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17. CRETACEOUS (MAESTRICHTIAN) RADIOLARIANS: LEG 114[1]

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ABSTRACT

Cretaceous radiolarians were recovered from subantarctic Atlantic calcareous submarine deposits from two of the seven sites drilled during ODP Leg 114 in 1987. Fairly well-preserved radiolarian assemblages were found in Hole 698A samples from the Northeast Georgia Rise, whereas assemblages with fair to good preservation were observed from Hole 700B in the East Georgia Basin. The assemblage compositions from both sites are rather low in diversity and are characterized by the dominance of *Protoamphipyndax*, *Dictyomitra*, and *Stichomitra* species, but lack zonal markers recognized from the midlatitude to low-latitude region. Assignment of a Maestrichtian age is based on co-occurring calcareous microfossils. This report constitutes the second such occurrence from the Atlantic sector of the Antarctic Ocean subsequent to the analysis of ODP Leg 113 materials from the Weddell Sea.

INTRODUCTION

When *JOIDES Resolution* left the Falkland Islands for Leg 114 of the Ocean Drilling Program (ODP), the occurrence of Mesozoic radiolarians from the midlatitude to high-latitude South Atlantic had previously been reported from Deep Sea Drilling Project (DSDP) Sites 327 (Maestrichtian to Aptian and older) and 330 (Cretaceous to Oxfordian) of Leg 36 (Shipboard Scientific Party, 1977a, 1977b) and ODP Sites 689 (Maestrichtian to Campanian) and 693 (Albian to Aptian) of Leg 113 (Barker, Kennett, et al., 1987), but without detailed taxonomy or geologic distribution (Fig. 1).

Late Cretaceous age radiolarian-bearing sediments were successfully recovered from two of the seven sites drilled during Leg 114. Hole 698A is located at 51°27.51′S, 33°05.96′W, in a water depth of 2138 m, and Hole 700B is at 51°31.977′S, 30°16.688′W, in a water depth of 3601 m. Not only are the specimens abundant and moderately to well preserved, but they were recovered primarily from the carbonate sections, thus permitting cross-correlation with the calcareous microfossils (foraminifers and calcareous nannofossils). Furthermore, their geological occurrence can be subsequently calibrated against the magnetic reversal history.

Thus, the objectives of the present study are to document for the first time the occurrence of Cretaceous radiolarian fauna from the subantarctic Atlantic and to provide the basis for future intercalibration against calcareous microfossils and magnetostratigraphy.

METHODS

As in previous radiolarian analyses by the present author (Ling, 1973), sediment samples of about 10 cm^3 were disaggregated chemically, and microscope slides were prepared from the fractions both coarser and finer than 63 μm using Canada balsam as a mounting medium. A Zeiss photomicroscope was used for transmitted light microscopy as well as for photomicrographs, and an England Finder was used to record the location of the illustrated specimens. For scanning electron photomicrographs, selected specimens were mounted and gold coated before being photographed with a JEOL 50A scanning electron microscope.

All the slides and specimens used for the present study are stored in the Micropaleontology Collection, Department of Geology, Northern Illinois University.

RESULTS AND DISCUSSION

Site 698, located near the eastern edge of the apex of the Northeast Georgia Rise, is approximately 60 to 100 km south of the present-day Antarctic Convergence Zone. The Cretaceous section at this site, from the top of Core 114-698A-14R (118.0 m below seafloor, or msbf) to Section 114-698A-21R-CC (183.60 msbf), consists of nannofossil chalk (lithostratigraphic Subunit IIB) and limestone (Subunit IIC) overlying basalt. The section ranges in age, in descending order based on calcareous nannofossils (Crux, this volume), from the *Nephrolithus frequens* Zone (late Maestrichtian) to the *Broinsonia parca* Zone (Campanian). Ages based on planktonic foraminifers are from the *Abathomphalus mayaroensis* Zone (late Maestrichtian) to unzoned early late Campanian (Shipboard Scientific Party, 1988).

The geological occurrence of radiolarians is shown in Table 1. Although a Maestrichtian age is suggested by the similarity of the faunal composition with that of correlative age in available publications, such as Foreman (1968) and Pessagno (1977), the diversity of the Hole 698A fauna is much lower and the zonal indices that define the currently accepted biostratigraphic zonations in the midlatitude and low-latitude regions are absent.

Two holes were drilled at Site 700 in the western region of the East Georgia Basin on the northeastern slope of the Northeast Georgia Rise. Here the Cretaceous section extends from the top of Section 114-700B-37R-1 (331.70 msbf) to the bottom of the hole, Section 114-700B-54R-CC (483.86 msbf), and consists of micritic limestone (lithostratigraphic Unit V). The age of this section ranges from the *N. frequens* Zone (late Maestrichtian) to the *Lithastrinus floralis* Zone (middle Maestrichtian to Santonian; Crux, this volume). Planktonic foraminifers, on the other hand, suggest ages from the *A. mayaroensis* Zone (late Maestrichtian) to the *Marginotruncana schneegansi* Zone (late Turonian; Nocchi et al. this volume).

As presented in Table 2, the section can be divided into the following three intervals based on radiolarian abundance and preservation: very rare with fair preservation from Samples 114-700B-37R-1, 47–49 cm, to 114-700B-43R-5, 49–51 cm

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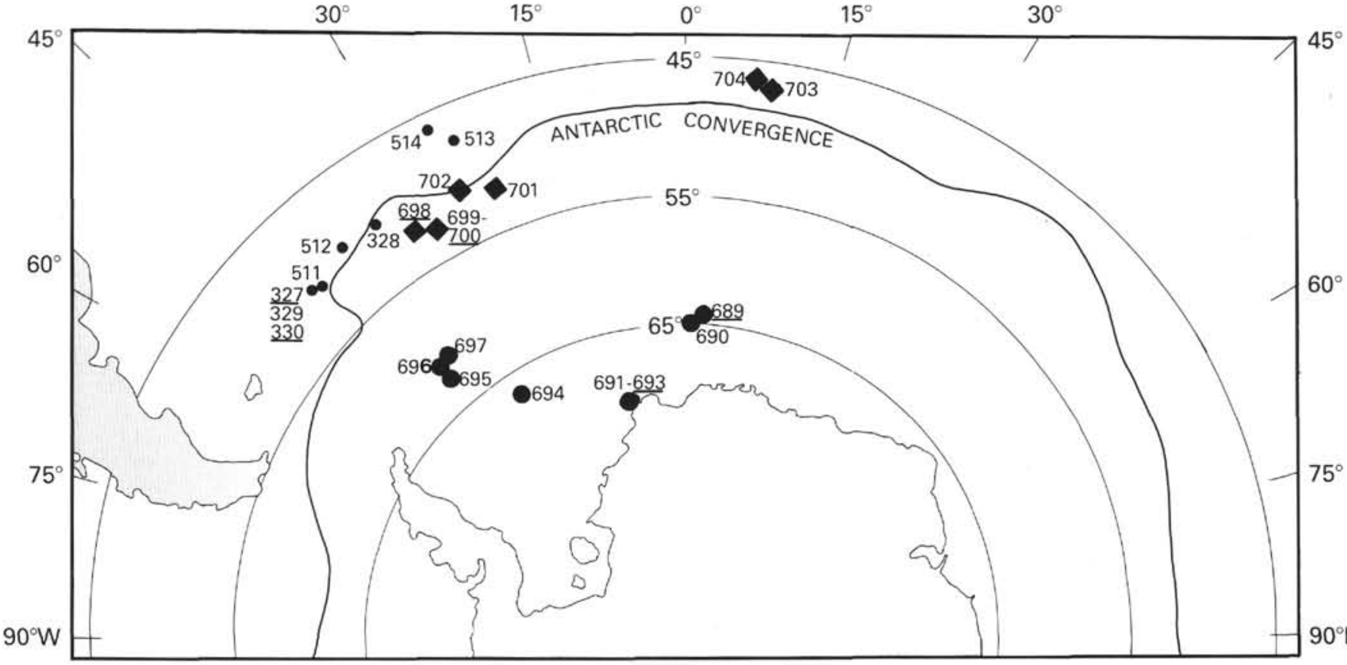

Figure 1. Index map of the high-latitude South Atlantic Ocean showing DSDP (small dots) and ODP Leg 113 (large dots) and Leg 114 (diamonds) sites. Cretaceous radiolarians have been recognized at the underlined site labels.

Table 1. Distribution of Cretaceous radiolarians from Hole 698A.

Sample (core, section, interval in cm) / Taxa	Abundance	Preservation	*Dictyomitra multicostata*	*Protoamphipyndax stocki*	*Diacanthocapsa amphora*	*Siphocampe altamontensis*	*Squinabolella putahensis*	? *Stichomitra campi*	*Spongopyle insolita*	*Cornutella californica*	*Dictyomitra andersoni*	? *Stichomitra* sp.	*Bathropyramis* sp.	*Cromyodruppa* (?) *concentrica*	*Tripodictya elegantissima*	*Stichomitra cathara*
14R-CC	R	P	+	R	+											
15R-1, 56–58	B															
16R-1, 49–519	R	M	+	+		+	+	+	+							
16R-CC	F	G	R	F			R	+		+	+	+				
17R-2, 55–57	F	G	R	F	R	+								+	+	
17R-CC	R	P	+													
20-R-1, 52–56	A	G	C	A	R	R		R					C			
21R-2, 0–2	F	G	R	C	R					+				F		
21R-CC	R	P														+

Note: Abundance: B = barren; R = rare; F = few; C = common; A = abundant. Preservation: P = poor; M = moderate; G = good. Relative abundance of individual taxon: + = single specimen; R (rare) = 1–5 specimens; F (few) = 6–10 specimens; C (common) = 11–25 specimens; A (abundant) = 26 specimens.

(331.17–393.01 mbsf); much diversified, common to abundant with good preservation from Samples 114-700B-43R-CC to 114-700B-49R-CC (392.5–439.21 mbsf); and where radiolarians are absent, from Samples 114-700B-50R-1, 50–52 cm, to 114-700B-54R-CC (442.01–483.86 mbsf).

Although the radiolarian assemblages from the Hole 700B samples show more diversified faunal components, they still consist predominantly of *Dictyomitra*, *Protoamphipyndax*, and *Stichomitra*. Like those from Hole 698A, they lack zonal markers for the midlatitude to low-latitude region, including the Campanian (cf. Empson-Morin, 1981; Foreman, 1978).

Therefore, the radiolarians recovered from Holes 698A and 700B of Leg 114 seem to represent a Maestrichtian assemblage from the subantarctic Atlantic region.

TAXONOMIC NOTES

The radiolarians are listed in alphabetical order on the generic, as well as specific, level. Only the original and recent references are given with the remarks as deemed appropriate.

Archaeodictyomitra rigida Pessagno, 1977, p. 81, pl. 7, fig. 10. (Pl. 3, Fig. 4)
Archicorys sp. (Pl. 1, Fig. 11)

Table 2. Distribution of radiolarians from Hole 700B samples.

Sample (core, section, interval in cm) / Taxa	Abundance	Preservation	*Protoamphipyndax stocki*	*Dictyomitra multicostata*	*Squinabolella putahensis*	*Cromyodruppa* (?) *concentrica*	*Diacanthocapsa amphora*	*Archicorys* sp.	*Bathropyramis* sp.	*Dictyomitra andersoni*	*Siphocampe altamontensis*	? *Stichomitra livermorensis*	*Tripodictya elegantissima*	*Archaeodictyomitra rigida*	*Orbiculiforma* sp.	*Cornutella californica*	? *Lithomespilus* sp.	*Theocampe* sp.	*Triactomma pachyacantha*	? *Stichomitra campi*	*Cyrtocalpis* sp. aff. *C. operosa*	*Dictyomitra regina*	? *Paronella* sp.	*Diacanthocapsa minima*
37R-1, 47–49	B																							
37R-CC	B																							
38R-1, 50–52	R	F	+	+																				
38R-3, 50–52	R	F		+																				
38R-5, 50–52	R	F	+	+																				
38R-CC	C	G	R	F	R																			
39R-1, 53–55	B																							
39R-3, 55–57	R	F				+																		
39R-CC	R	F	R																					
40R-1, 55–57	B																							
40R-3, 55–57	R	F	+			R																		
40R-5, 55–57	B																							
40R-CC	R	F	R				+	R																
41R-1, 50–52	B																							
41R-3, 50–52	R	F	+																					
41R-CC	R	F	+				+																	
42R-1, 30–32	B																							
42R-3, 30–32	B																							
42R-CC	R	F	+			+																		
43R-1, 49–51	R	F						+	+															
43R-3, 49–51	R	F	R																					
43R-5, 49–51	R	F	R				+																	
43R-CC	F	G	F				R	R	+	+														
44R-1, 49–51	C	G	F	F		R	R																	
44R-CC	A	G	F	F			R	+		F	+													
45R-1, 69–71	C	G	R	R							+	+												
45R-2, 69–71	R	G	R																					
45R-CC	A	G	C	R		C	R	F		R	R	+	+	+										
46R-1, 34–36	R	F	R	+		R					+	+		+										
46R-3, 59–61	R	F	R			R										+								
46R-CC	C	G	F			R											+							
47R-2, 50–52	C	G	F	+									+											
47R-4, 58–60	A	G	C	F		R	+	R		R	R		+					+	+					
47R-CC	R	F	+	+			+	+																
48R-1, 48–50	R	F	R	R		R		+		+														
48R-3, 50–52	R	F		+		+														R				
48R-5, 52–54	R	F	R			R										+				R				
48R-CC	C	F	F	R		R		+		+										R				
49R-1, 50–52	R	F	+			+																		
49R-3, 50–52	R	F	+			+	+														+			
49R-5, 50–52	R	F	+			+																		
49R-CC	R	F	+			R	+													R		+	+	
50R-CC	R	F	R					+																+

Note: Abundance: B = barren; R = rare; F = few; C = common; A = abundant. Preservation: P = poor; M = moderate; G = good. Relative abundance of individual taxon: + = single specimen; R (rare) = 1–5 specimens; F (few) = 6–10 specimens; C (common) = 11–25 specimens; A (abundant) = 26 specimens. Samples examined and found barren of radiolarians: 51R-1, 50–52; 51R-3, 50–52; 51R-5, 50–52; 51R-CC; 52R-1, 65–67; 52R-3, 67–69; 52R-CC; 53R-1, 38–40; 53R-3, 36–38; 53R-5, 36–38; 53R-CC; 54R-1, 123–125; 54R-2, 61–63; 54R-3, 55–57; 54R-CC.

Remarks. This species resembles *A. turgida* (Tan Sin Hok, 1927, p. 40, pl. 7, figs. 25, 26) except for the deep-seated pores arranged in horizontal rows instead of randomly. Thus, the present form seems to be best described as the thick-walled well-known Cenozoic *Artostrobus annulatus* (Bailey).

Bathropyramis sp. (Pl. 2, Fig. 1)

Remarks. The specimens provisionally placed under this genus are characterized by possessing a rather stout, long upper part (cephalus?) and consisting of a simple longitudinal and horizontal latticework throughout.

Cornutella californica Campbell and Clark, 1944, pp. 22–23, pl. 7, figs. 33, 34, 42, 43; Foreman, 1968, pp. 21–22, pl. 3, figs. 1a–1c. (Pl. 1, Fig. 14)

Cromyodruppa (?) *concentrica* Lipman in Kozlova and Gorbovetz, 1966, p. 62, pl. 1, figs. 1–4; Foreman, 1978, p. 742, pl. 2, fig. 62; Ling and Lazarus, 1990, p. 355, pl. 1, figs. 11–14. (Pl. 1, Fig. 4)

Remarks. The possible ontogenetic relationship of the present species to *Amphibrachium* sp. cf. *A. concentricum* (Riedel and Sanfilippo, 1970, pl. 1, figs. 6, 7) has been suggested by Ling and Lazarus (1990).

Cyrtocalpis sp. aff. *C. operosa* Foreman, 1978, pl. 5, fig. 6. (Pl. 1, Fig. 10)

Remarks. Although Foreman (1978) referred the present species to Tan Sin Hok's (1927, p. 40, pl. 7, figs. 25, 26) species, the original illustration did not show a clearly defined cephalus and a collar stricture that was also illustrated by Riedel and Sanfilippo (1974, p. 778, pl. 4, figs. 1–3, pl. 14, fig. 10). Superficially, therefore, the present forms are reminiscent of *Eucyrtidium* sp. cf. *E. panthera* Ehrenberg (Ling, 1975, p. 731, pl. 12, fig. 18).

Diacanthocapsa amphora (Campbell and Clark) = *Theocapsa* (*Theocapsomma*) *amphora* Campbell and Clark, 1944, p. 35, pl. 7, figs. 30, 31 = *Tricolocapsa* (*Tricolocapsium*) *granti* Campbell and Clark, 1944, p. 35, pl. 7, figs. 37, 38; *Theocapsomma amphora* Campbell and Clark, Foreman, 1968, p. 31, 32, pl. 4, figs. 9a–9c.

Remarks. The three specimens illustrated here show the wide intraspecific variation of the present species, especially in the nature and size of the abdominal segment. A North Pacific specimen illustrated as *Theocapsomma ancus* by Schaaf (1981, p. 467, pl. 24, fig. 4) is apparently identical with those illustrated here.

Diacanthocapsa minima Dumitrică, 1970, pp. 62–63, pl. 15, figs. 92, 93, 95; ? *Myllocercion* sp. aff. *M. minima* Dumitrică, Petrushevskaya and Kozlova, 1972, pl. 2, figs. 19, 20.

Remarks. There seems to be no doubt that the illustrated subantarctic Atlantic specimen is conspecific with that of Cenomanian Romanian forms described by Dumitrică (1970), although the latter possess irregular, poreless areas among longitudinally aligned pores. The North Atlantic specimens illustrated by Petrushevskaya and Kozlova (1972) also seem to lack such poreless areas but were assigned to Foreman's genus *Myllocercion*; however, the type specimen of the genus, *M. acineton* (Foreman, 1968, pp. 37–38, pl. 5, fig. 11, pl. 7, fig. 3), has longitudinal ridges on the thorax and three lamellar feet that were not observed either in the Leg 114 material or in the North Atlantic specimens by Petrushevskaya and Kozlova (1972).

Dictyomitra andersoni (Campbell and Clark) Foreman, 1968, p. 68, pl. 7, figs. 6a–6d = *Lithocampe* (*Lithocampanula*) *andersoni* Campbell and Clark, 1944, p. 42, pl. 8, fig. 25 = ? *Dictyomitra* (*Dictyomitroma*) *tiara* Campbell and Clark, 1944, p. 40, pl. 8, figs. 1, 2, 3, 4, 12. (Pl. 2, Figs. 2 and 3)

Remarks. The present species is characterized by a lobate outline due to slightly inflated postcephalic segments and longitudinal and horizontal ridges between the circular depressions. Foreman (1968) noted that this is the most common stichocyrtid in her studied upper Maestrichtian samples.

Dictyomitra multicostata Zittel, 1876, p. 81, pl. e, figs. 2–4; Campbell and Clark, 1944 (part), pp. 38–39, pl. 8, figs. 22–24, 35, 42 (not fig. 29); Foreman, 1968, p. 63, pl. 7, figs. 4a, 4b; Pessagno, 1976, p. 52, pl. 14, figs. 4–9. (Pl. 2, Figs. 4 and 5; Pl. 3, Fig. 5)

Remarks. As in the occurrence from the Weddell Sea (Ling and Lazarus, 1990), emendation of a broader species concept by Pessagno (1976) is followed here.

Dictyomitra regina (Campbell and Clark) Foreman, 1968, pp. 68–69, pl. 8, figs. 5a–5c = *Lithomitra* (*Lophomitrissa*) *regina* Campbell and Clark, 1944, p. 41, pl. 8, figs. 30, 38, 40. (Pl. 2, Fig. 6)

? *Lithomespilus* sp., Campbell and Clark, 1944, p. 13, pl. 4, fig. 2. (Pl. 1, Fig. 1)

Remarks. There seems to be no doubt that the present specimens are conspecific with the Californian species observed by Campbell and Clark (1944) based on their general appearance, especially the presence of several short but stout spines at both ends of the major axis, and their sizes. Their assignment to Haeckel's genus is tentative, because according to Haeckel's (1887, p. 301) definition the specimen "bears at one pole a single spine, at the other a bunch of several spines." The specimens also superficially resemble *Ellipsoxiphus bipolaris* Haeckel (1887, p. 297, pl. 14, fig. 11), but the Leg 114 Cretaceous and Paleogene specimens under preparation are much larger.

Orbiculiforma sp. (Pl. 3, Fig. 2)

Remarks. The disc-shaped circular outline with depressed center agrees with the definition of the genus proposed and emended by Pessagno (1973, 1976). Unfortunately, the rare occurrence and obscured surface ornamentation prevent its identification to specific level or any further biostratigraphic consideration.

? *Paronella* sp. (Pl. 3, Fig. 3)

Remarks. This relatively large, triangular specimen is characterized by straight sides and a single central spine on each ray, which is accompanied by a few stout lateral spines. The species is provisionally identified under the present genus because of the absence of a bracchiopyle, but it has a similar general appearance to numerous species within the genus described by Pessagno (1971).

Protoamphipyndax stocki (Campbell and Clark) Empson-Morin, 1982, pl. 4, figs. 1–12 = *Stichocapsa* (?) *stocki* Campbell and Clark, 1944, p. 44, pl. 8, figs. 31–33 = *Amphipyndax stocki* (Campbell and Clark) Foreman, 1968, p. 78, pl. 8, figs. 12a–12c. (Pl. 2, Figs. 7–9; Pl. 3, Figs. 6 and 7)

Siphocampe altamontensis (Campbell and Clark) = *Tricolocampe* (*Tricolocamptra*) *altamontensis* Campbell and Clark, 1944, p. 33, pl. 7, figs. 24, 26 = *Theocampe altamontensis* (Campbell and Clark), Foreman, 1968, p. 53, pl. 6, figs. 14a, 14b. (Pl. 1, Fig. 12)

Remarks. Following the emendation of Nigrini (1977), the generic name is transferred here.

Spongopyle insolita Kozlova group, Petrushevskaya and Kozlova, 1972, pl. 5, fig. 10; Riedel and Sanfilippo, 1974, p. 780, pl. 2, figs. 7, 8, 11 (not figs. 9, 10), pl. 14, fig. 4; Renz, 1974, p. 796, pl. 3, figs. 7, 8, pl. 10, fig. 10; Schaaf, 1981, p. 439, pl. 17, figs. 7, 8. (Pl. 1, Fig. 3)

Squinabolella putahensis Pessagno, 1969, p. 418, pl. 33, fig. 9; Renz, 1974, p. 797, pl. 11, fig. 14. (Pl. 1, Fig. 13)

Stichomitra cathara Foreman, 1968, p. 73, pl. 8, fig. 9. (Pl. 2, Fig. 10)

Remarks. The Leg 114 specimens agree well with the Californian specimens both in size and in tendency of longitudinal pore alignment.

? *Stichomitra campi* (Campbell and Clark) Foreman, 1968, pp. 75–76, pl. 8, figs. 3a–3c = *Cyrtocapsa* (*Cyrtocapsoma*) *campi* Campbell and Clark, 1944, p. 43, pl. 8, figs. 14, 15, 17, 20 (fig. 16?). (Pl. 2, Figs. 11 and 12)

? *Stichomitra livermorensis* (Campbell and Clark) Foreman, 1968, p. 76, pl. 8, figs. 2a, 2b = *Artocapsa livermorensis* Campbell and Clark, 1944, p. 45, pl. 8, figs. 10, 19, 21, 27. (Pl. 3, Fig. 8)

? *Stichomitra* sp. (Pl. 2, Fig. 13)

Remarks. The specimens are provisionally assigned to the present genus, but may also be closely related to *Eucyrtidium*. This species is characterized by much longer, but fewer, segments starting from thorax and is ornamented with numerous randomly oriented circular pores.

Theocampe sp. (Pl. 1, Fig. 9)

Remarks. In its overall outline, the present species is closely related with *T. apicata* Foreman (1971, p. 1679, pl. 4, fig. 6; 1978, p. 745, pl. 5, figs. 21–23), but differs from the latter by its randomly distributed—rather than longitudinally aligned—circular pores on the thorax.

Triactomma pachyacantha Rüst, 1885, p. 289, pl. 28, fig. 6 = *Tripocyclia blakei* (Pessagno), Foreman, 1978, p. 743, pl. 1, fig. 15. (Pl. 3, Fig. 1)

Remarks. A spherical cortical shell with circular pores of the same size throughout and three spines characterize the present species. Pessagno's (1977, p. 80, pl. 6, figs. 15, 16) original illustrations clearly show the "spines with complicated system of longitudinal ridges and grooves" whereas the original figure by Rüst (1885) and probably Foreman's (1978) specimen, judging from her illustration, all have a simple "rundlichen Fortsätzen."

Tripodictya elegantissima Vinassa, Renz, 1974, p. 799, pl. 1, figs. 13–15, pl. 9, fig. 5; Ling and Lazarus, 1990, pl. 1, fig. 2, pl. 4, fig. 3. (Pl. 1, Fig. 2)

Remarks. Like the Weddell Sea specimens (Ling and Lazarus, 1990), the primary spines are circular in cross section, and no "nodes" are recognized at the vertices of triangular frames.

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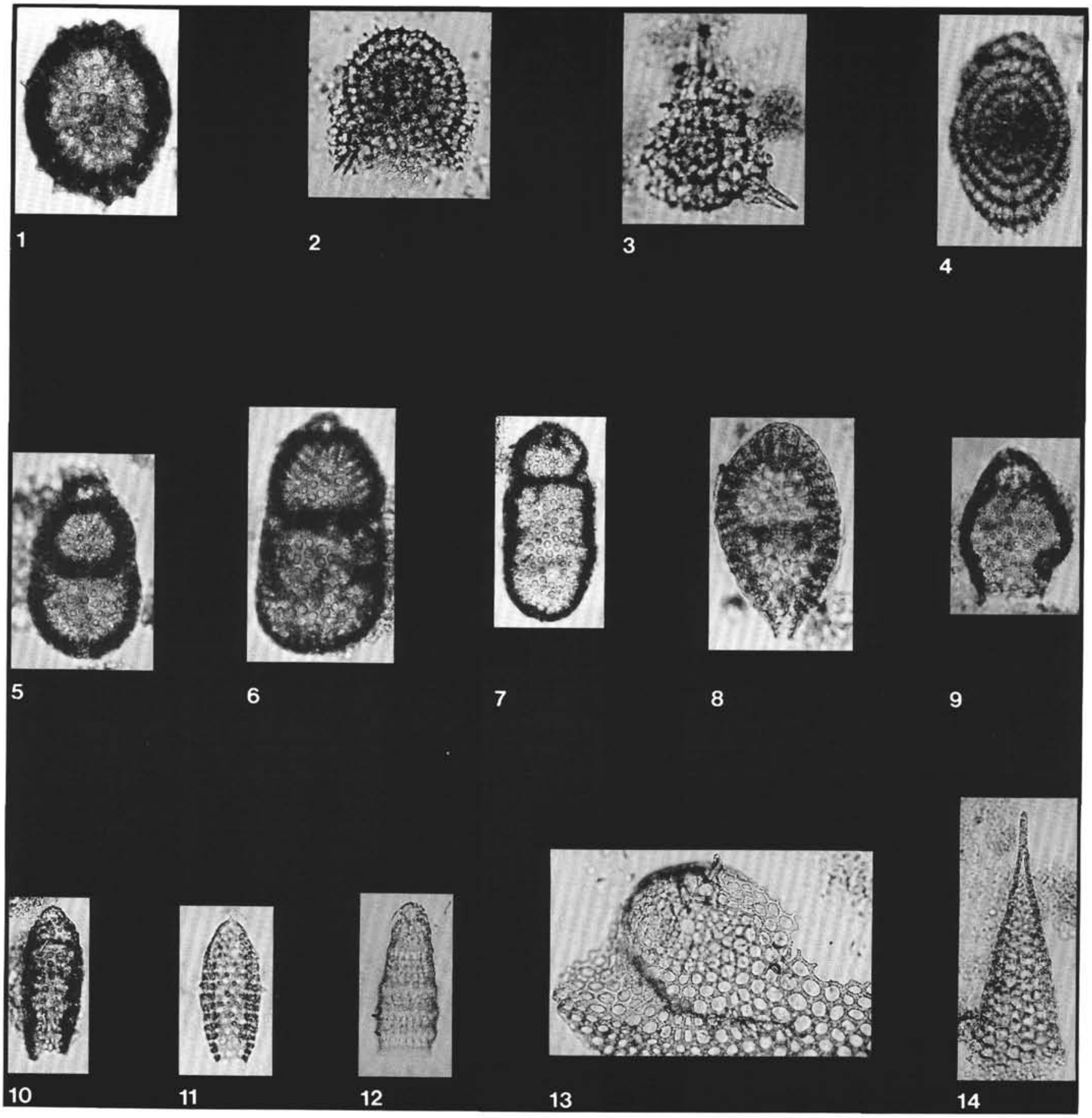

Plate 1. Magnification 200× unless otherwise indicated. **1.** ? *Lithomespilus* sp. Sample 114-700B-46R-CC, R-1 (F13/0). **2.** *Tripodictya elegantissima*. Sample 114-700B-47R-2, 50–52 cm, R-1 (Y19/3). **3.** *Spongopyle insolita* group. Sample 114-698A-16R-1, 49–51 cm, R-1 (X10/0), 250×. **4.** *Cromyodruppa* (?) *concentrica*. Sample 114-700B-45R-CC, R-1 (M14/4). **5–7.** *Diacanthocapsa amphora*. Sample 114-700B-45R-CC, R-2, 250×. Fig. 5 (Y28/2); Fig. 6 (E7/2); Fig. 7 (Z16/2). **8.** *Diacanthocapsa minima*. Sample 114-700B-50R-CC, R-1 (P11/4), 250×. **9.** *Theocampe* sp. Sample 114-700B-47R-4, 58–60 cm, R-1 (L23/2). **10.** *Cyrtocalpis* sp. aff. *C. operosa*. Sample 114-700B-49R-3, 50–52 cm, R-1 (C13/0), 250×. **11.** *Archicorys* sp. Sample 114-700B-38R-1, 50–52 cm, R-1 (S35/2), 250×. **12.** *Siphocampe altamontensis*. Sample 114-698A-16R-1, 49–51 cm, R-1 (R25/2). **13.** *Squinabolella putahensis*. Sample 114-698A-16R-1, 49–51 cm, R-1 (Q25/1). **14.** *Cornutella californica*. Sample 114-698A-21R-2, 0–2 cm, R-2 (N6/1).

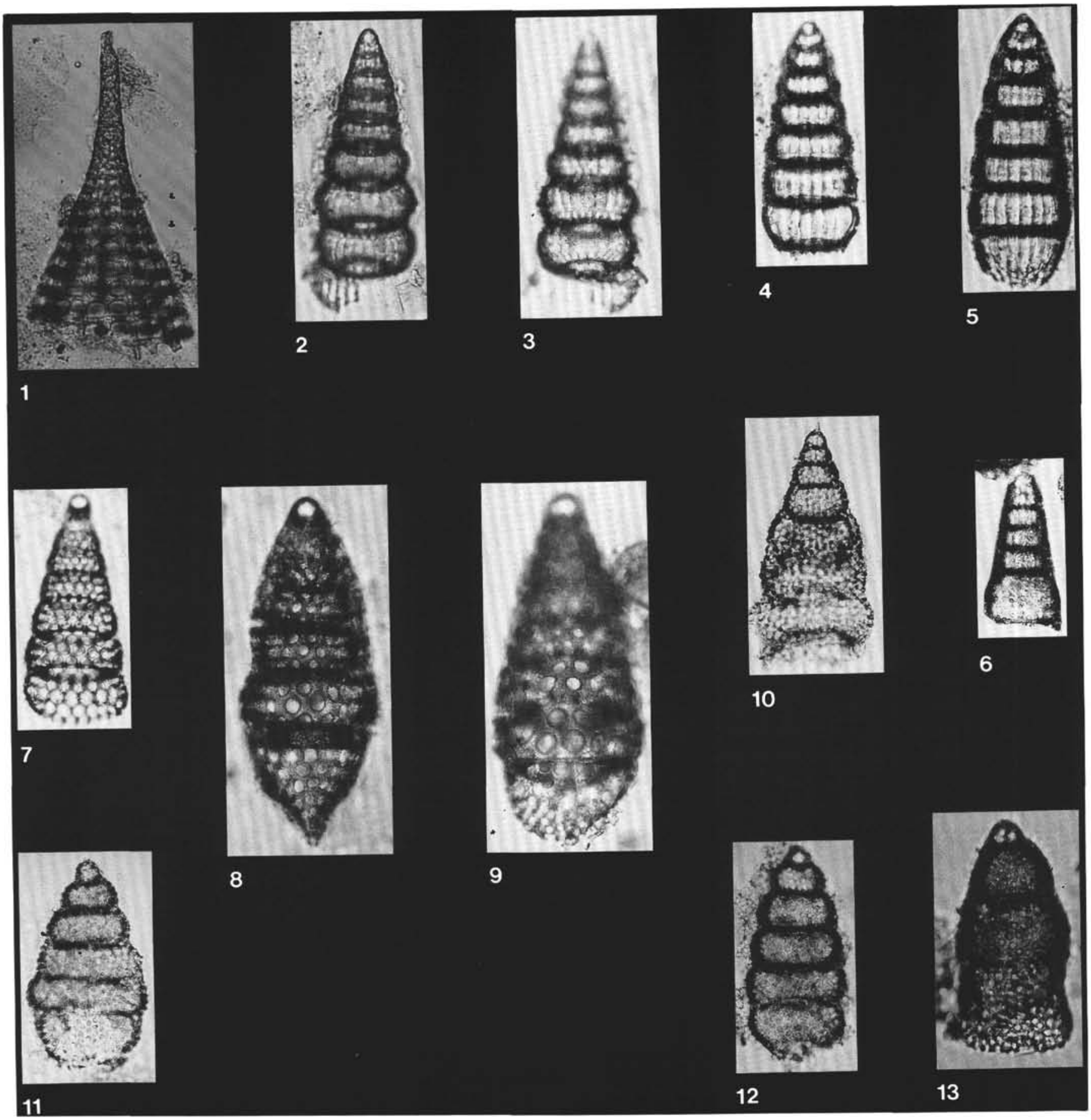

Plate 2. Magnification 200× unless otherwise indicated. **1.** *Bathropyramis* sp. Sample 114-698A-16R-CC, R-1 (E20/0). **2** and **3.** *Dictyomitra andersoni.* Sample 114-698A-16R-CC, R-1 (O24/1), different focus levels. **4** and **5.** *Dictyomitra multicostata.* Sample 114-700B-45R-CC, R-2. Fig. 4 (R13/4); Fig. 5 (G21/0). **6.** *Dictyomitra regina.* Sample 114-700B-46R-CC, R-1 (K18/3). **7–9.** *Protoamphipyndax stocki.* Fig. 7, Sample 114-700B-38R-CC, R-1 (L20/4), 160×; Fig. 8, Sample 114-698A-16R-CC, R-1 (K27/1); Fig. 9, Sample 114-700B-45R-CC, R-1 (E7/2), 250×. **10.** *Stichomitra cathara.* Sample 114-698A-21R-2, 0–2 cm, R-2 (H24/3). **11** and **12.** ? *Stichomitra campi.* Fig. 11, Sample 114-698A-21R-2, 0–2 cm, R-1 (T16/4); Fig. 12, Sample 114-700B-47R-4, 58–60 cm, R-2 (P39/1). **13.** ? *Stichomitra* sp. Sample 114-698A-16R-CC, R-2 (D29/1).

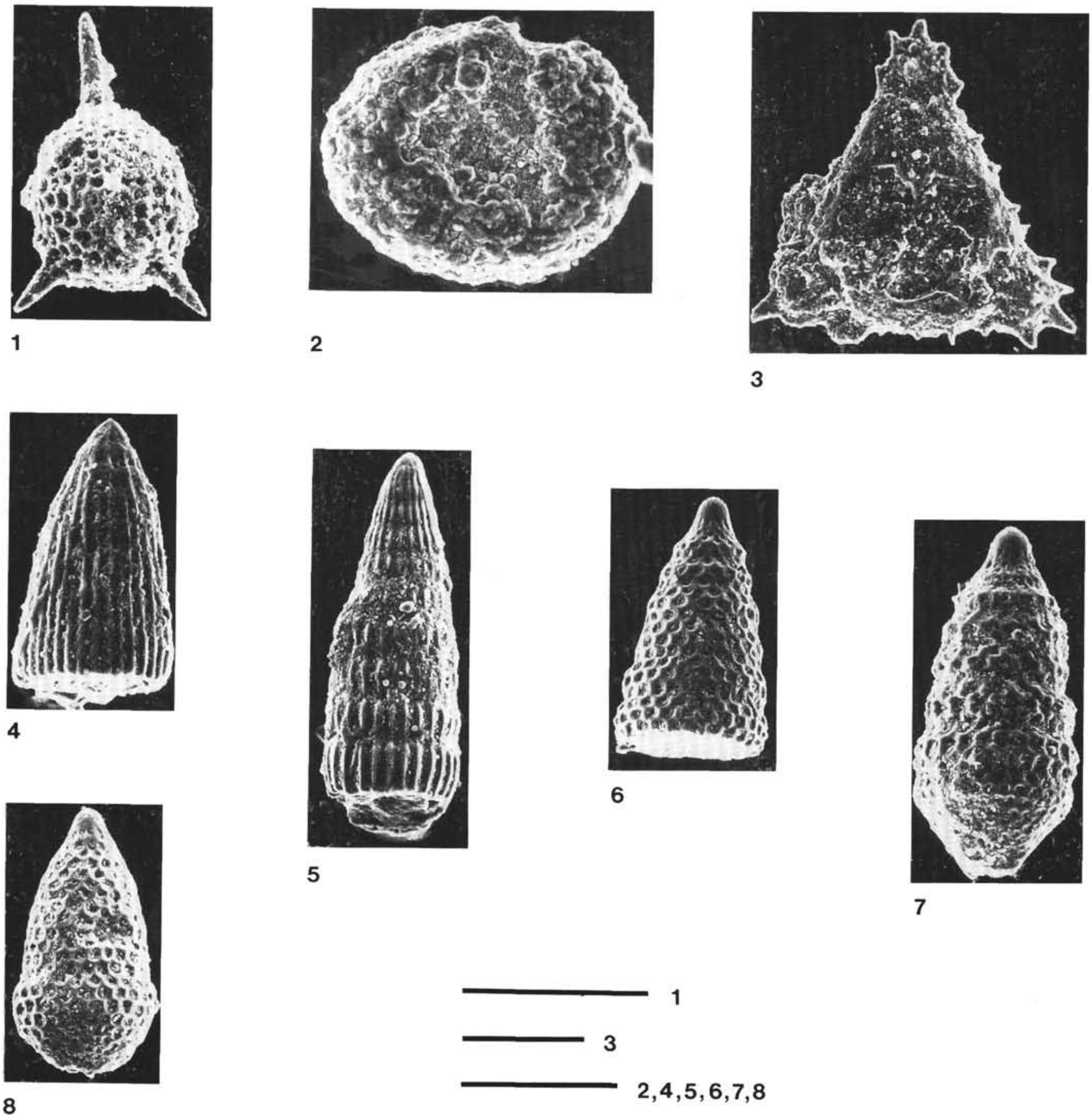

Plate 3. Scale bars = 100 μm. **1.** *Triactomma pachyacantha*. Sample 114-700B-47R-4, 58–60 cm. **2.** *Orbiculiforma* sp. Sample 114-700B-45R-CC. **3.** ? *Paronella* sp. Sample 114-700B-49R-CC. **4.** *Archaeodictyomitra rigida*. Sample 114-700B-45R-CC. **5.** *Dictyomitra multicostata*. Sample 114-700B-45R-CC. **6** and **7.** *Protoamphipyndax stocki*. Sample 114-700B-45R-CC. **8.** *Stichomitra livermorensis*. Sample 114-700B-45R-CC.