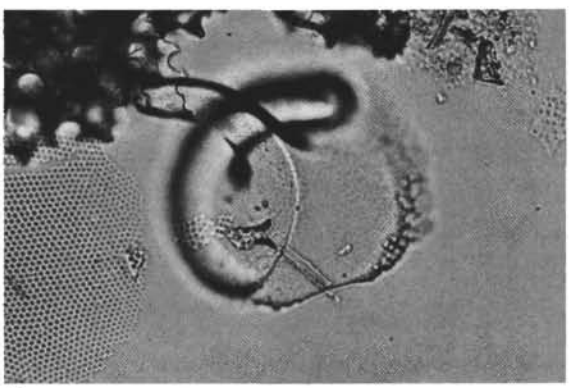

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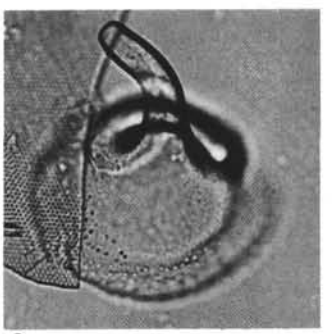

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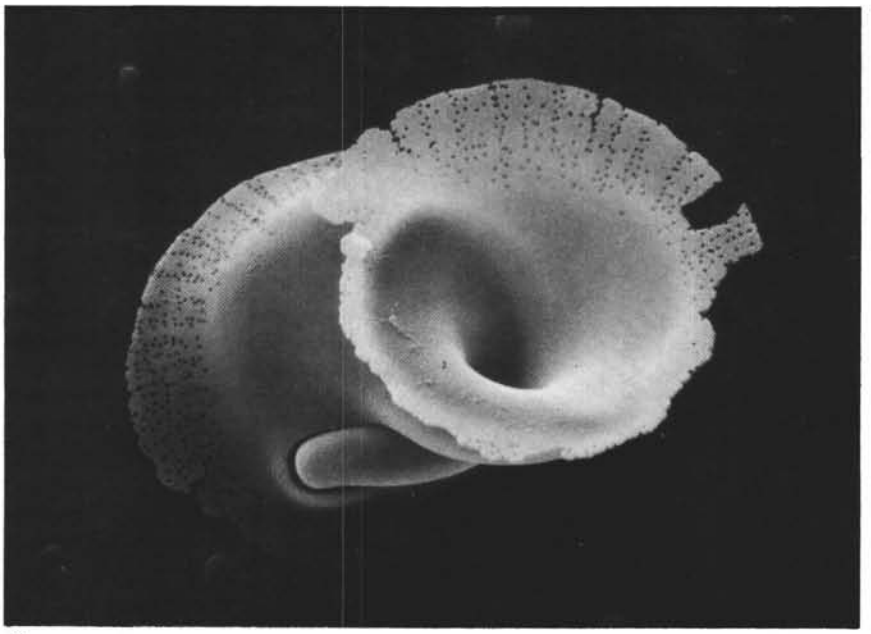
Plate 5. (All magnifications ×500.) 1–6. *Tubaformis unicornis* n. sp. (1) Holotype. Sample 512-10,CC (2–6) Sample 512-10,CC.



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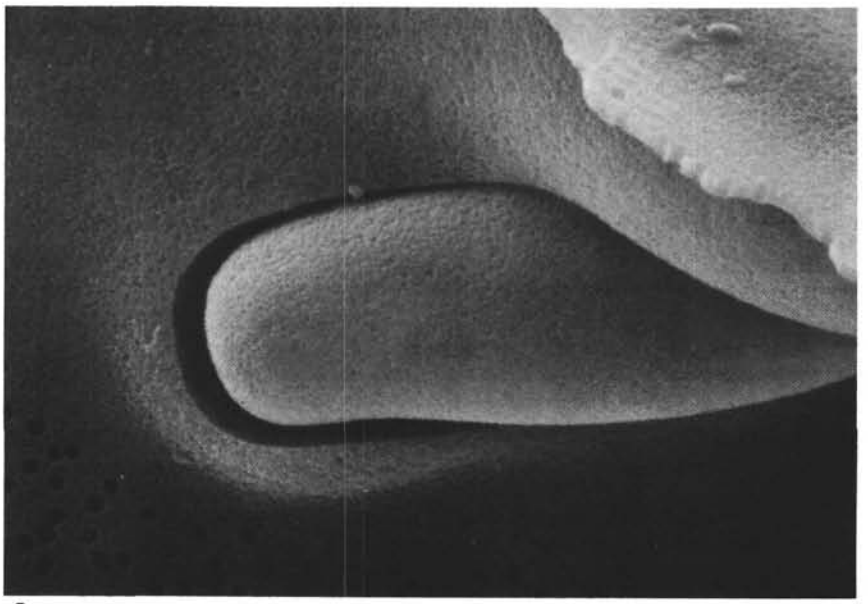
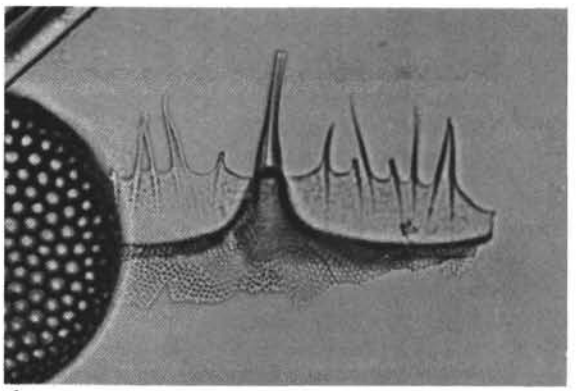


2

Plate 6. 1–2. *Tubaformis unicornis* n. sp., (1) Sample 512-15-3, 15–17 cm (bar = 20 μm). Same specimen as Fig. 1. Sample 512-15-3, 15–17 cm (bar = 10 μm).



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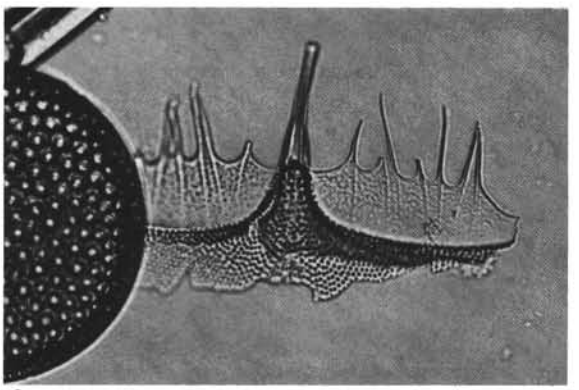

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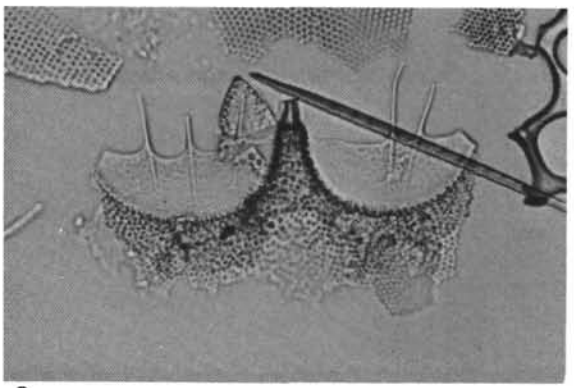

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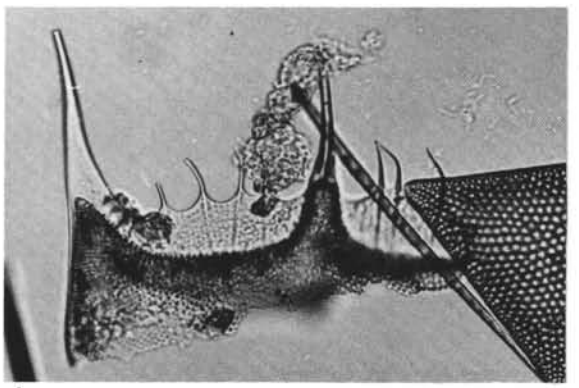

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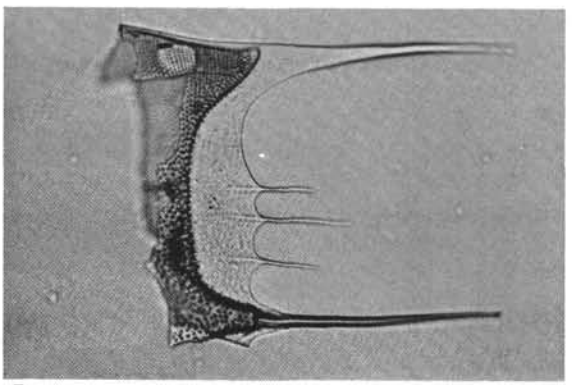

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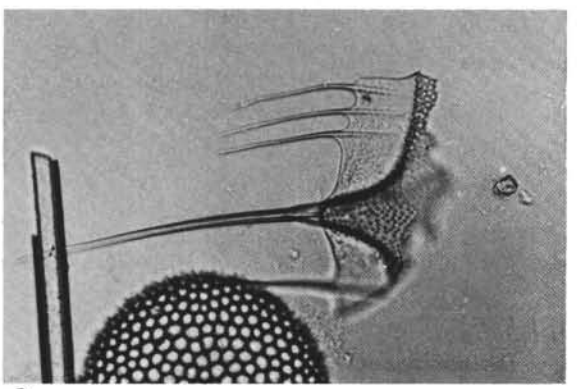

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Plate 7. (All magnifications ×500). 1–6. Genus and species uncertain #1 (1–2) Sample 512-13-1, 33–35 cm (3) Sample 512-11-1, 78–80 cm (4–6) Sample 512-9-3, 64–66 cm.

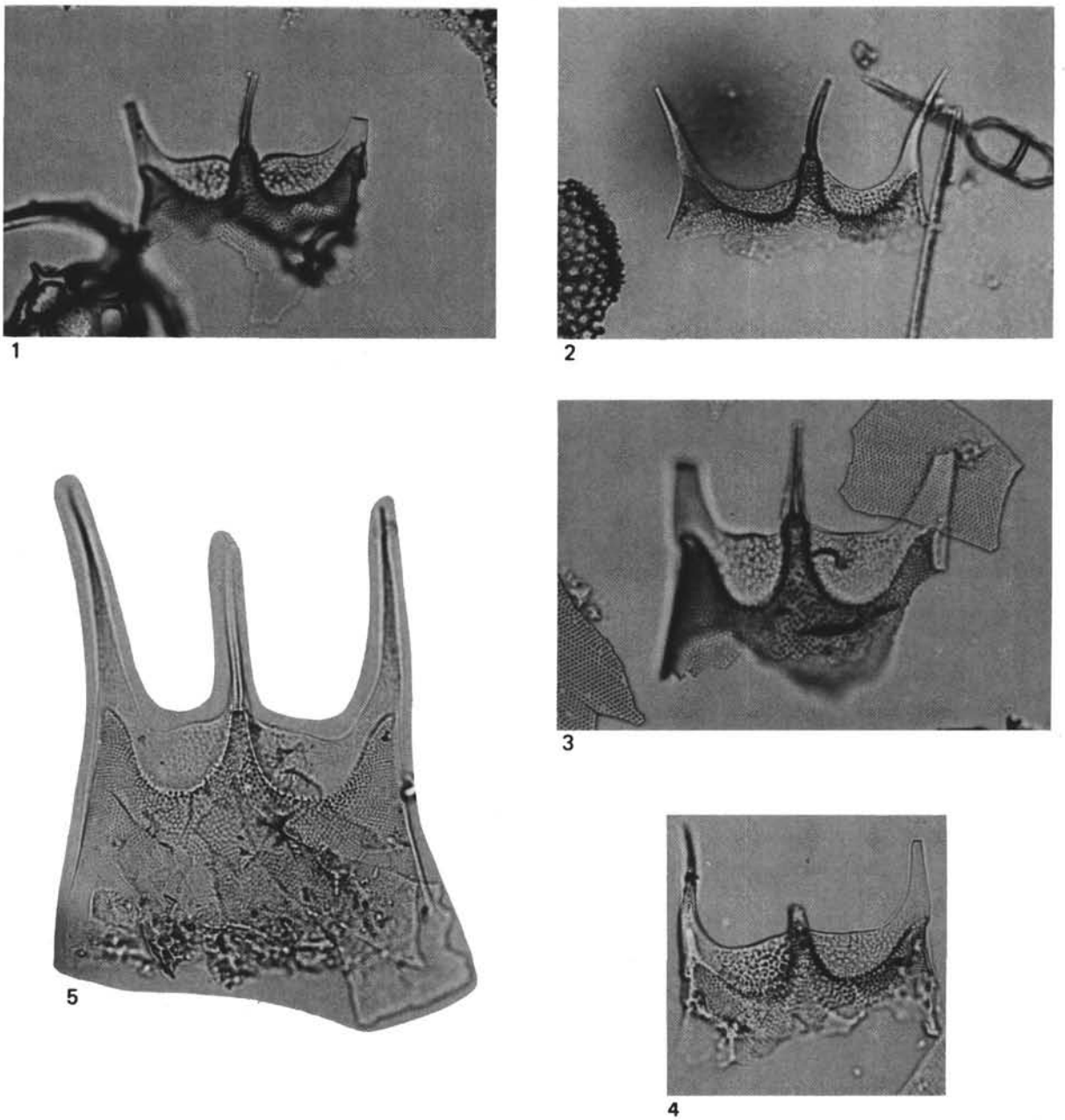

Plate 8. (All magnifications ×500.) 1–5. Genus and species uncertain #2 (1) Sample 512-11-3, 60–62 cm (2) Sample 512-9-3, 64–66 cm (3) Sample 512-11-1, 78–80 cm (4) Sample 512-18-1, 41–43 cm (5) Sample 512-16,CC.