

Radiolarian assemblages from the lower to middle Miocene at IODP Site U1335 in the eastern equatorial Pacific

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Abstract: Totally 183 species or species group of radiolarians including 78 spumellarians and 105 nassellarians were identified from the lower to middle Miocene at IODP Site U1335 in the eastern equatorial Pacific. Photographs have been illustrated in 18 plates. These taxa include 70 unidentified forms, particularly within the families Actinommidae, Collosphaeridae, Hexalonychidae, Litheliidae, Pyloniidae, Spongodiscidae and Stylodictyidae. Some of these taxa might be new species.

Keywords: radiolaria, Miocene, equatorial Pacific

1. Introduction

The eastern equatorial Pacific is one of the major upwelling areas and supports a significant proportion of the new biological production (Chavez and Barber, 1987). The band of cool surface water from about 3°S to 3°N is called the equatorial “cold tongue” (Fiedler and Talley, 2006; Kessler, 2006; Pennington *et al.*, 2006). Hence this area makes global contribution to biogenic sediment burial due to equatorial upwelling.

Integrated Ocean Drilling Program (IODP) Expedition 320, “Pacific Equatorial Age Transect (PEAT)”, was designed to recover continuous well-preserved sediments of the eastern equatorial Pacific (Pälike *et al.*, 2010). The primary object was to reconstruct the evolution of the equatorial climate system throughout the Cenozoic. Pälike *et al.* (2012) presented a record of the carbonate compensation depth (CCD) that covers the past 53 million years from a depth transect in the eastern equatorial Pacific, and found large superimposed fluctuations in the CCD during the middle Eocene.

One of the other aims of this program was to provide information about rapid biological evolution and turnover rates during times of climatic stress (Pälike *et al.*, 2010). IODP Exp. 320 Site 1335 focused on the early and middle Miocene. This interval of the time is noted for its significantly heavy benthic oxygen isotopes, indicating long-term global cooling (Zachos *et al.*, 2001). The early and middle Miocene also marks the beginning of the deposition of the abundant siliceous microfossil in the eastern equatorial Pacific (Keller and Barron, 1983).

Species components and the faunal turnover of

radiolarians, which is one of siliceous microfossils, have been well documented from the Quaternary to late Neogene in the eastern equatorial Pacific (e.g. Molina-Cruz, 1977; Moore *et al.*, 1981; Haslett and Funnell, 1996; Kamikuri *et al.*, 2009). However that of radiolarian assemblages during the early and middle Miocene are still unknown. The purpose of this study is to illustrate radiolarian morphotypes from the lower to middle Miocene at IODP Site U1335 in order to record the species components in the eastern equatorial Pacific.

2. Material and methods

Site U1335 was drilled at a water depth of 4,327.5 m (5°18.735' N, 126°17.002' W) in the eastern tropical Pacific (Fig. 1). The position of this site was estimated to

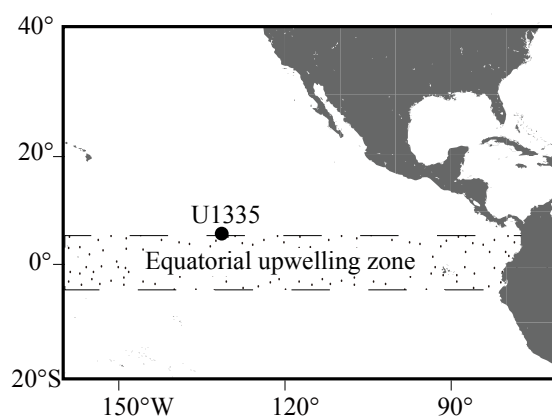


Fig. 1 Location map of IODP Site U1335 in the eastern equatorial Pacific.

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have ranged in latitude from about 0° to 2°N from the early to middle Miocene (Pälike *et al.*, 2010). The lithology from the lower to middle Miocene of this site consists of nannofossil ooze with well-preserved radiolarians (Pälike *et al.*, 2010). A total of 21 sediment samples from U1335A-10H-CC to 31H-CC (106.0 to 337.1 meters composite core depth below seafloor) were examined in this study. The samples were treated with standard methods to isolate radiolarian individuals (Sanfilippo *et al.*, 1985). The sediment samples were treated with H₂O₂ and HCl solution. The residues were sieved with 63 µm, and covered with a 24 × 40 mm cover glass with

Norland Optical Adhesive #61 as the mounting medium. The studied interval was divided into four radiolarian biostratigraphic zones from RN5 to RN2 (Pälike *et al.*, 2010).

3. Radiolarian fauna

The aim of this study is to illustrate radiolarians of the early to middle Miocene age collected from IODP Site U1335 in the eastern equatorial Pacific. A total 183 morphotypes of radiolarians including 78 spumellarians and 105 nassellarians were encountered (Table 1, Plates 1 to 18). These taxa

Table 1 Explanation of Plates 1 to 18.

Plate no.	Species and species group	Location	Zone	Reference
Pl.01, fig. 1	<i>Trisolenia combinata</i> Bjørklund and Goll	13H-2, 104–106 cm, D32/4	RN5	Bjørklund and Goll, 1979
Pl.01, fig. 2	<i>Collosphaera macropora</i> Popofsky	15H-CC, B26/3	RN5	Popofsky, 1917
Pl.01, fig. 3	<i>Trisolenia</i> sp. A	15H-CC, K44/0	RN5	
Pl.01, fig. 4	<i>Siphonosphaera</i> sp. C	13H-2, 104–106 cm, Z20/0	RN5	
Pl.01, fig. 5	<i>Collosphaera pyloma</i> Reynolds	13H-CC, Q23/0	RN5	Reynolds, 1980
Pl.01, fig. 6	<i>Collosphaera reynoldsi</i> Kamikuri	10H-CC, H23/1	RN5	Kamikuri, 2010
Pl.01, fig. 7	<i>Trisolenia megalactis costlowi</i> Bjørklund and Goll	13H-2, 104–106 cm, Y39/4	RN5	Bjørklund and Goll, 1979
Pl.01, fig. 8	<i>Polysolenia spinosa</i> (Haeckel) group	15H-CC, R37/2	RN5	Nigrini and Lombardi, 1984
Pl.01, fig. 9	<i>Polysolenia murrayana</i> (Haeckel)	11H-CC, T33/3	RN5	Nigrini and Lombardi, 1984
Pl.01, fig. 10	<i>Polysolenia spinosa</i> (Haeckel) group	11H-CC, D20/1	RN5	Nigrini and Moore, 1979
Pl.02, fig. 1	<i>Trisolenia megalactis megalactis</i> Ehrenberg	17H-CC, W48/4	RN4	Bjørklund and Goll, 1979
Pl.02, fig. 2	<i>Trisolenia megalactis megalactis</i> Ehrenberg	18H-CC, G40/4	RN4	Bjørklund and Goll, 1979
Pl.02, fig. 3	<i>Trisolenia megalactis megalactis</i> Ehrenberg	17H-CC, Y48/1	RN4	Bjørklund and Goll, 1979
Pl.02, fig. 4	<i>Siphonosphaera</i> sp. A	17H-CC, G41/3	RN4	
Pl.02, fig. 5	<i>Siphonosphaera</i> sp. A	17H-CC, D22/1	RN4	
Pl.02, fig. 6	<i>Siphonosphaera</i> sp. D	18H-CC, R10/1	RN4	
Pl.02, fig. 7	<i>Siphonosphaera</i> sp. B	13H-2, 104–106 cm, P39/2	RN5	
Pl.02, fig. 8	<i>Collosphaera glebulenta</i> Bjørklund and Goll	19H-CC, V21/1	RN3	Bjørklund and Goll, 1979
Pl.02, fig. 9	<i>Collosphaera glebulenta</i> Bjørklund and Goll	13H-CC, R21/3	RN5	Bjørklund and Goll, 1979
Pl.02, fig. 10	<i>Collosphaera</i> sp. A	15H-CC, E36/3	RN5	
Pl.02, fig. 11	<i>Collosphaera</i> sp. A	13H-2, 104–106 cm, Q37/3	RN5	
Pl.02, fig. 12	<i>Collosphaera</i> sp. A	13H-CC, J15/4	RN5	
Pl.02, fig. 13	<i>Collosphaera brattstroemi</i> Bjørklund and Goll	10H-CC, S38/4	RN5	Bjørklund and Goll, 1979
Pl.03, fig. 1	<i>Axoprunum bispiculum</i> (Popofsky)	11H-CC, K20/0	RN5	Takemura, 1992
Pl.03, fig. 2	<i>Axoprunum bispiculum</i> (Popofsky)	11H-CC, V12/1	RN5	Takemura, 1992
Pl.03, fig. 3	<i>Stylosphaera communis</i> (Carnevale)	23H-CC, D38/0	RN2	Sanfilippo <i>et al.</i> , 1978
Pl.03, fig. 4	<i>Stylosphaera</i> sp. B	13H-CC, P35/0	RN5	
Pl.03, fig. 5	<i>Amphisphaera santaeannae</i> (Campbell and Clark)	16H-CC, S38/0	RN5	Petrushevskaya and Kozlova, 1972
Pl.03, fig. 6	<i>Amphistylus polistylus</i> (Carnevale)	16H-CC, X40/0	RN5	Takemura, 1992
Pl.03, fig. 7	<i>Amphisphaera neptunus</i> (Haeckel)	17H-CC, U43/3	RN4	Petrushevskaya and Kozlova, 1972
Pl.03, fig. 8	<i>Stylosphaera</i> sp. A	23H-CC, L46/4	RN2	
Pl.03, fig. 9	<i>Amphistylus angelinus</i> (Campbell and Clark)	16H-CC, U45/2	RN5	Campbell and Clark, 1944
Pl.03, fig. 10	<i>Stylosphaera</i> sp. B	13H-CC, F14/1	RN5	
Pl.04, fig. 1	<i>Actinomma robusta</i> (Kling)	10H-CC, G38/0	RN5	Morley and Nigrini, 1995
Pl.04, fig. 2	<i>Actinomma robusta</i> (Kling)	10H-CC, W20/1	RN5	Morley and Nigrini, 1995
Pl.04, fig. 3	<i>Thecosphaera</i> sp. A	11H-CC, O35/0	RN5	
Pl.04, fig. 4	<i>Actinomma robusta</i> (Kling)	13H-2, 104–106 cm, E39/4	RN5	Morley and Nigrini, 1995
Pl.04, fig. 5	<i>Thecosphaera</i> sp. B	13H-CC, U36/0	RN5	
Pl.04, fig. 6	<i>Thecosphaera</i> sp. C	18H-CC, N15/3	RN4	
Pl.04, fig. 7	<i>Thecosphaera</i> sp. D	18H-CC, H20/3	RN4	
Pl.04, fig. 8	<i>Thecosphaera</i> sp. E	25H-CC, T34/2	RN2	
Pl.04, fig. 9	<i>Hexacantium</i> sp. B	20H-CC, U27/3	RN3	
Pl.04, fig. 10	<i>Hexacantium</i> cf. <i>arachnoidale</i> Hollande and Enjume	11H-CC, E21/2	RN5	
Pl.04, fig. 11	<i>Saturnalis circularis</i> Haeckel	11H-CC, W43/1	RN5	Nishimura and Yamauchi, 1984
Pl.05, fig. 1	<i>Cenosphaera</i> sp. A	15H-CC, Q45/4	RN5	
Pl.05, fig. 2	<i>Heliodiscus</i> sp. B	15H-CC, X21/1	RN5	
Pl.05, fig. 3	<i>Hexapyle dodecantha</i> Haeckel	15H-CC, L15/2	RN5	Haeckel, 1887
Pl.05, fig. 4	<i>Excentrodiscus</i> sp. A	15H-CC, R12/0	RN5	
Pl.05, fig. 5	<i>Cenosphaera</i> sp. B	15H-CC, E12/0	RN5	
Pl.05, fig. 6	<i>Heliodiscus</i> sp. A	16H-CC, C46/0	RN5	
Pl.05, fig. 7	<i>Thecosphaera</i> sp. E	15H-CC, N37/0	RN5	
Pl.05, fig. 8	<i>Hexacantium</i> sp. C	15H-CC, V37/3	RN5	
Pl.05, fig. 9	<i>Axoprunum</i> sp. A	15H-CC, Q45/4	RN5	
Pl.05, fig. 10	<i>Didymocyrtis violina</i> (Haeckel)	18H-CC, P33/2	RN4	Sanfilippo <i>et al.</i> , 1985
Pl.05, fig. 11	<i>Didymocyrtis tubaria</i> (Haeckel)	17H-CC, T46/4	RN4	Sanfilippo <i>et al.</i> , 1985

Early to middle Miocene radiolarians in the tropical Pacific (Kamikuri)

Table 1 Continued.

Plate no.	Species and species group	Location	Zone	Reference
Pl.05, fig. 12	<i>Didymocyrtis mammifera</i> (Haeckel)	15H-CC, X21/0	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.05, fig. 13	<i>Spongurus cylindricus</i> Haeckel	15H-CC, Y39/3	RN5	Takahashi, 1991
Pl.06, fig. 1	<i>Cladococcus</i> sp. A	16H-CC, L44/2	RN5	
Pl.06, fig. 2	<i>Hexacantium pachydermum</i> Jørgensen	13H-CC, Y40/1	RN5	Petrushevskaya and Kozlova, 1972
Pl.06, fig. 3	<i>Hexalonche</i> sp. A	21H-CC, S23/3	RN3	
Pl.06, fig. 4	<i>Didymocyrtis prismatica</i> (Haeckel)	25H-CC, D11/2	RN2	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 5	<i>Didymocyrtis prismatica</i> (Haeckel)	23H-CC, O31/0	RN2	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 6	<i>Didymocyrtis tubaria</i> (Haeckel)	16H-CC, G16/0	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 7	<i>Didymocyrtis tubaria</i> (Haeckel)	16H-CC, K41/2	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 8	<i>Didymocyrtis laticonus</i> (Riedel)	10H-CC, L30/2	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 9	<i>Didymocyrtis mammifera</i> (Haeckel)	13H-2, 104-106 cm, D23/1	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 10	<i>Didymocyrtis bassanii</i> (Carnevale)	25H-CC, Y43/0	RN2	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 11	<i>Cladococcus dentata</i> (Mast)	17H-CC, O45/1	RN4	Nigrini and Moore, 1979
Pl.06, fig. 12	<i>Didymocyrtis bassanii</i> (Carnevale)	13H-CC, V12/0	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 13	<i>Didymocyrtis bassanii</i> (Carnevale)	18H-CC, Q37/0	RN4	Sanfilippo <i>et al.</i> , 1985
Pl.07, fig. 1	<i>Larcopyle hayesi</i> (Chen) group	15H-CC, U42/3	RN5	Lazarus <i>et al.</i> , 2005
Pl.07, fig. 2	<i>Larcopyle hayesi</i> (Chen) group	13H-2, 104-106 cm, Z24/0	RN5	Lazarus <i>et al.</i> , 2005
Pl.07, fig. 3	<i>Larcopyle hayesi</i> (Chen) group	19H-CC, W15/2	RN3	Lazarus <i>et al.</i> , 2005
Pl.07, fig. 4	<i>Larcopyle hayesi</i> (Chen) group	23H-CC, C26/0	RN2	Lazarus <i>et al.</i> , 2005
Pl.07, fig. 5	<i>Larcopyle</i> sp. C	13H-2, 104-106 cm, M39/0	RN5	
Pl.07, fig. 6	<i>Lithelius</i> sp. A	12H-4, 104-106 cm, X27/2	RN5	
Pl.07, fig. 7	<i>Larcopyle polyacantha</i> (Campbell and Clark)	23H-CC, N37/0	RN3	Motoyama, 1996
Pl.07, fig. 8	<i>Larcopyle</i> sp. B	17H-CC, S14/3	RN4	
Pl.07, fig. 9	<i>Lithelius</i> sp. A	16H-CC, K31/1	RN5	
Pl.07, fig. 10	<i>Lithelius</i> sp. A	15H-CC, Q43/3	RN5	
Pl.07, fig. 11	<i>Lithelius</i> sp. A	23H-CC, N37/1	RN2	
Pl.07, fig. 12	<i>Lithelius</i> sp. C	25H-CC, J36/2	RN2	
Pl.07, fig. 13	<i>Larcopyle</i> sp. A	10H-CC, F22/2	RN5	
Pl.07, fig. 14	<i>Larcopyle</i> sp. A	15H-CC, X33/4	RN5	
Pl.07, fig. 15	<i>Larcopyle</i> sp. A	15H-CC, J12/0	RN5	
Pl.07, fig. 16	<i>Larcopyle titan</i> (Campbell and Clark)	15H-CC, F40/0	RN5	Campbell and Clark, 1944
Pl.07, fig. 17	<i>Actinomma</i> sp. B	17H-CC, M44/2	RN4	
Pl.07, fig. 18	<i>Larospira moschkowskii</i> Kruglikova	10H-CC, V23/0	RN4	Nigrini and Lombardi, 1984
Pl.08, fig. 1	<i>Stylodictya</i> sp. A	15H-CC, R43/2	RN4	
Pl.08, fig. 2	<i>Stylodictya</i> sp. A	11H-CC, C14/4	RN4	
Pl.08, fig. 3	<i>Stylodictya</i> sp. A	25H-CC, R36/0	RN2	
Pl.08, fig. 4	<i>Spongurus cylindricus</i> Haeckel	17H-CC, J16/0	RN4	Takahashi, 1991
Pl.08, fig. 5	<i>Stylodictya camerina</i> Campbell and Clark	14H-2, 105-107 cm, N10/2	RN5	Campbell and Clark, 1944
Pl.08, fig. 6	<i>Stylodictya camerina</i> Campbell and Clark	25H-CC, T36/2	RN2	Campbell and Clark, 1944
Pl.08, fig. 7	<i>Stylodictya</i> sp. B	15H-CC, U34/1	RN5	
Pl.08, fig. 8	<i>Stylodictya camerina</i> Campbell and Clark	15H-CC, Y32/3	RN5	Campbell and Clark, 1944
Pl.08, fig. 9	<i>Amphymenium amphistylum</i> Haeckel	11H-CC, D27/1	RN5	Morley and Nigrini, 1995
Pl.08, fig. 10	<i>Stylodictya</i> sp. C	25H-CC, P30/3	RN2	
Pl.08, fig. 11	<i>Porodiscus circularis</i> Clark and Campbell	10H-CC, J36/1	RN5	Clark and Campbell, 1942
Pl.08, fig. 12	<i>Porodiscus</i> sp. A	15H-CC, Z39/1	RN5	
Pl.08, fig. 13	<i>Heliodiscus</i> sp. A	16H-CC, F38/2	RN5	
Pl.08, fig. 14	<i>Phacodiscus</i> sp. A	11H-CC, T19/3	RN5	
Pl.08, fig. 15	<i>Dictyocoryne</i> sp. B	16H-CC, V34/0	RN5	
Pl.09, fig. 1	<i>Spongasteriscus marylandicus</i> Martin	25H-CC, D28/0	RN2	Palmer, 1986
Pl.09, fig. 2	<i>Heliodiscus</i> sp. C	17H-CC, E31/0	RN4	
Pl.09, fig. 3	<i>Tetrapyle</i> sp. A	10H-CC, D40/0	RN5	
Pl.09, fig. 4	<i>Tetrapyle</i> sp. A	17H-CC, G37/1	RN4	
Pl.09, fig. 5	<i>Dictyocoryne malagaense</i> (Campbell and Clark)	10H-CC, G46/3	RN5	Campbell and Clark, 1944
Pl.09, fig. 6	<i>Spongaster</i> sp. A	13H-CC, J30/1	RN5	
Pl.09, fig. 7	<i>Dictyocoryne</i> sp. A	18H-CC, U32/0	RN4	
Pl.09, fig. 8	<i>Spongopyle osculosa</i> Dreyer	17H-CC, H46/4	RN4	Nigrini and Moore, 1979
Pl.09, fig. 9	<i>Spongodiscus resurgens</i> Ehrenberg	17H-CC, Q31/4	RN4	Petrushevskaya and Kozlova, 1972
Pl.09, fig. 10	<i>Spongodiscus resurgens</i> Ehrenberg	23H-CC, O44/4	RN2	Petrushevskaya and Kozlova, 1972
Pl.09, fig. 11	<i>Spongodiscus resurgens</i> Ehrenberg	23H-CC, O43/4	RN2	Petrushevskaya and Kozlova, 1972
Pl.09, fig. 12	<i>Spongodiscus resurgens</i> Ehrenberg	17H-CC, R29/2	RN4	Petrushevskaya and Kozlova, 1972
Pl.09, fig. 13	<i>Excentrococcus annulatus</i> Dumitrica	16H-CC, H13/4	RN5	Dumitrica, 1978
Pl.09, fig. 14	<i>Spongodiscus</i> sp. B	16H-CC, C29/3	RN5	
Pl.09, fig. 15	<i>Spongodiscus</i> sp. C	15H-CC, N21/3	RN5	
Pl.09, fig. 16	<i>Spongodiscus klingi</i> Caulet	25H-CC, J34/2	RN2	Caulet, 1986
Pl.10, fig. 1	<i>Cyrtocapsella tetrapera</i> Haeckel	10H-CC, U23/0	RN5	Sakai, 1980
Pl.10, fig. 2	<i>Cyrtocapsella tetrapera</i> Haeckel	12H-4, 104-106 cm, W44/1	RN5	Sakai, 1980
Pl.10, fig. 3	<i>Cyrtocapsella japonica</i> (Nakaseko)	17H-CC, X10/1	RN4	Sakai, 1980
Pl.10, fig. 4	<i>Cyrtocapsella japonica</i> (Nakaseko)	19H-CC, S42/4	RN3	Sakai, 1980
Pl.10, fig. 5	<i>Cyrtocapsella cornuta</i> Haeckel	12H-4, 104-106 cm, V18/0	RN5	Sakai, 1980
Pl.10, fig. 6	<i>Cyrtocapsella cornuta</i> Haeckel	10H-CC, Y15/2	RN5	Sakai, 1980
Pl.10, fig. 7	<i>Lithopera baueri</i> Sanfilippo and Riedel	13H-2, 104-106 cm, X30/4	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.10, fig. 8	<i>Stichocorys delmontensis</i> (Campbell and Clark)	13H-CC, T33/1	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.10, fig. 9	<i>Lithopera renzae</i> Sanfilippo and Riedel	15H-CC, L37/0	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.10, fig. 10	<i>Stichocorys wolffii</i> Haeckel	21H-CC, R41/1	RN3	Sanfilippo <i>et al.</i> , 1985
Pl.10, fig. 11	<i>Lithopera thornburgi</i> Sanfilippo and Riedel	10H-CC, U43/0	RN5	Sanfilippo <i>et al.</i> , 1985

Table 1 Continued.

Plate no.	Species and species group	Location	Zone	Reference
Pl.10, fig. 12	<i>Eucyrtidium</i> sp. A	23H-CC, D38/0	RN2	
Pl.10, fig. 13	<i>Stichocorys armata</i> (Haeckel)	19H-CC, L40/3	RN3	Sanfilippo <i>et al.</i> , 1985
Pl.10, fig. 14	<i>Phormocyrtis alexandrae</i> O'Connor	25H-CC, Z39/1	RN2	O'Connor, 1997b
Pl.10, fig. 15	<i>Eucyrtidium</i> sp. C	17H-CC, N12/3	RN4	
Pl.10, fig. 16	<i>Eucyrtidium cienkowskii</i> Haeckel	10H-CC, V9/3	RN5	Sakai, 1980
Pl.10, fig. 17	<i>Stichocorys diaphanes</i> (Sanfilippo and Riedel)	27H-CC, C46/1	RN2	Sanfilippo <i>et al.</i> , 1985
Pl.11, fig. 1	<i>Carpocanium cingulatum</i> (Riedel and Sanfilippo)	18H-CC, T15/0	RN4	Nigrini and Lombardi, 1984
Pl.11, fig. 2	<i>Carpocanium bramlettei</i> (Riedel and Sanfilippo)	15H-CC, E44/1	RN5	Nigrini and Lombardi, 1984
Pl.11, fig. 3	<i>Carpocanium bramlettei</i> (Riedel and Sanfilippo)	10H-CC, Z44/1	RN5	Nigrini and Lombardi, 1984
Pl.11, fig. 4	<i>Carpacanium</i> sp. B	23H-CC, T42/0	RN2	
Pl.11, fig. 5	<i>Carpacanium kinugasense</i> Nishimura	10H-CC, S34/1	RN5	Nishimura, 1990
Pl.11, fig. 6	<i>Carpacanium kinugasense</i> Nishimura	25H-CC, G44/1	RN2	Nishimura, 1990
Pl.11, fig. 7	<i>Siphocampe</i> sp. D	17H-CC, K18/3	RN4	
Pl.11, fig. 8	<i>Siphocampe grantmackiei</i> O'Connor	15H-CC, L24/0	RN5	O'Connor, 1997b
Pl.11, fig. 9	<i>Botryostrobus</i> sp. B	10H-CC, M43/0	RN5	
Pl.11, fig. 10	<i>Botryostrobus aquilonaris</i> (Bailey)	15H-CC, W38/2	RN5	Nigrini and Lombardi, 1984
Pl.11, fig. 11	<i>Spirocorytis subtilis</i> Petrushevskaya	12H-4, 104-106 cm, D39/2	RN5	Nigrini and Lombardi, 1984
Pl.11, fig. 12	<i>Siphosticharta corona</i> (Haeckel)	10H-CC, E20/3	RN5	Nigrini and Lombardi, 1984
Pl.11, fig. 13	<i>Botryostrobus</i> sp. A	15H-CC, L37/0	RN5	
Pl.11, fig. 14	<i>Theocampe ovata</i> (Haeckel)	16H-CC, Z42/0	RN5	Nigrini and Lombardi, 1984
Pl.11, fig. 15	<i>Siphocampe</i> sp. B	13H-CC, V36/0	RN5	
Pl.11, fig. 16	<i>Siphocampe</i> sp. B	15H-CC, T38/1	RN5	
Pl.11, fig. 17	<i>Phormostichoartus fistula</i> Nigrini	15H-CC, M34/0	RN5	Nigrini and Lombardi, 1984
Pl.11, fig. 18	<i>Phormostichoartus fistula</i> Nigrini	11H-CC, K40/0	RN5	Nigrini and Lombardi, 1984
Pl.11, fig. 19	<i>Lithocampiana</i> sp. A	17H-CC, X10/1	RN4	
Pl.11, fig. 20	<i>Lithocampiana</i> sp. B	17H-CC, Y42/1	RN4	
Pl.11, fig. 21	<i>Cycladophora conica</i> Lombardi and Lazarus	25H-CC, F36/4	RN2	Lombardi and Lazarus, 1988
Pl.12, fig. 1	<i>Calocykletta caepa</i> Moore	16H-CC, N38/4	RN5	Nigrini and Lombardi, 1984
Pl.12, fig. 2	<i>Calocykletta virginis</i> (Haeckel)	17H-CC, T42/1	RN4	Nigrini and Lombardi, 1984
Pl.12, fig. 3	<i>Calocykletta serrata</i> Moore	30H-CC, S38/0	RN2	Nigrini and Lombardi, 1984
Pl.12, fig. 4	<i>Calocykletta costata</i> (Riedel)	14H-CC, V39/4	RN5	Nigrini and Lombardi, 1984
Pl.12, fig. 5	<i>Calocykletta robusta</i> Moore	31H-CC, X43/4	RN2	Nigrini and Lombardi, 1984
Pl.12, fig. 6	<i>Albatrossidium minzok</i> Sanfilippo and Riedel	10H-CC, J23/3	RN5	Sanfilippo and Riedel, 1992
Pl.12, fig. 7	<i>Anthocyrtidium</i> sp. A	25H-CC, Y37/3	RN2	
Pl.12, fig. 8	<i>Anthocyrtidium</i> sp. B	25H-CC, T46/1	RN2	
Pl.12, fig. 9	<i>Cyrtolagena</i> sp. A	19H-CC, M26/4	RN3	
Pl.13, fig. 1	<i>Lophocyrtis tanythorax</i> (Sanfilippo and Riedel)	13H-2, 104-106 cm, W25/4	RN5	Sanfilippo and Riedel, 1970
Pl.13, fig. 2	<i>Lophocyrtis tanythorax</i> (Sanfilippo and Riedel)	15H-CC, S38/4	RN5	Sanfilippo and Riedel, 1970
Pl.13, fig. 3	<i>Cincolopyramis pacifica</i> (Nakaseko)	18H-CC, N12/4	RN4	Nakaseko, 1963
Pl.13, fig. 4	<i>Cincolopyramis woodringi</i> (Campbell and Clark)	17H-CC, T16/0	RN4	Campbell and Clark, 1944
Pl.13, fig. 5	<i>Lophocyrtis</i> sp. A	25H-CC, Y43/4	RN2	
Pl.13, fig. 6	<i>Calocyclura</i> sp. A	12H-4, 104-106 cm, Y24/4	RN5	
Pl.14, fig. 1	<i>Lamprocyclus maritilis</i> Haeckel	11H-CC, M20/0	RN5	Nigrini and Moore, 1979
Pl.14, fig. 2	<i>Lophocyrtis aspera</i> (Ehrenberg)	25H-CC, S29/3	RN2	Sanfilippo and Caulet, 1998
Pl.14, fig. 3	<i>Theocorys spongoconus</i> Kling	27H-CC, C28/0	RN2	Nigrini and Lombardi, 1984
Pl.14, fig. 4	<i>Lamprocyclus</i> sp. B	27H-CC, H49/3	RN2	
Pl.14, fig. 5	<i>Theocorys</i> sp. A	17H-CC, J22/0	RN4	
Pl.14, fig. 6	<i>Clathrocanium atreta</i> Sanfilippo and Riedel	25H-CC, C45/1	RN2	Sanfilippo <i>et al.</i> , 1973
Pl.14, fig. 7	<i>Lithomelissa</i> sp. A	11H-CC, D22/0	RN5	
Pl.14, fig. 8	<i>Lithomelissa</i> sp. A	12H-4, 104-106 cm, M39/0	RN5	
Pl.14, fig. 9	<i>Lophophaena</i> sp. A	11H-CC, G19/0	RN5	
Pl.14, fig. 10	<i>Ceratocyrtis</i> sp. A	12H-4, 104-106 cm, K44/1	RN5	
Pl.14, fig. 11	<i>Lamprocyclus margaritensis</i> Campbell and Clark var. A	16H-CC, U9/3	RN5	Campbell and Clark, 1944
Pl.14, fig. 12	<i>Lipmanella conica</i> Petrushevskaya	25H-CC, T28/3	RN2	Petrushevskaya and Kozlova, 1979
Pl.14, fig. 13	<i>Lophophaena tekopua</i> O'Connor	12H-4, 104-106 cm, X36/2	RN5	O'Connor, 1997a
Pl.14, fig. 14	<i>Lophophaena tekopua</i> O'Connor	25H-CC, L40/4	RN2	O'Connor, 1997a
Pl.14, fig. 15	<i>Clathrocanium coarctatum</i> Ehrenberg	16H-CC, Z40/0	RN5	Takahashi, 1991
Pl.15, fig. 1	<i>Pterocanium audax</i> (Riedel)	14H-2, 105-107 cm, G17/3	RN5	Nigrini and Lombardi, 1984
Pl.15, fig. 2	<i>Pterocanium audax</i> (Riedel)	23H-CC, J20/1	RN2	Nigrini and Lombardi, 1984
Pl.15, fig. 3	<i>Lychnocanoma elongata</i> (Vinassa de Regny)	25H-CC, W33/4	RN2	Sanfilippo <i>et al.</i> , 1985
Pl.15, fig. 4	<i>Pterocanium</i> aff. <i>tridentatum</i> (Ehrenberg)	13H-2, 104-106 cm, L15/0	RN5	
Pl.15, fig. 5	<i>Pterocanium charybdeum</i> (Müller)	16H-CC, J43/0	RN5	Lazarus <i>et al.</i> , 1985
Pl.15, fig. 6	<i>Pterocanium</i> sp. A	10H-CC, E43/3	RN5	
Pl.16, fig. 1	<i>Lychnocanoma</i> sp. A	23H-CC, P42/2	RN2	
Pl.16, fig. 2	<i>Lychnocanoma</i> sp. A	23H-CC, E29/2	RN2	
Pl.16, fig. 3	<i>Lychnocanoma</i> sp. A	27H-CC, H41/1	RN2	
Pl.16, fig. 4	<i>Lychnocanoma nodosum</i> (Haeckel)	21H-CC, S28/4	RN3	Haeckel, 1887
Pl.16, fig. 5	<i>Lychnocanoma nodosum</i> (Haeckel)	18H-CC, U41/3	RN4	Haeckel, 1887
Pl.16, fig. 6	<i>Dictyophimus splendens</i> (Campbell and Clark)	11H-CC, W43/1	RN5	Morley and Nigrini, 1995
Pl.16, fig. 7	<i>Dictyophimus</i> sp. A	17H-CC, D12/0	RN4	
Pl.16, fig. 8	<i>Valkyria pukapuka</i> O'Connor	15H-CC, W44/1	RN5	O'Connor, 1997a
Pl.16, fig. 9	<i>Valkyria pukapuka</i> O'Connor	13H-CC, D41/2	RN5	O'Connor, 1997a
Pl.17, fig. 1	<i>Dorcadospyris dentata</i> Haeckel	18H-CC, U11/0	RN4	Sanfilippo <i>et al.</i> , 1985
Pl.17, fig. 2	<i>Dorcadospyris alata</i> (Riedel)	16H-3, 149-151 cm, D44/0	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.17, fig. 3	<i>Dorcadospyris ateuchus</i> (Ehrenberg)	27H-CC, O46/1	RN2	Sanfilippo <i>et al.</i> , 1985

Table 1 Continued.

Plate no.	Species and species group	Location	Zone	Reference
Pl.17, fig. 4	<i>Lamprocyclus margatensis</i> Campbell and Clark var. B	15H-CC, V38/2	RN5	Campbell and Clark, 1944
Pl.17, fig. 5	<i>Lamprocyclus margatensis</i> Campbell and Clark var. B	16H-CC, U27/4	RN5	Campbell and Clark, 1944
Pl.17, fig. 6	<i>Lamprocyclus margatensis</i> Campbell and Clark var. B	15H-CC, V36/3	RN5	Campbell and Clark, 1944
Pl.17, fig. 7	<i>Cornutella trochus</i> Ehrenberg	15H-CC, N37/0	RN5	Ehrenberg, 1873
Pl.18, fig. 1	<i>Tympanomma binoctonum</i> (Haeckel)	25H-CC, G43/3	RN2	Nigrini and Lombardi, 1984
Pl.18, fig. 2	<i>Tympanomma binoctonum</i> (Haeckel)	18H-CC, N15/0	RN4	Nigrini and Lombardi, 1984
Pl.18, fig. 3	<i>Tholospyrus anthophora</i> (Haeckel)	19H-CC, E42/3	RN3	Nigrini and Lombardi, 1984
Pl.18, fig. 4	<i>Tholospyrus anthophora</i> (Haeckel)	17H-CC, T13/2	RN4	Nigrini and Lombardi, 1984
Pl.18, fig. 5	<i>Dendrospyrus pannosa</i> Goll	23H-CC, O44/4	RN2	Petrushevskaya and Kozlova, 1972
Pl.18, fig. 6	<i>Tholospyrus mammillaris</i> (Haeckel)	19H-CC, J49/3	RN3	Nigrini and Lombardi, 1984
Pl.18, fig. 7	<i>Tholospyrus kantiana</i> (Haeckel)	10H-CC, K45/2	RN5	Nigrini and Lombardi, 1984
Pl.18, fig. 8	<i>Tympanomma tuberosum</i> (Haeckel)	17H-CC, V14/1	RN4	Petrushevskaya and Kozlova, 1972
Pl.18, fig. 9	<i>Liriospyris mutuarua</i> Goll	25H-CC, D29/0	RN2	Nigrini and Lombardi, 1984
Pl.18, fig. 10	<i>Liriospyris</i> sp. A	25H-CC, C43/4	RN2	
Pl.18, fig. 11	<i>Dendrospyrus</i> sp. A	10H-CC, Q40/4	RN5	
Pl.18, fig. 12	<i>Eucoronis octopylus</i> (Haeckel)	14H-CC, X37/4	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.18, fig. 13	<i>Eucoronis perspicillum</i> Haeckel	16H-CC, V22/3	RN5	Petrushevskaya and Kozlova, 1972
Pl.18, fig. 14	<i>Eucoronis perspicillum</i> Haeckel	16H-CC, P45/0	RN5	Petrushevskaya and Kozlova, 1972
Pl.18, fig. 15	<i>Acanthodesmia circumflexa</i> (Goll)	25H-CC, C45/1	RN2	Nigrini and Lombardi, 1984
Pl.18, fig. 16	<i>Acanthodesmia</i> sp. A	25H-CC, X36/0	RN2	
Pl.18, fig. 17	<i>Acanthodesmia</i> sp. B	13H-2, 104-106 cm, Q30/0	RN5	
Pl.18, fig. 18	<i>Dendrospyrus pododendros</i> (Carnevale)	13H-CC, C46/3	RN5	Petrushevskaya and Kozlova, 1972
Pl.18, fig. 19	<i>Giraffospyris annulispina</i> Goll	18H-CC, U11/0	RN4	Goll, 1969
Pl.18, fig. 20	<i>Eucoronis toxarium</i> (Haeckel)	14H-CC, D16/2	RN5	Goll, 1969
Pl.18, fig. 21	<i>Phormospyris stabilis</i> (Goll)	11H-CC, C11/4	RN5	Nigrini and Lombardi, 1984
Pl.18, fig. 22	<i>Phormospyris</i> sp. B	13H-CC, D41/0	RN5	
Pl.18, fig. 23	<i>Liriospyris parkerae</i> Riedel and Sanfilippo	17H-CC, Q31/0	RN4	Riedel and Sanfilippo, 1978
Pl.18, fig. 24	<i>Liriospyris stauropora</i> (Haeckel)	17H-CC, J16/0	RN4	Riedel and Sanfilippo, 1978
Pl.18, fig. 25	<i>Zygocircus</i> sp.	15H-CC, Z39/1	RN5	
Pl.18, fig. 26	<i>Zygocircus</i> sp.	15H-CC, S37/0	RN5	
Pl.18, fig. 27	<i>Botryocyrtis</i> sp. A	23H-CC, D38/3	RN2	
Pl.18, fig. 28	<i>Centrobotrys thermophila</i> Petrushevskaya	28H-CC, S45/2	RN2	Sanfilippo <i>et al.</i> , 1985
Pl.18, fig. 29	<i>Centrobotrys petrushevskayae</i> Sanfilippo and Riedel	28H-CC, S45/2	RN2	Sanfilippo <i>et al.</i> , 1985
Pl.18, fig. 30	<i>Acrobotrys disolenia</i> Haeckel	25H-CC, G44/3	RN2	Haeckel, 1887

include 70 unidentified forms, particularly within the families Actinommidae, Collosphaeridae, Hexalonchidae, Litheliidae, Pyloniidae, Spongodiscidae and Stylodictyidae. Some of these taxa will be described as new species in the near future. The radiolarian assemblages included at least 68 tropical-subtropical taxa (e.g. *Acanthodesmia circumflexa*, *Calocyclus caepa*, *Calocyclus robusta*, *Carpocanium cingulatum*, *Centrobotrys petrushevskayae*, *Collosphaera brattstroemi*, *Dendrospyrus pannosa*, *Didymocyrtis laticonus*, *Didymocyrtis tubaria*, *Dorcadospyrus alata*, *Eucoronis octopylus*, *Hexapyle dodecantha*, *Liriospyris parkerae*, *Lithopera thornburgi*, *Lophocyrtis tanythorax*, *Lychnocanoma elongata*, *Polysolenia spinosa*, *Pterocanium audax*, *Stichocorys armata*, *Stichocorys wolffii*, *Tholospyrus anthophora*, *Trisolenia megalactis costlowi*) and 31 cosmopolitan taxa (e.g. *Actinomma robusta*, *Amphisphaera neptunus*, *Amphymenium amphistylum*, *Axoprimum bispiculum*, *Botryostrobos aquilonaris*, *Cincolopyramis pacifica*, *Cladococcus dentata*, *Cycladophora conica*, *Cyrtocapsella japonica*, *Dictyophimus splendens*, *Lamprocyclus margatensis*, *Larcopyle polyacantha*, *Lipmanella conica*, *Lophocyrtis aspera*, *Stylodictya camerina*, *Theocamptra ovata*).

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東赤道太平洋における統合国際深海掘削計画 (IODP) U1335 地点の下部および中部中新統から産出した放散虫群集

上栗伸一

要 旨

東赤道太平洋における統合国際深海掘削計画 (IODP) U1335地点の下部および中部中新統から、78種のSpumellaria亜目および105種のNassellaria亜目を含む合計183種の放散虫化石が産出した。その写真を18枚のプレートに示した。これらの分類群にはActinommidae科, Collosphaeridae科, Hexalonchidae科, Litheliidae科, Pyloniidae科, Spongodiscidae科およびStylocyrtidae科を含む70の未同定種が含まれており、この中のいくつかは新種である可能性がある。

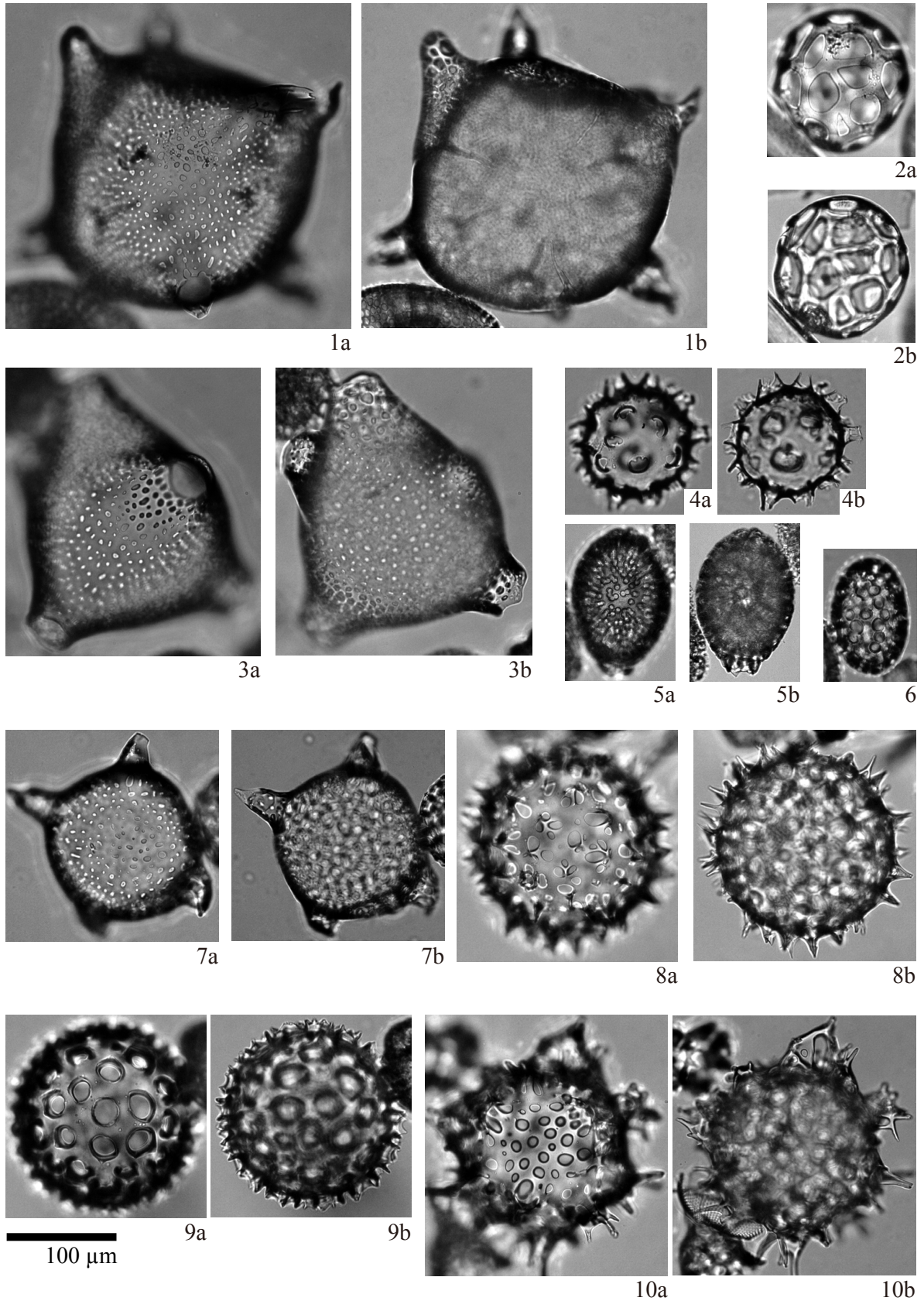


Plate 1 Illustrations of the encountered radiolarians. 1: *Trisolenia combinata* Bjørklund and Goll; 2: *Collosphaera macropora* Popofsky; 3: *Trisolenia* sp. A; 4: *Siphonosphaera* sp. C; 5: *Collosphaera pyloma* Reynolds; 6: *Collosphaera reynoldsi* Kamikuri; 7: *Trisolenia megalactis costlowi* Bjørklund and Goll; 8, 10: *Polysolenia spinosa* (Haeckel) group; 9: *Polysolenia murrayana* (Haeckel).

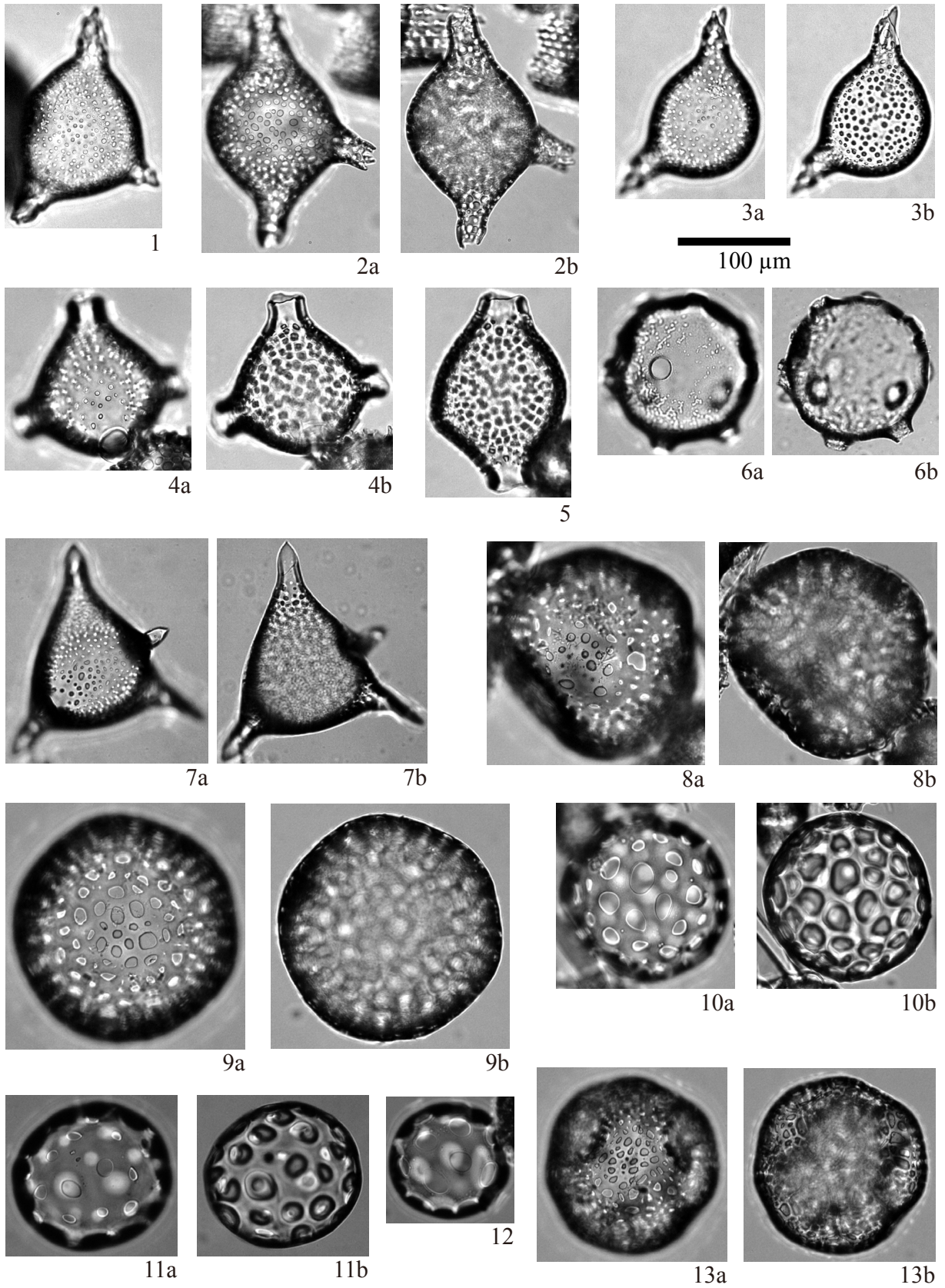


Plate 2 Illustrations of the encountered radiolarians. 1–3: *Trisolonia megalactis megalactis* Ehrenberg; 4, 5: *Siphonosphaera* sp. A; 6: *Siphonosphaera* sp. D; 7: *Siphonosphaera* sp. B; 8, 9: *Collosphaera glebulenta* Bjørklund and Goll; 10–12: *Collosphaera* sp. A; 13: *Collosphaera brattstroemi* Bjørklund and Goll.

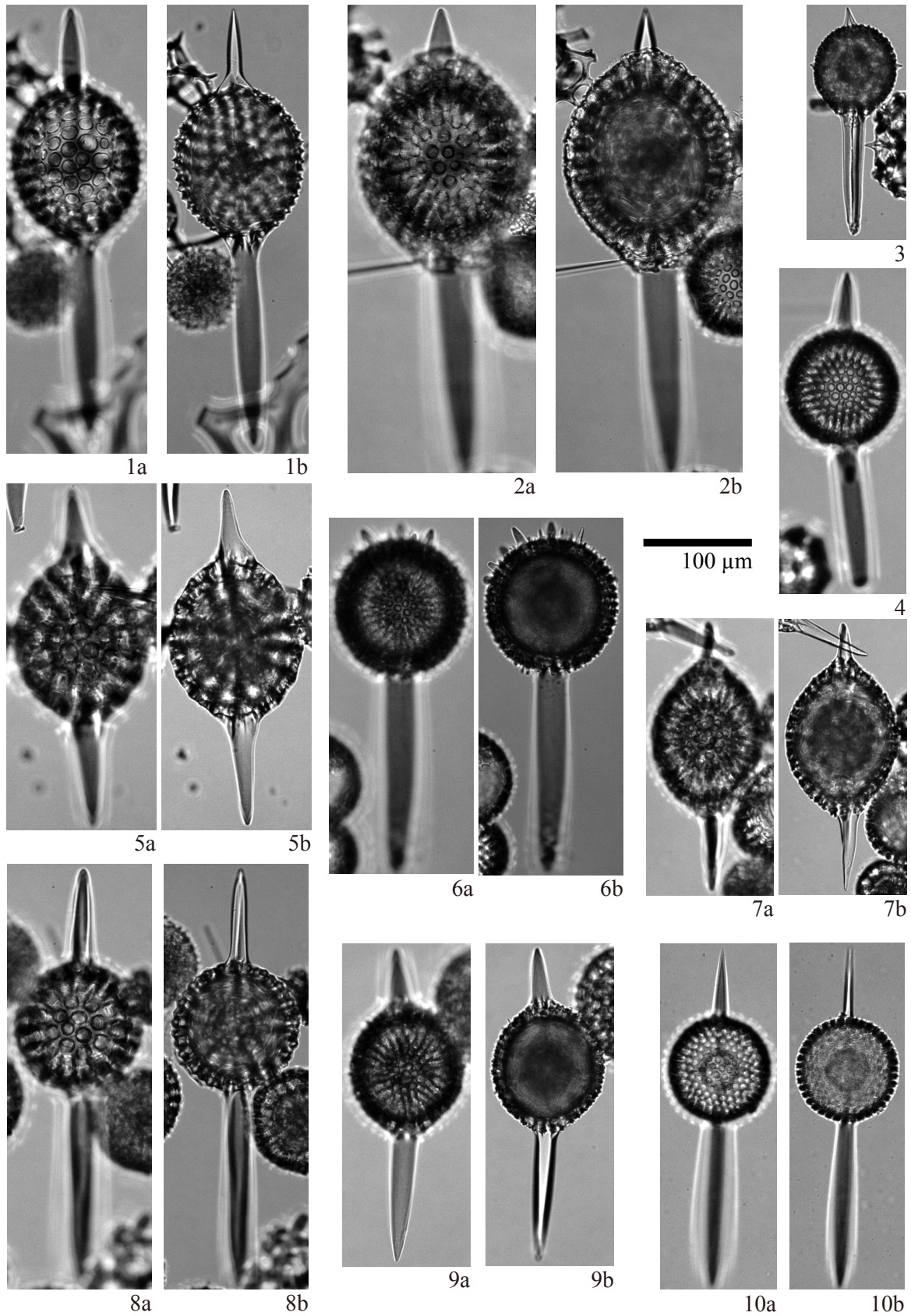


Plate 3 Illustrations of the encountered radiolarians. 1, 2: *Axoprunum bispiculum* (Popofsky); 3: *Stylosphaera communis* (Carnevale); 4, 10: *Stylosphaera* sp. B; 5: *Amphisphaera santaeannae* (Campbell and Clark); 6: *Amphistylus polistylus* (Carnevale); 7: *Amphisphaera neptunus* (Haeckel); 8: *Stylosphaera* sp. A; 9: *Amphistylus angelinus* (Campbell and Clark).

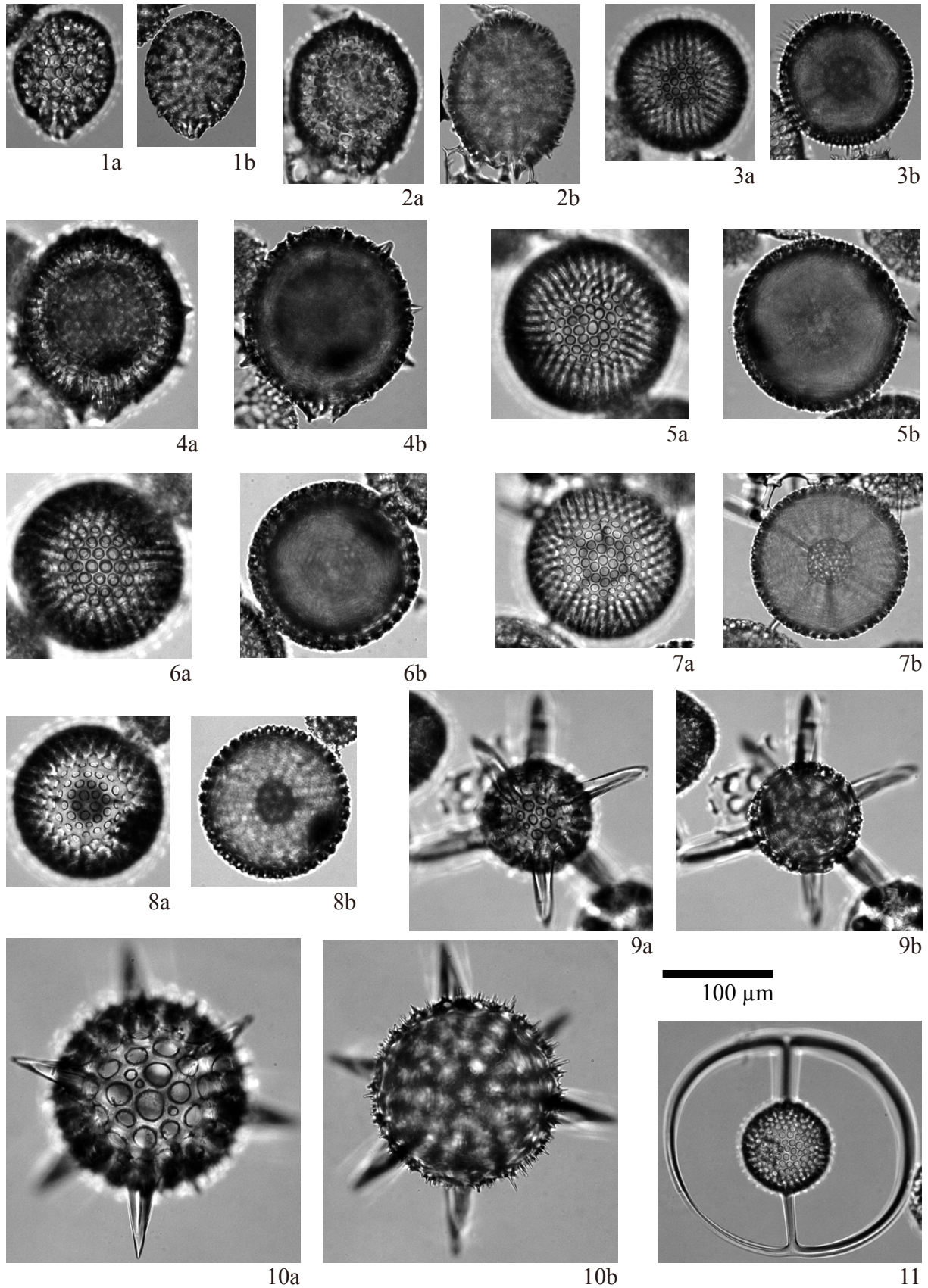


Plate 4 Illustrations of the encountered radiolarians. 1, 2, 4: *Actinomma robusta* (Kling); 3: *Thecosphaera* sp. A; 5: *Thecosphaera* sp. B; 6: *Thecosphaera* sp. C; 7: *Thecosphaera* sp. D; 8: *Thecosphaera* sp. E; 9: *Hexacontium* sp. B; 10: *Hexacontium* cf. *arachnoidale* Hollande and Enjume; 11: *Saturnalis circularis* Haeckel.

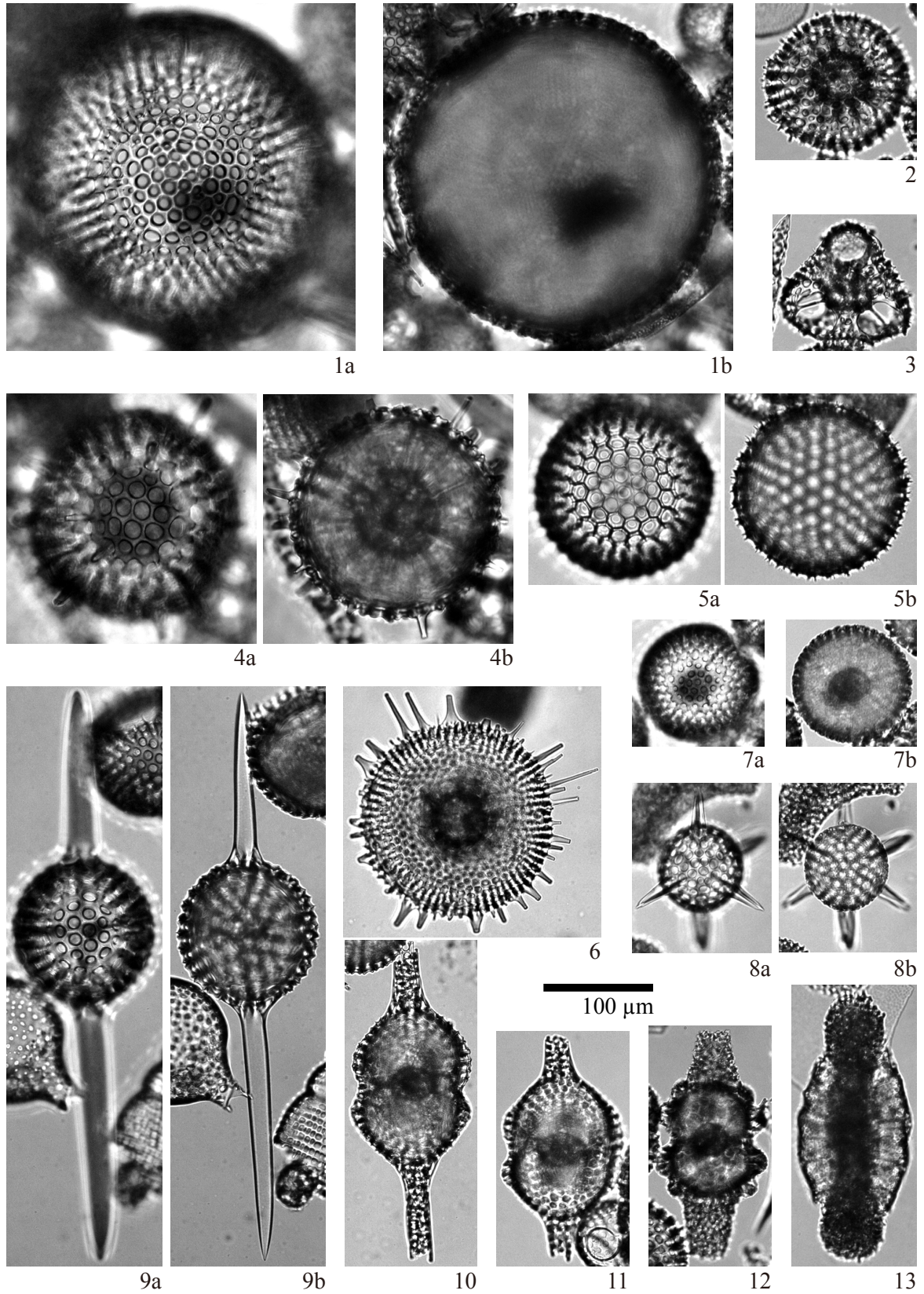


Plate 5 Illustrations of the encountered radiolarians. 1: *Cenosphaera* sp. A; 2: *Heliodiscus* sp. B; 3: *Hexapyle dodecantha* Haeckel; 4: *Excentrodiscus* sp. A; 5: *Cenosphaera* sp. B; 6: *Heliodiscus* sp. A; 7: *Thecosphaera* sp. E; 8: *Hexacantium* sp. C; 9: *Axoprunum* sp. A; 10: *Didymocyrtis violina* (Haeckel); 11: *Didymocyrtis tubaria* (Haeckel); 12: *Didymocyrtis mammifera* (Haeckel); 13: *Spongurus cylindricus* Haeckel.

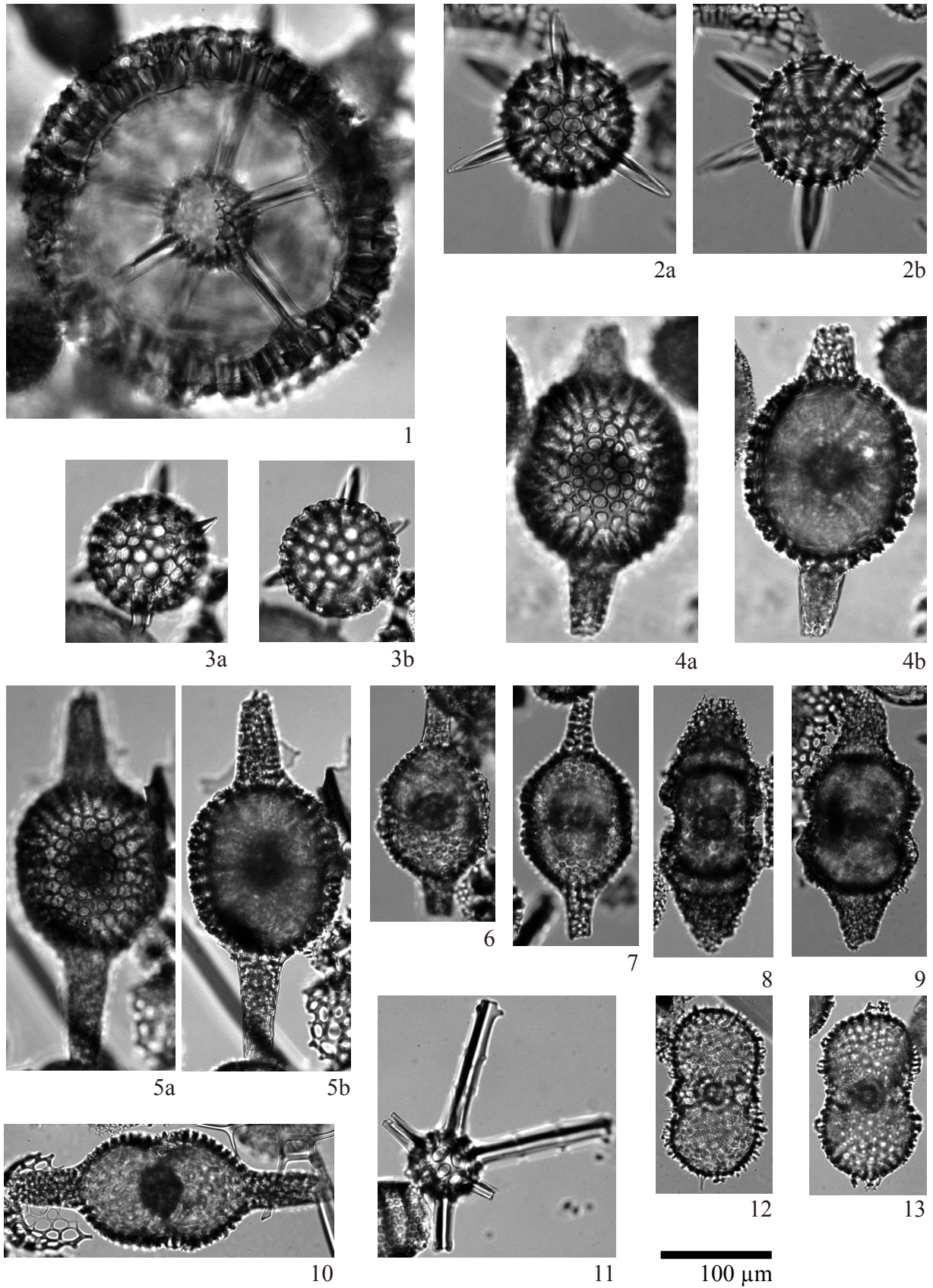


Plate 6 Illustrations of the encountered radiolarians. 1: *Cladococcus* sp. A; 2: *Hexacontium pachydermum* Jørgensen; 3: *Hexalonche* sp. A; 4, 5: *Didymocyrtis prismatica* (Haeckel); 6, 7: *Didymocyrtis tubaria* (Haeckel); 8: *Didymocyrtis laticonus* (Riedel); 9: *Didymocyrtis mammifera* (Haeckel); 10, 12, 13: *Didymocyrtis bassanii* (Carnevale); 11: *Cladococcus dentata* (Mast).

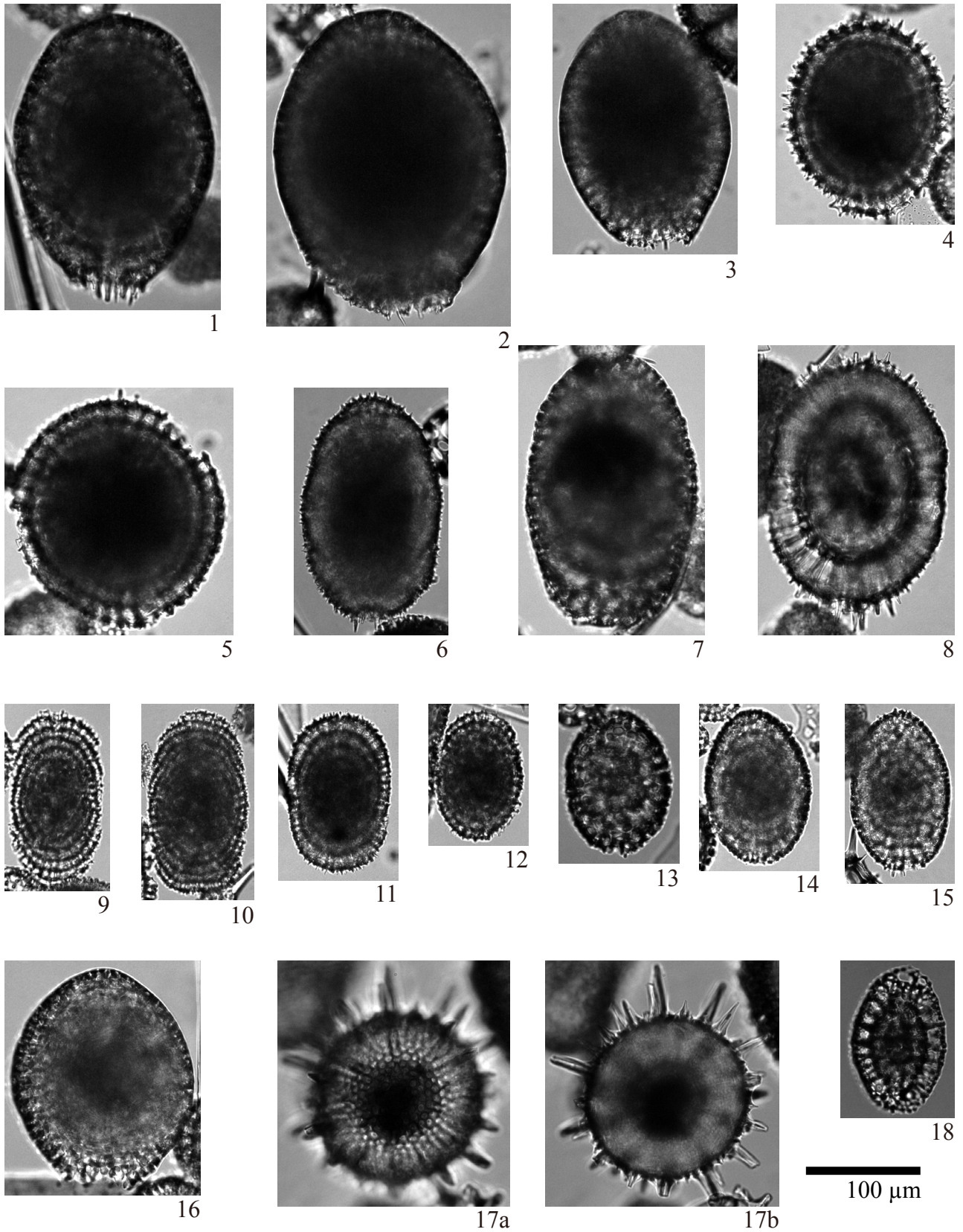


Plate 7 Illustrations of the encountered radiolarians. 1–4: *Larcopyle hayesi* (Chen) group; 5: *Larcopyle* sp. C; 6, 9–11: *Lithelius* sp. A; 7: *Larcopyle polyacantha* (Campbell and Clark); 8: *Larcopyle* sp. B; 12: *Lithelius* sp. C; 13–15: *Larcopyle* sp. A; 16: *Larcopyle titan* (Campbell and Clark); 17: *Actinomma* sp. B; 18: *Larcospira moschkowskii* Kruglikova.

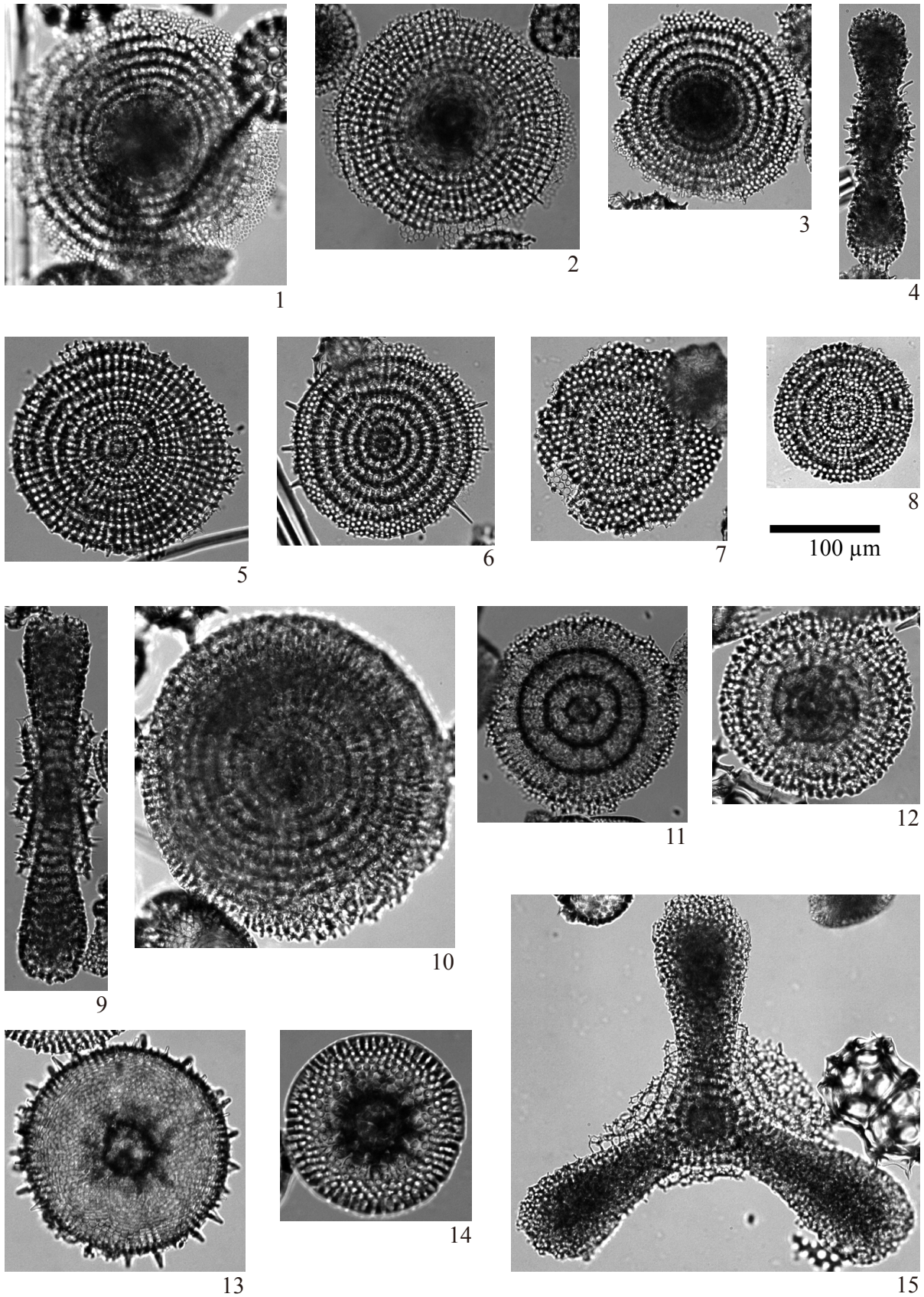


Plate 8 Illustrations of the encountered radiolarians. 1–3: *Stylodictya* sp. A; 4: *Spongurus cylindricus* Haeckel; 5, 6, 8: *Stylodictya camerina* Campbell and Clark; 7: *Stylodictya* sp. B; 9: *Amphymenium amphistylum* Haeckel; 10: *Stylodictya* sp. C; 11: *Porodiscus circularis* Clark and Campbell; 12: *Porodiscus* sp. A; 13: *Heliodiscus* sp. A; 14: *Phacodiscus* sp. A; 15: *Dictyocoryne* sp. B.

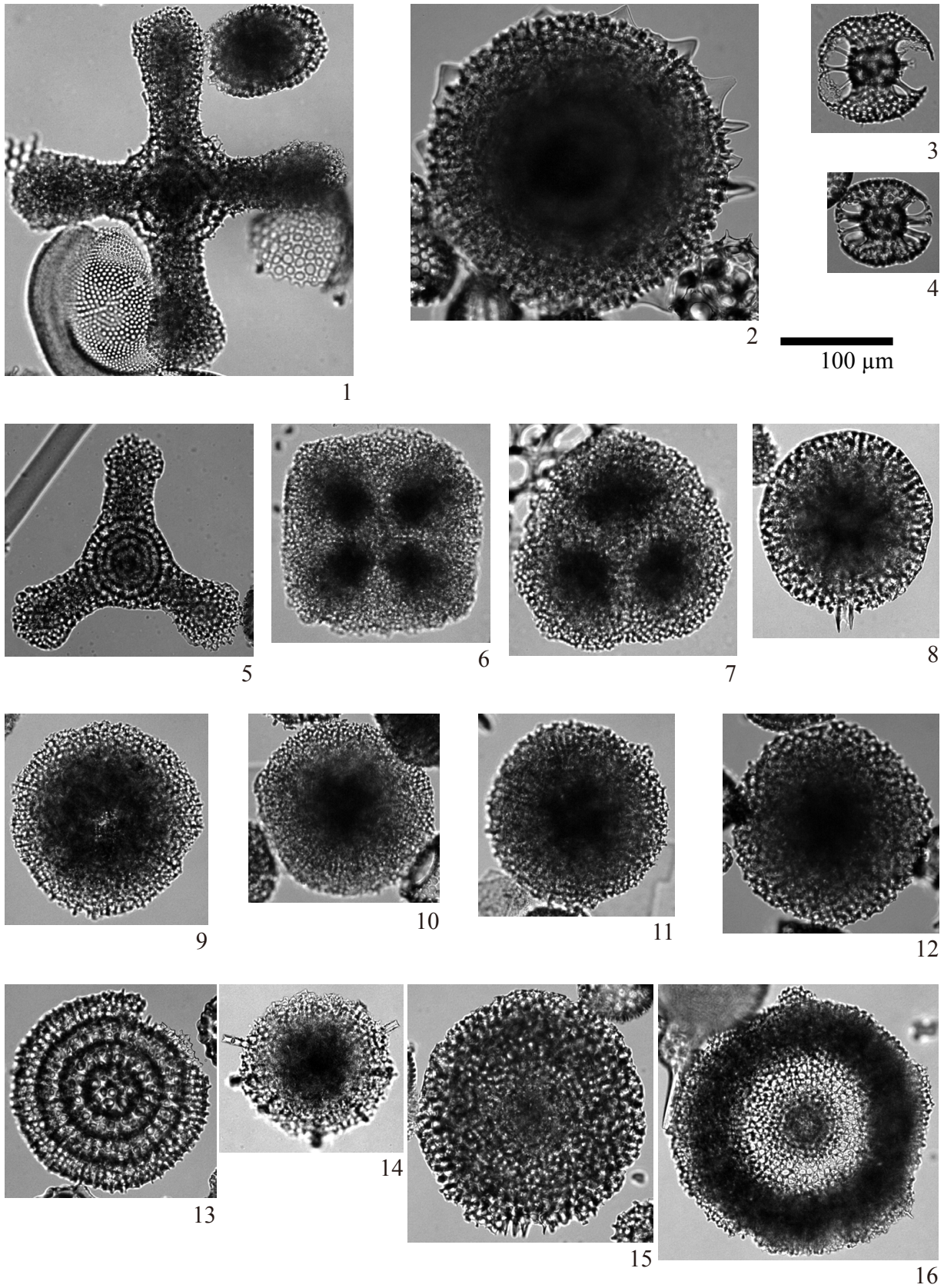


Plate 9 Illustrations of the encountered radiolarians. 1: *Spongasteriscus marylandicus* Martin; 2: *Heliodiscus* sp. C; 3, 4: *Tetrapyle* sp. A; 5: *Dictyocoryne malagaense* (Campbell and Clark); 6: *Spongaster* sp. A; 7: *Dictyocoryne* sp. A; 8: *Spongopyle osculosa* Dreyer; 9–12: *Spongodiscus resurgens* Ehrenberg; 13: *Excentrococcus annulatus* Dumitrica; 14: *Spongodiscus* sp. B; 15: *Spongodiscus* sp. C; 16: *Spongodiscus klingi* Caulet.

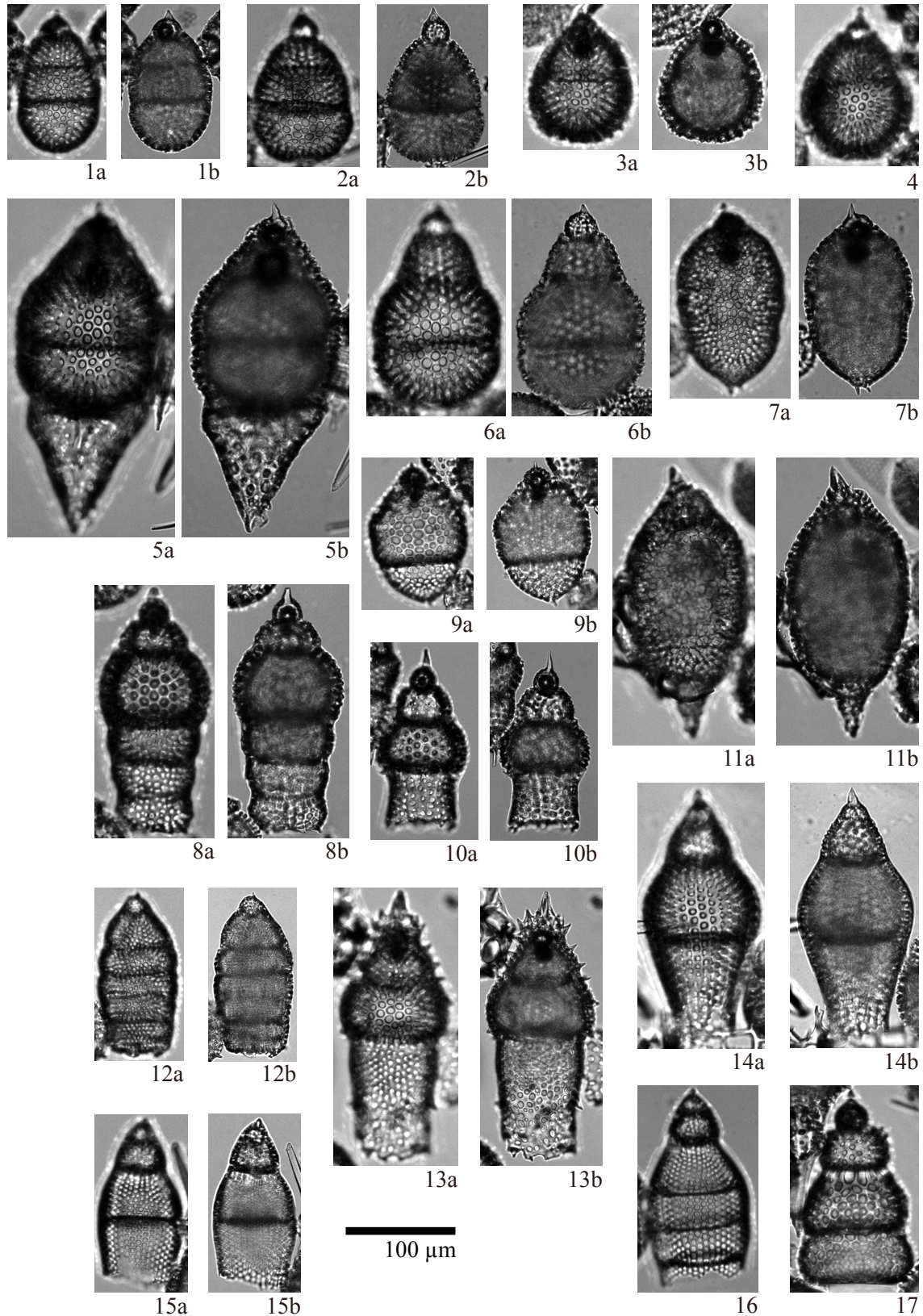


Plate 10 Illustrations of the encountered radiolarians. 1, 2: *Cyrtocapsella tetrapera* Haeckel; 3, 4: *Cyrtocapsella japonica* (Nakaseko); 5, 6: *Cyrtocapsella cornuta* Haeckel; 7: *Lithopera baueri* Sanfilippo and Riedel; 8: *Stichocorys delmontensis* (Campbell and Clark); 9: *Lithopera renzae* Sanfilippo and Riedel; 10: *Stichocorys wolffii* Haeckel; 11: *Lithopera thornburgi* Sanfilippo and Riedel; 12: *Eucyrtidium* sp. A; 13: *Stichocorys armata* (Haeckel); 14: *Phormocyrtis alexandrae* O'Connor; 15: *Eucyrtidium* sp. C; 16: *Eucyrtidium cienkowskii* Haeckel; 17: *Stichocorys diaphanes* (Sanfilippo and Riedel).

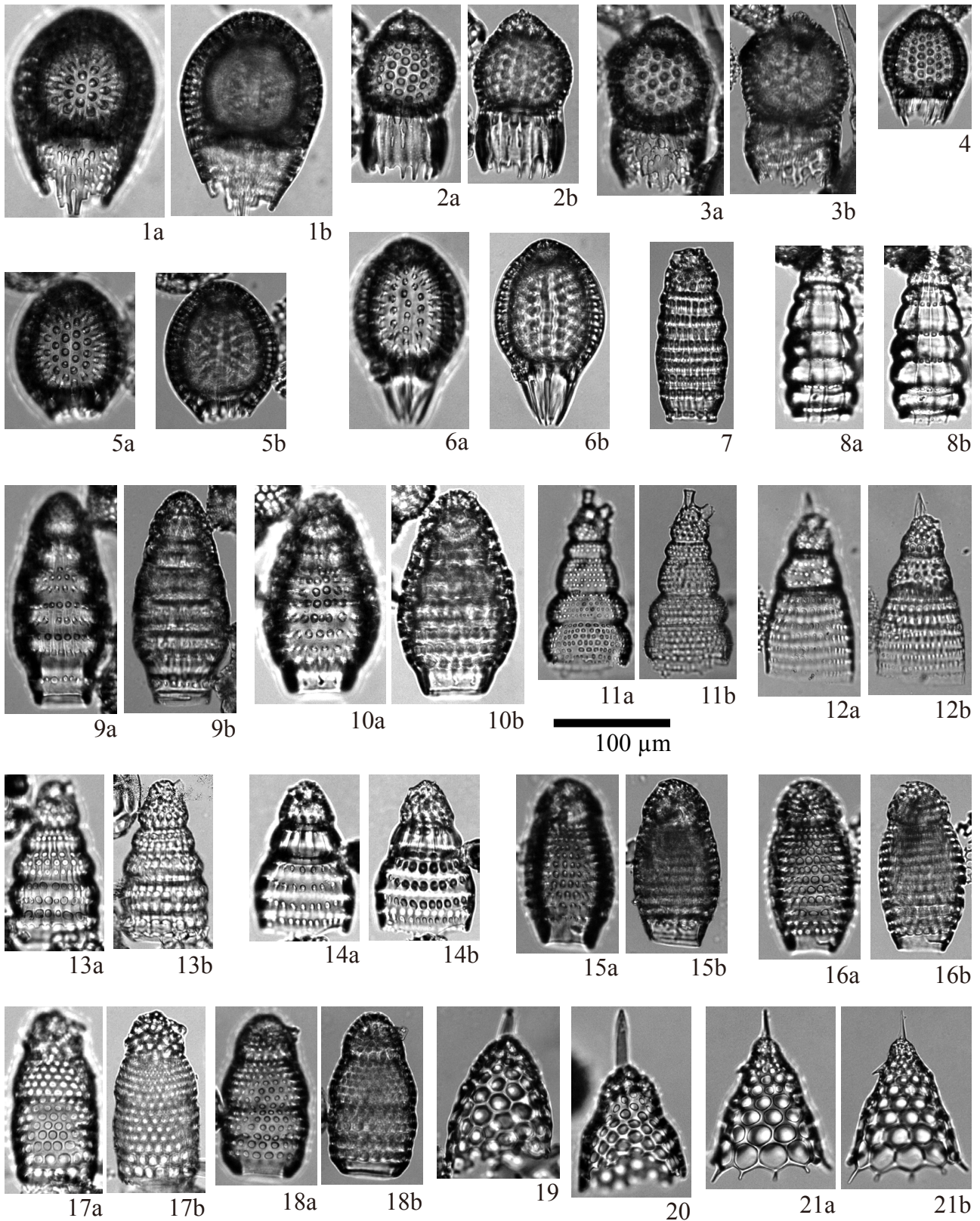


Plate 11 Illustrations of the encountered radiolarians. 1: *Carpocanium cingulatum* (Riedel and Sanfilippo); 2, 3: *Carpocanium bramlettei* (Riedel and Sanfilippo); 4: *Carpacanium* sp. B; 5, 6: *Carpacanium kinugasense* Nishimura; 7: *Siphocampe* sp. D; 8: *Siphocampe grantmackiei* O'Connor; 9: *Botryostrobus* sp. B; 10: *Botryostrobus aquilonaris* (Bailey); 11: *Spirocyrtis subtilis* Petrushevskaya; 12: *Siphostichartus corona* (Haeckel); 13: *Botryostrobus* sp. A; 14: *Theocamptra ovata* (Haeckel); 15, 16: *Siphocampe* sp. B; 17, 18: *Phormostichoartus fistula* Nigrini; 19: *Lithocampana* sp. A; 20: *Lithocampana* sp. B; 21: *Cycladophora conica* Lombardi and Lazarus.

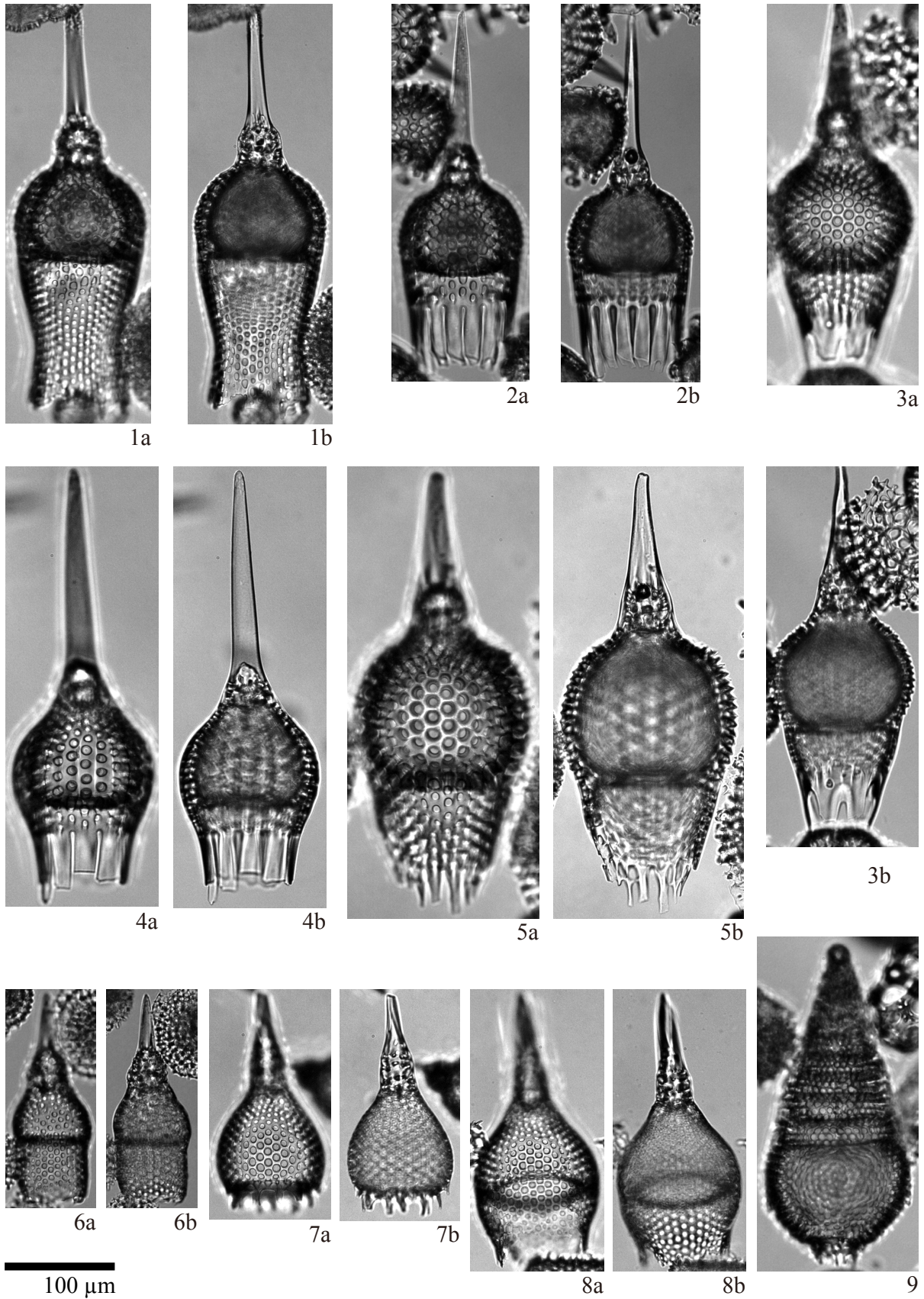


Plate 12 Illustrations of the encountered radiolarians. 1: *Calocycletta caepa* Moore; 2: *Calocycletta virginis* (Haeckel); 3: *Calocycletta serrata* Moore; 4: *Calocycletta costata* (Riedel); 5: *Calocycletta robusta* Moore; 6: *Albatrossidium minzok* Sanfilippo and Riedel; 7: *Anthocyrtidium* sp. A; 8: *Anthocyrtidium* sp. B; 9: *Cyrtolagena* sp. A.

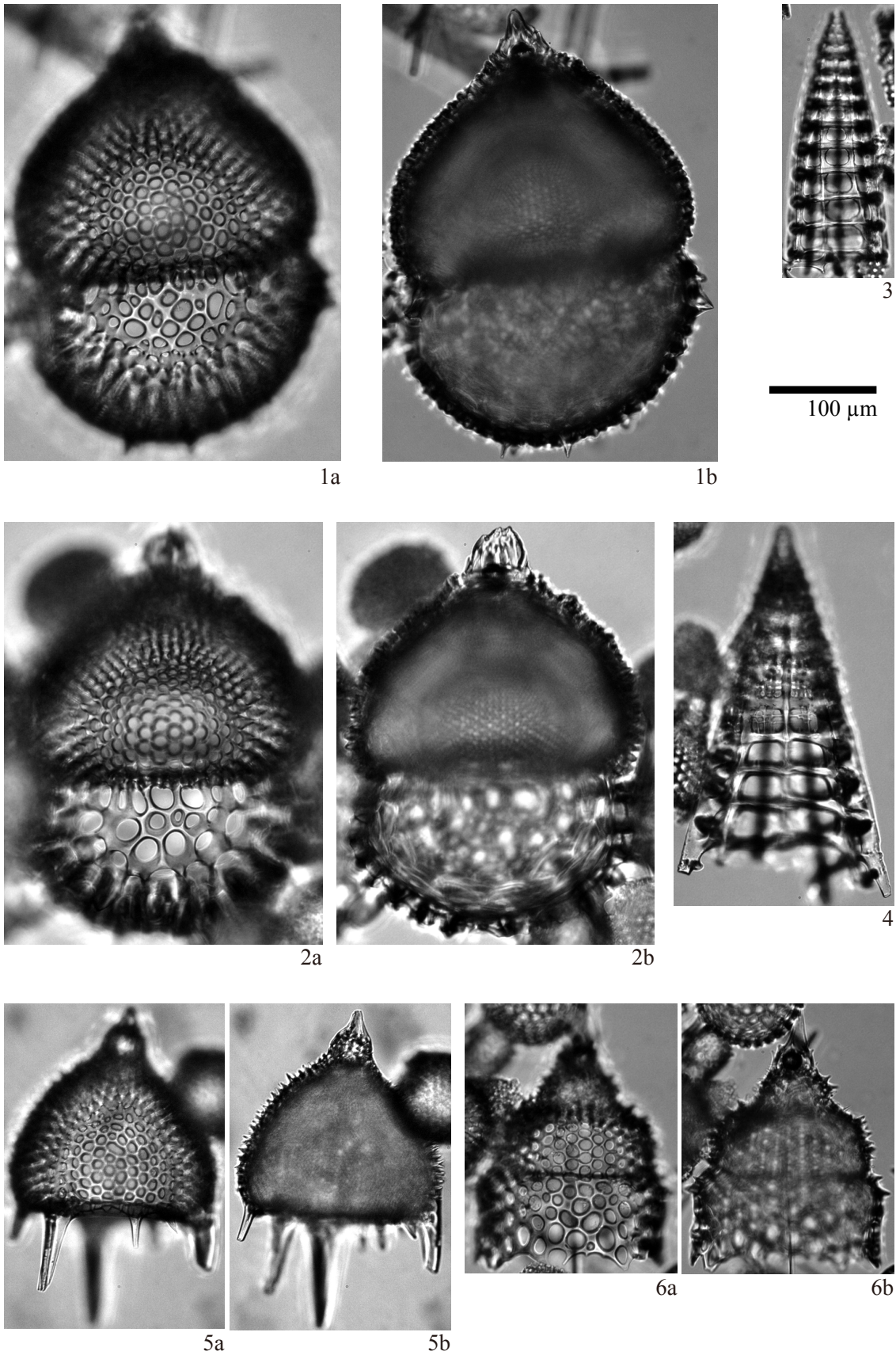


Plate 13 Illustrations of the encountered radiolarians. 1, 2: *Lophocyrtis tanythorax* (Sanfilippo and Riedel); 3: *Cinclopyramis pacifica* (Nakaseko); 4: *Cinclopyramis woodringi* (Campbell and Clark); 5: *Lophocyrtis* sp. A; 6: *Calocyclus* sp. A.

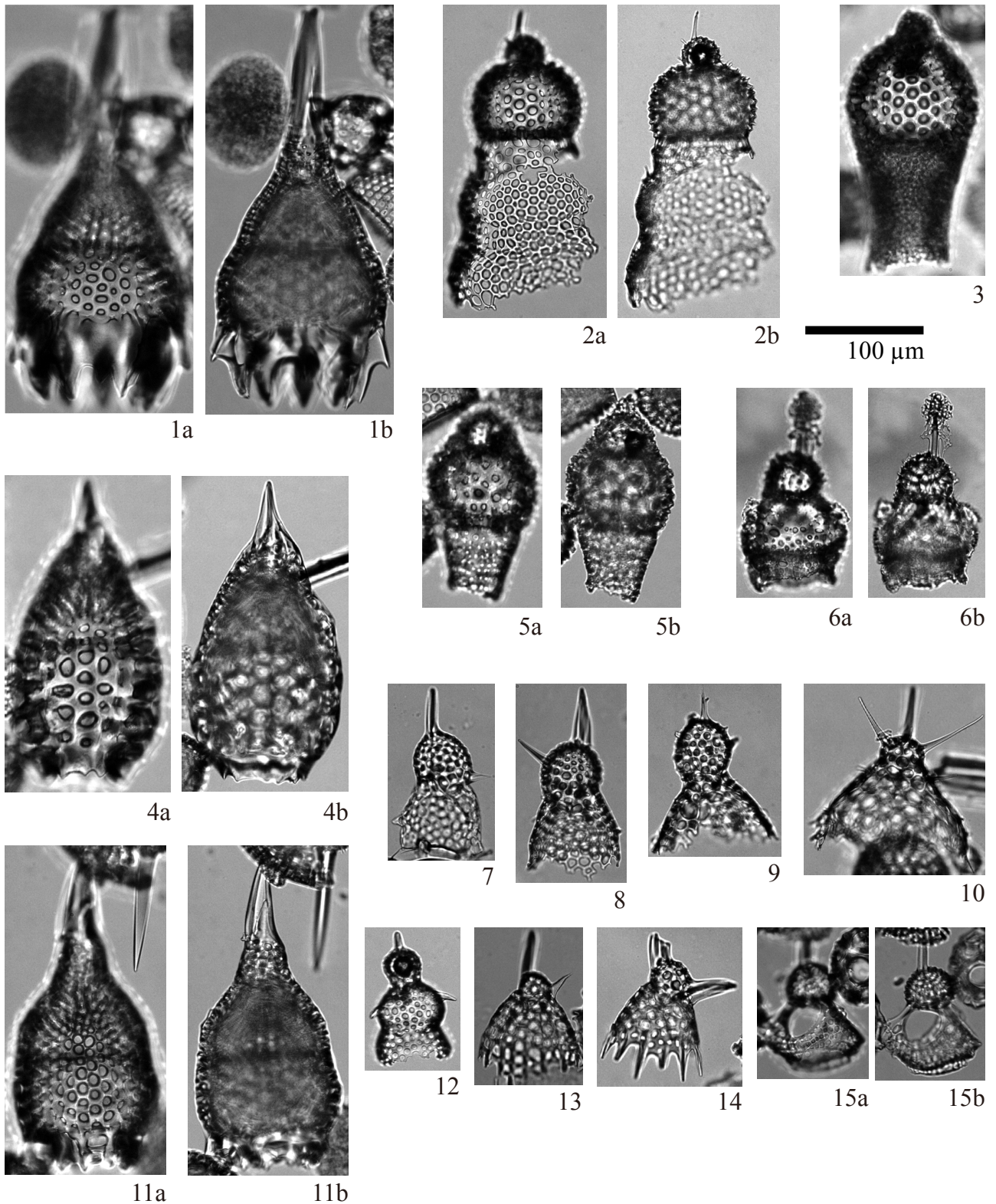


Plate 14 Illustrations of the encountered radiolarians. 1: *Lamprocyclas maritalis* Haeckel; 2: *Lophocyrtis aspera* (Ehrenberg); 3: *Theocorys spongoconus* Kling; 4: *Lamprocyclas* sp. B; 5: *Theocorys* sp. A; 6: *Clathrocanium atreta* Sanfilippo and Riedel; 7, 8: *Lithomelissa* sp. A; 9: *Lophophaena* sp. A; 10: *Ceratocyrtis* sp. A; 11: *Lamprocyclas margatensis* Campbell and Clark var. A; 12: *Lipmanella conica* Petrushevskaya; 13, 14: *Lophophaena tekopua* O'Connor; 15: *Clathrocanium coarctatum* Ehrenberg.

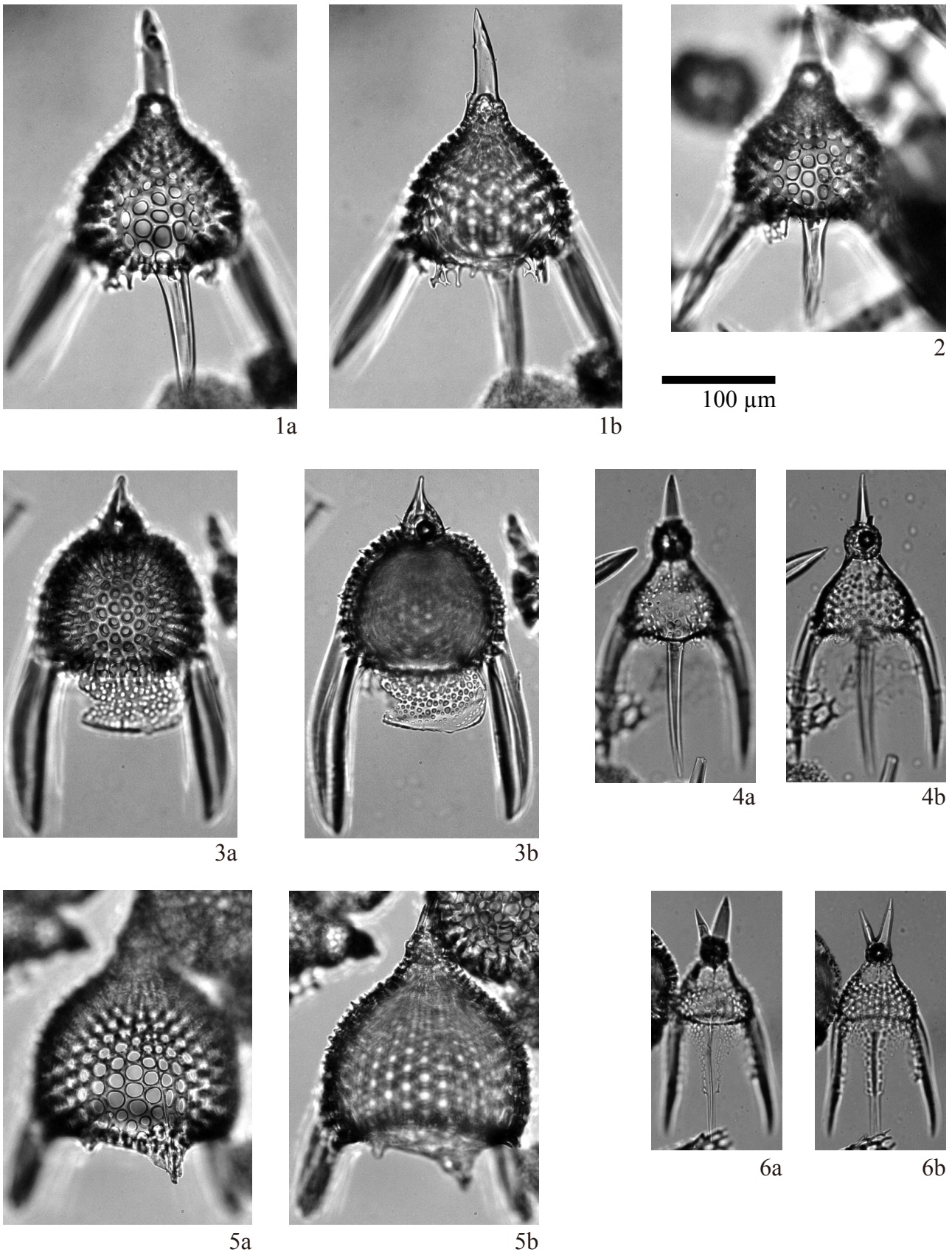


Plate 15 Illustrations of the encountered radiolarians. 1, 2: *Pterocanium audax* (Riedel); 3: *Lychnocanoma elongata* (Vinassa de Regny); 4: *Pterocanium* aff. *tridentatum* (Ehrenberg); 5: *Pterocanium charybdeum* (Müller); 6: *Pterocanium* sp. A.

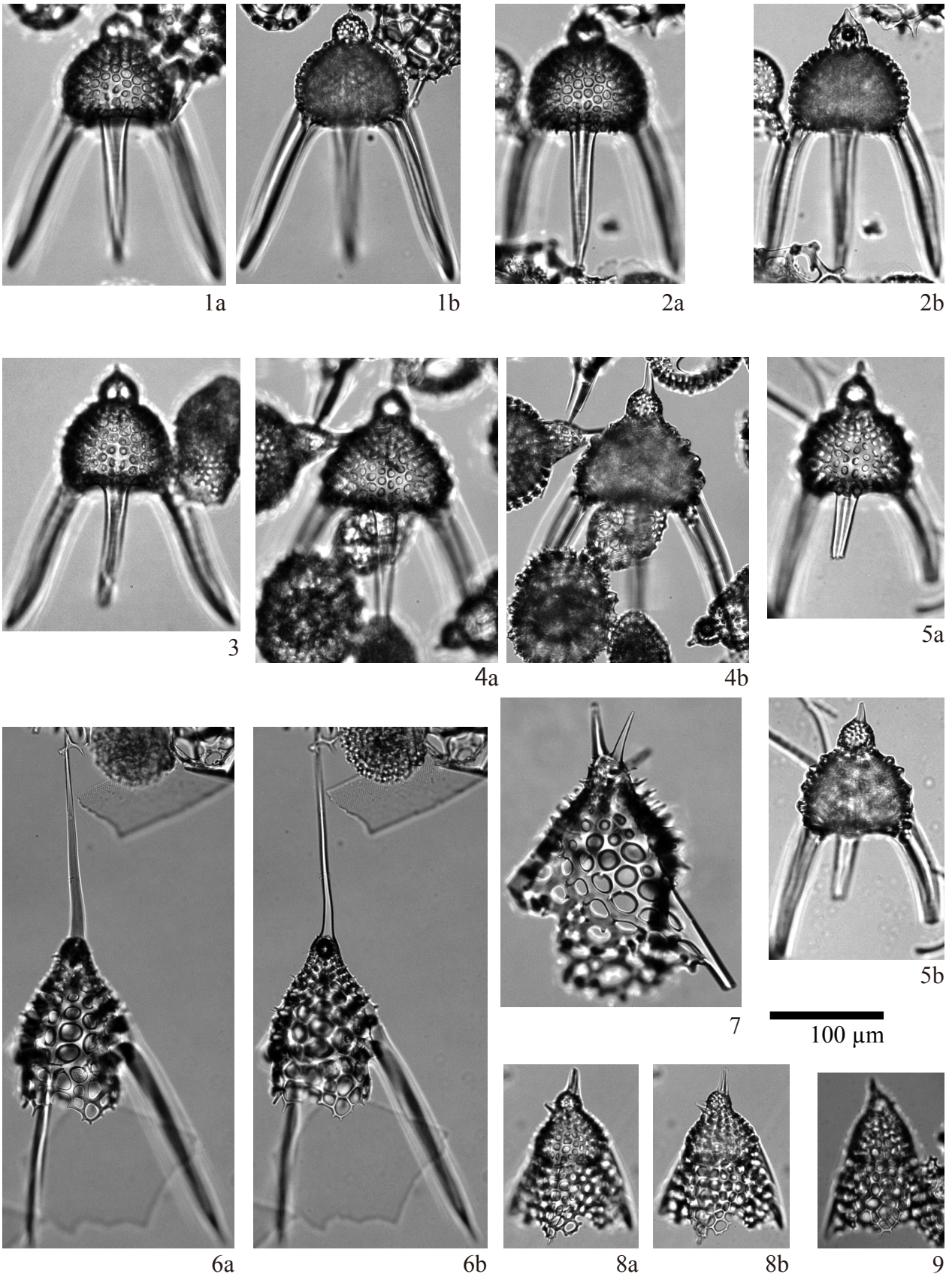
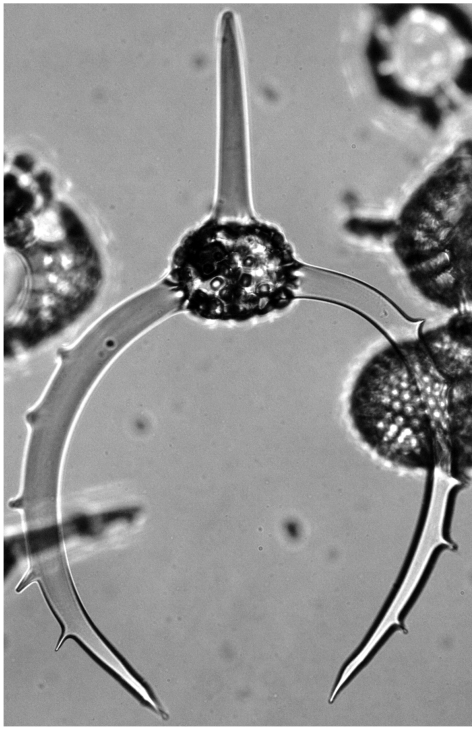
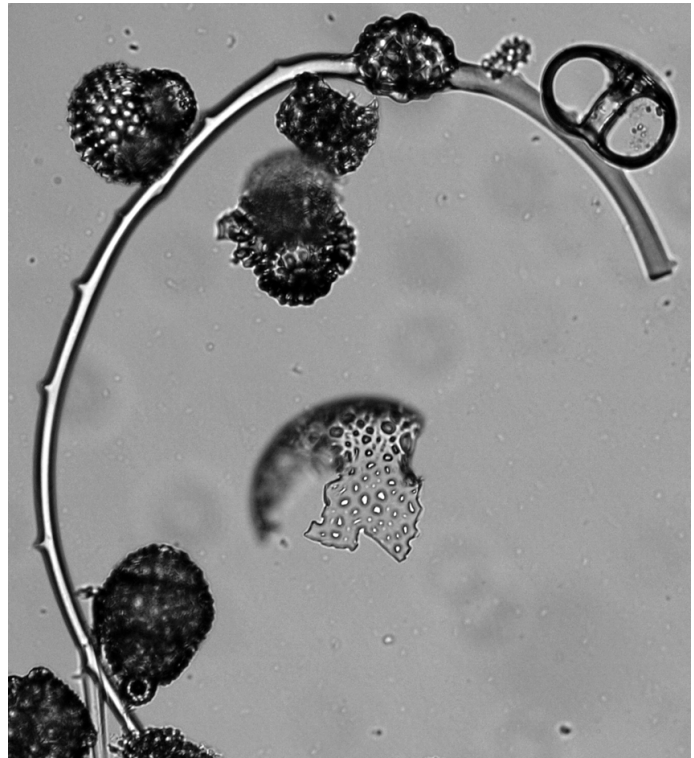


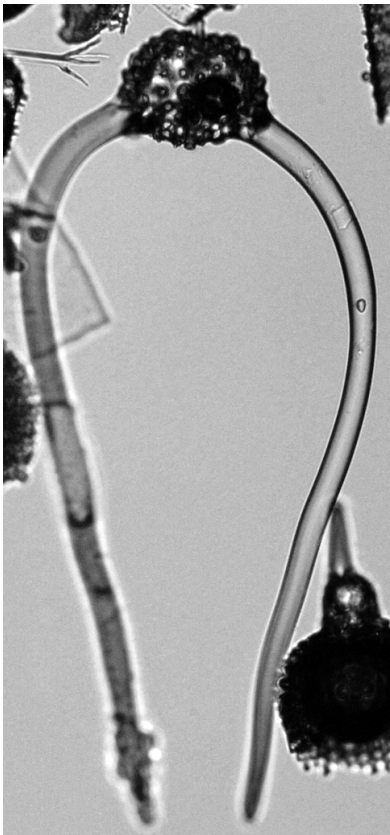
Plate 16 Illustrations of the encountered radiolarians. 1–3: *Lychnocanoma* sp. A; 4, 5: *Lychnocanoma nodosum* (Haeckel); 6: *Dictyophimus splendens* (Campbell and Clark); 7: *Dictyophimus* sp. A; 8, 9: *Valkyria pukapuka* O'Connor.



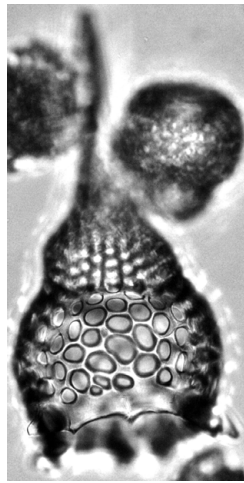
1



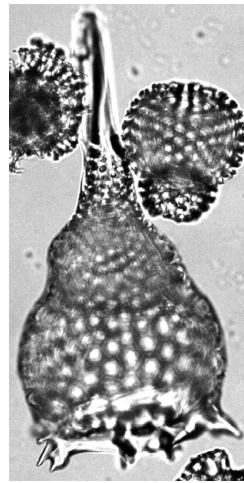
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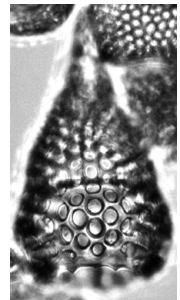
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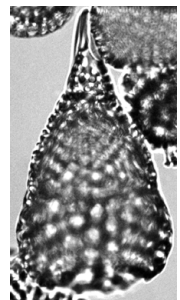
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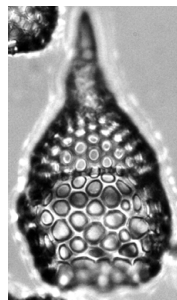
4b



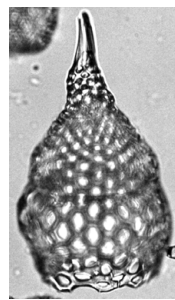
5a



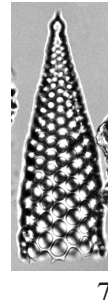
5b



6a



6b



7

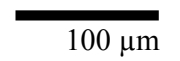


Plate 17 Illustrations of the encountered radiolarians. 1: *Dorcadospyrus dentata* Haeckel; 2: *Dorcadospyrus alata* (Riedel); 3: *Dorcadospyrus ateuchus* (Ehrenberg); 4–6: *Lamprocyclus margatensis* Campbell and Clark var. B; 7: *Cornutella trochus* Ehrenberg.

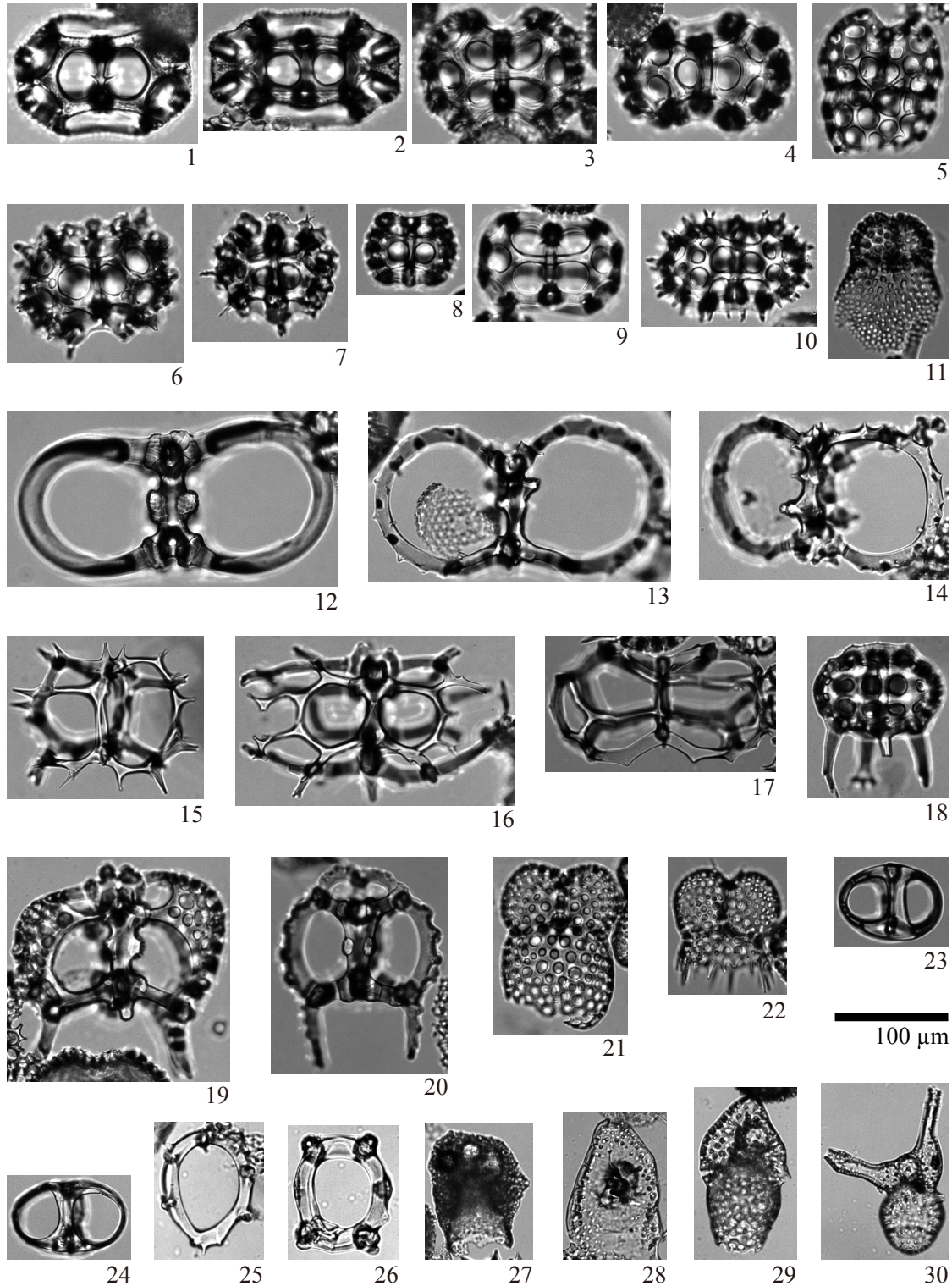


Plate 18 Illustrations of the encountered radiolarians. 1, 2: *Tympanomma binooctonum* (Haeckel); 3, 4: *Tholospyris anthophora* (Haeckel); 5: *Dendrospyris pannosa* Goll; 6: *Tholospyris mammillaris* (Haeckel); 7: *Tholospyris kantiana* (Haeckel); 8: *Tympanomma tuberosum* (Haeckel); 9: *Liriospyris mutuarua* Goll; 10: *Liriospyris* sp. A; 11: *Dendrospyris* sp. A; 12: *Eucoronis octopylus* (Haeckel); 13, 14: *Eucoronis perspicillum* Haeckel; 15: *Acanthodesmia circumflexa* (Goll); 16: *Acanthodesmia* sp. A; 17: *Acanthodesmia* sp. B; 18: *Dendrospyris pododendros* (Carnevale); 19: *Giraffospyris annulispina* Goll; 20: *Eucoronis toxarium* (Haeckel); 21: *Phormospyris stabilis* (Goll); 22: *Phormospyris* sp. B; 23: *Liriospyris parkerae* Riedel and Sanfilippo; 24: *Liriospyris stauropora* (Haeckel); 25, 26: *Zygocircus* sp.; 27: *Botryocyrtis* sp. A; 28: *Centrobotrys thermophila* Petrushevskaya; 29: *Centrobotrys petrushevskayae* Sanfilippo and Riedel; 30: *Acrobotrys disolenia* Haeckel.

