Notes and Comments

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, Hexalonchidae, 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

Plate no. Species and species group Location Zone Reference PIO1, fig. 1 Trisolenia combinate Bjerklund and Goll 13H+2. 104-106 cm, D32/4 RNS Popofsky, 1917 PIO1, fig. 2 Callosphara macropora Popofsky 15H+CC, 626/3 RNS Popofsky, 1917 PIO1, fig. 4 Siphonospharer sp. C 13H+2, 104-106 cm, Z23/0 RNS Reynolds, 1980 PIO1, fig. 5 Callosphara reynolds RNS Reynolds, 1980 RNS Reynolds, 1980 PIO1, fig. 7 Trisolenia magalectic acotlowi Bjerklund and Goll 13H+2, 104-106 cm, Y39/4 RNS Bjerklund and Goll, 1917 PIO1, fig. 1 Frisolenia magnalectic megalectic Etheroherg 11H+CC, 733/3 RNS Nigrini and Lombari, 1916, 19, 10 PIO2, fig. 1 Trisolenia magalectic Etheroherg 17H+CC, V48/1 RN4 Bjerklund and Goll, 19102, fig. 3 Siphonosphare sp. A 17H+CC, V48/1 RN4 Bjerklund and Goll, 19102, fig. 5 Siphonosphare sp. A 17H+CC, V48/1 RN4 Bjerklund and Goll, 19102, fig. 5 Siphonosphare sp. A 17H+CC, V48/1 RN4 Bjerklund and Goll, 19102, fig. 6 Giolospharer sp. B 18H+CC, R10/1 <		
P101. fig. 1 Trisolenia combinata Bjerklund and Goll 13H-2. 104-106 cm, D32/4 RNS Bjerklund and Goll, 1 P101. fig. 2 Collosphaera macropora Popofsky 15H-CC, B36/3 RNS Popofsky, 1917 P101. fig. 4 Sphonosphaera sp. C 13H-2, 104-106 cm, 220/0 RNS Papolity, 1917 P101. fig. 5 Collosphaera pytoma Reynolds 13H-2, 104-106 cm, 734/4 RNS Reynolds, 1980 P101. fig. 6 Collosphaera pytoma Reynolds 13H-2, 104-106 cm, 734/4 RNS Bjerklund and Goll, 1 P101. fig. 7 Polysolenia marrayana (Haeckel) 11H-CC, 733/3 RNS Nigrini and Lombari, 1 P101. fig. 1 Polysolenia marrayana (Haeckel) 11H-CC, 120/1 RN4 Bjerklund and Goll, 1 P102. fig. 1 Trisolenia megalactis megalactis Ehrenberg 17H-CC, 48/4 RN4 Bjerklund and Goll, 1 P102. fig. 3 Trisolenia megalactis megalactis Ehrenberg 17H-CC, 48/1 RN4 Bjerklund and Goll, 1 P102. fig. 4 Sphonosphaera sp. A 17H-CC, 22/1 RN4 Bjerklund and Goll, 1 P102. fig. 5 Sphonosphaera sp. B 13H-2, 104-106 cm, 37/3 RN5<	Location Zone Reference	
P101.fg.2 Collosphara macropora Popofsky 15H-CC, B26/3 RN5 Popofsky, 1917 P101.fg.3 Trisolenia sp. A 15H-CC, K44/0 RN5 Popofsky, 1917 P101.fg.4 Sphonosphara sp. C 13H-2, 104-106 cm, 220/0 RN5 Reynolds, 1980 P101.fg.5 Collosphara pyloma Reynolds 13H-2, 104-106 cm, 220/0 RN5 Kamikuri, 2010 P101.fg.7 Trisolenia megalactis costlowi Bjorklund and Goll 13H-2, 104-106 cm, 23/4 RN5 Kamikuri, 2010 P101.fg.9 Polysolenia spinosa (Haeckel) group 15H-CC, R3/7.2 RN5 Nigrini and Lombari, 1910, fg.9 Polysolenia spinosa (Haeckel) group 11H-CC, 20/1 RN4 Bjerklund and Goll, 1910, fg.1 Pioselia spinosa (Haeckel) group 11H-CC, C, 44/1 RN4 Bjerklund and Goll, 1910, fg.1 Trisolenia megalactis megalactis Ehrenberg 17H-CC, 44/1 RN4 Bjerklund and Goll, 1910, fg.1 Sphonosphara sp. A 17H-CC, C, 44/1 RN4 Bjerklund and Goll, 1910, fg.2 Sphonosphara sp. A 17H-CC, C, 44/1 RN4 Bjerklund and Goll, 1910, fg.2 Fissolenia megalactis megalactis Herenberg 18H-CC, R10/1 RN4 Bjerklund and Goll, 1910, fg.2 Sphonosphara sp. A	13H-2, 104-106 cm, D32/4 RN5 Biørklund and Goll, 1979	
P101, fig. 3 Trisolenia sp. A I5H-CC, K44/0 RNS P101, fig. 4 Siphonosphaera sp. C 13H-2C, Q23/0 RNS Reynolds, 1980 P101, fig. 5 Collosphaera pyloma Reynolds 13H-CC, Q23/0 RNS Kamikuri, 2010 P101, fig. 6 Collosphaera pyloma Reynolds 13H-CC, Q23/0 RNS Kamikuri, 2010 P101, fig. 7 Trisolenia magalactis costolowi Bjorklund and Goll 13H-2C, CL, 23/3 RNS Ngrini and Coll, 1 P101, fig. 9 Polysolenia murrayana (Haeckel) 11H-CC, CD2/1 RNS Ngrini and Lombari, 1 P102, fig. 1 Trisolenia megalactis megalactis Ehrenberg 17H-CC, V48/4 RN4 Bjørklund and Goll, 1 P102, fig. 3 Trisolenia megalactis megalactis Ehrenberg 17H-CC, V48/1 RN4 Bjørklund and Goll, 1 P102, fig. 4 Siphonosphaera sp. A 17H-CC, Q2/1 RN4 Bjørklund and Goll, 1 P102, fig. 5 Siphonosphaera sp. A 17H-CC, CL 22/1 RN4 Bjørklund and Goll, 1 P102, fig. 8 Collosphaera sp. A 17H-CC, CL 22/1 RN4 Bjørklund and Goll, 1 P102, fig. 1 <	15H-CC, B26/3 RN5 Popofsky, 1917	
P101.fig. 4 Siphonosphaera sp. C 13H-2.104-106 cm. 720/0 RN5 P101.fig. 5 Collosphaera pyloma Reynolds 13H-CC.Q33/0 RN5 Reynolds.1980 P101.fig. 7 Trisolenia megalactis costlowi Bjorklund and Goll 13H-2. 104-106 cm. 739/4 RN5 Kamikuri. 2010 P101.fig. 7 Trisolenia megalactis costlowi Bjorklund and Goll 13H-2. 104-106 cm. 739/4 RN5 Nigrini and Lombari. P101.fig. 7 Polysolenia spinose (Hacekel) group 15H-CC, R37/2 RN5 Nigrini and Lombari. P102.fig. 1 Trisolenia megalactis megalactis Ehrenberg 17H-CC, V48/1 RN4 Bjørklund and Goll. P102.fig. 3 Trisolenia megalactis megalactis Ehrenberg 17H-CC, C44/3 RN4 Bjørklund and Goll. P102.fig. 3 Siphonosphaera sp. A 17H-CC, C44/3 RN4 Bjørklund and Goll. P102.fig. 6 Siphonosphaera sp. B 13H-2.104-106 cm. P39/2 RN4 Ejørklund and Goll. P102.fig. 1 Collosphaera sp. D 13H-2.104-106 cm. P39/2 RN4 Ejørklund and Goll. P102.fig. 1 Collosphaera sp. A 13H-CC, C41/3 RN4 Ejørklund and Goll.	15H-CC, K44/0 RN5	
PIO1, fig. 5 Collosphaera pyloma Reynolds. 13H-CC, Q23/0 RNS Reynolds. 1980. PIO1, fig. 6 Collosphaera reynolds/ Kamikuri 10H-CC, H23/1 RNS Kamikuri, 2010 PIO1, fig. 7 <i>Trisolenia megalactis costlowi</i> Bjerklund and Goll 13H-2. 104-106 om, Y39/4 RNS Kamikuri, 2010 PIO1, fig. 8 <i>Polysolenia spinosa</i> (Haeckel) group 15H-CC, R37/2 RNS Nigrini and Lombari, PIO1, fig. 10 <i>Polysolenia spinosa</i> (Haeckel) group 11H-CC, W48/4 RN4 Bjørklund and Goll, PIO2, fig. 1 <i>Trisolenia megalactis megalactis</i> Ehrenberg 11H-CC, V48/1 RN4 Bjørklund and Goll, PIO2, fig. 2 <i>Trisolenia megalactis megalactis</i> Ehrenberg 17H-CC, V48/1 RN4 Bjørklund and Goll, PIO2, fig. 4 <i>Siphonosphaera</i> sp. A 17H-CC, C441/3 RN4 Bjørklund and Goll, PIO2, fig. 5 <i>Siphonosphaera</i> sp. B 13H-2, 104-106 cm, Q37/3 RN4 Bjørklund and Goll, PIO2, fig. 1 <i>Collosphaera</i> sp. A 13H-CC, C41/3 RN5 Bjørklund and Goll, PIO2, fig. 10 <i>Collosphaera</i> sp. A 13H-C2, C41/1 RN8	13H-2, 104-106 cm, Z20/0 RN5	
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PIO1. fig. 9 Polysolenia murrayana (Haeckel) 11H-CC, T33/3 RN5 Nigrini and Lombari, PIO1. fig. 10 Polysolenia spinosa (Haeckel) group 11H-CC, D20/1 RN4 RN4 Nigrini and Moore, I PIO2. fig. 1 Trisolenia megalactis megalactis Ehrenberg 11H-CC, W48/4 RN4 Bjorklund and Goll, 1 PIO2. fig. 2 Trisolenia megalactis megalactis Ehrenberg 11H-CC, C40/4 RN4 Bjorklund and Goll, 1 PIO2. fig. 4 Siphonosphaera sp. A 17H-CC, C41/3 RN4 Bjorklund and Goll, 1 PIO2. fig. 5 Siphonosphaera sp. A 17H-CC, C41/3 RN4 Bjorklund and Goll, 1 PIO2. fig. 6 Siphonosphaera sp. B 18H-CC, R21/3 RN5 Bjorklund and Goll, 1 PIO2. fig. 7 Siphonosphaera sp. A 18H-CC, R21/3 RN5 Bjorklund and Goll, 1 PIO2. fig. 10 Collosphaera sp. A 18H-CC, S38/4 RN5 Bjorklund and Goll, 1 PIO2. fig. 12 Collosphaera sp. A 18H-2, 104-106 cm, 037/3 RN5 Bjorklund and Goll, 1 PIO2. fig. 12 Collosphaera sp. A 18H-2, 104-106 cm, 037/3 RN5 Bjorklund and	15H-CC, R37/2 RN5 Nigrini and Lombari, 1984	
PI01. fig. 10 Polysolenia spinosa (Haeckel) group 11H-CC, D20/1 RN5 Nigrini and More, 1 PI02. fig. 1 <i>Trisolenia megalactis megalactis</i> Ehrenberg 17H-CC, W48/4 RN4 Bjerklund and Goll, 1 PI02. fig. 2 <i>Trisolenia megalactis megalactis</i> Ehrenberg 17H-CC, V48/1 RN4 Bjerklund and Goll, 1 PI02. fig. 4 <i>Trisolenia megalactis</i> megalactis Ehrenberg 17H-CC, C41/3 RN4 Bjerklund and Goll, 1 PI02. fig. 5 <i>Siphonosphaera</i> sp. A 17H-CC, D22/1 RN4 Bjerklund and Goll, 1 PI02. fig. 6 <i>Siphonosphaera</i> sp. D 18H-CC, R10/1 RN4 Bjerklund and Goll, 1 PI02. fig. 7 <i>Collosphaera glebulenta</i> Bjerklund and Goll 19H-CC, V21/1 RN3 Bjerklund and Goll, 1 PI02. fig. 10 <i>Collosphaera</i> sp. A 15H-CC, R21/3 RN5 Siphonosphaera PI02. fig. 12 <i>Collosphaera</i> sp. A 13H-2, 104-106 cm, 037/3 RN5 Siperklund and Goll, 1 PI02. fig. 12 <i>Collosphaera</i> sp. A 13H-2, 104-106 cm, 037/3 RN5 Siperklund and Goll, 1 PI02. fig. 12 <i>Collosphaera</i> b, A 13H-CC, 15/4	11H-CC, T33/3 RN5 Nigrini and Lombari, 1984	
PI02. fig. 1 Trisolenia megalactis megalactis Ehrenberg 17H-CC, W48/4 RN4 Bjørklund and Goll, 1 PI02. fig. 2 Trisolenia megalactis megalactis Ehrenberg 18H-CC, G40/4 RN4 Bjørklund and Goll, 1 PI02. fig. 3 Trisolenia megalactis megalactis Ehrenberg 17H-CC, V48/1 RN4 Bjørklund and Goll, 1 PI02. fig. 4 Siphonosphaera sp. A 17H-CC, Q42/1 RN4 PI02. fig. 5 Siphonosphaera sp. B 13H-C, C, R10/1 RN4 PI02. fig. 6 Siphonosphaera sp. B 13H-CC, R10/1 RN4 PI02. fig. 7 Siphonosphaera sp. B 13H-CC, R10/1 RN4 PI02. fig. 8 Collosphaera sp. A 13H-CC, R21/3 RN5 PI02. fig. 10 Collosphaera sp. A 13H-CC, R34/3 RN5 PI02. fig. 12 Collosphaera sp. A 13H-CC, R34/3 RN5 PI02. fig. 12 Collosphaera sp. A 13H-CC, R38/4 RN5 PI03. fig. 1 Axoprunum bispiculum (Popofsky) 11H-CC, K30/0 RN5 Takemura, 1992 PI03. fig. 3 Stylosphaera sp. B 13H-CC, D38/0 RN5 Takemura, 1992	11H-CC, D20/1 RN5 Nigrini and Moore, 1979	
PI02. fig. 2 Trisolenia megalactis megalactis Ehrenberg 18H-CC. G40/4 RN4 Bjørklund and Goll, 1 PI02. fig. 3 Trisolenia megalactis ehrenberg 17H-CC, Y48/1 RN4 Bjørklund and Goll, 1 PI02. fig. 4 Siphonosphaera sp. A 17H-CC, Q41/3 RN4 Bjørklund and Goll, 1 PI02. fig. 5 Siphonosphaera sp. A 17H-CC, Q22/1 RN4 PI02. fig. 6 Siphonosphaera sp. D 18H-CC, R10/1 RN4 PI02. fig. 7 Siphonosphaera sp. A 13H-C, Q2/1/1 RN5 PI02. fig. 10 Collosphaera glebulenta Bjørklund and Goll 19H-CC, Q21/1 RN5 Bjørklund and Goll, 1 PI02. fig. 10 Collosphaera sp. A 15H-CC, E36/3 RN5 Bjørklund and Goll, 1 PI02. fig. 11 Collosphaera sp. A 13H-CC, U, J1/4 RN5 Bjørklund and Goll, 10H-CC, S28/4 RN5 PI02. fig. 12 Collosphaera sp. A 13H-CC, C, 42/3 RN5 Bjørklund and Goll, 10H-CC, S38/4 RN5 PI03. fig. 1 Axoprunum bispiculum (Popofsky) 11H-CC, V12/1 RN5 Takemura, 1992 PI03. fig. 3 Stylosphaera sp. B	17H-CC, W48/4 RN4 Bjørklund and Goll, 1979	
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P103, fig. 10 Stylosphaera sp. B 13H-CC, F14/1 RN5 P104, fig. 1 Actinomma robusta (Kling) 10H-CC, G38/0 RN5 Morley and Nigrini, 1 P104, fig. 2 Actinomma robusta (Kling) 10H-CC, G38/0 RN5 Morley and Nigrini, 1 P104, fig. 3 Thecosphaera sp. A 11H-CC, O35/0 RN5 P104, fig. 4 Actinomma robusta (Kling) 13H-2, 104-106 cm, E39/4 RN5 P104, fig. 5 Thecosphaera sp. B 13H-CC, U36/0 RN5 P104, fig. 6 Thecosphaera sp. B 13H-CC, U36/0 RN5 P104, fig. 7 Thecosphaera sp. C 18H-CC, N15/3 RN4 P104, fig. 8 Thecosphaera sp. D 18H-CC, T34/2 RN2 P104, fig. 9 Hexacontium sp. B 20H-CC, U27/3 RN3 P104, fig. 10 Hexacontium cf. arachnoidale Hollande and Enjumet 11H-CC, E21/2 RN5 P104, fig. 11 Saturnalis circularis Haeckel 11H-CC, Q45/4 RN5 P104, fig. 2 Heliodiscus sp. B 15H-CC, X21/1 RN5 P105, fig. 2 Heliodiscus sp. B 15H-CC, Q45/4 RN5 P105, fig. 3 Hexaple dodecantha Haeckel	16H-CC, U45/2 RN5 Campbell and Clark, 1944	
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PI.04, fig. 7 Thecosphaera sp. D 18H-CC, H20/3 RN4 PI.04, fig. 8 Thecosphaera sp. E 25H-CC, T34/2 RN2 PI.04, fig. 9 Hexacontium sp. B 20H-CC, U27/3 RN3 PI.04, fig. 10 Hexacontium cf. arachnoidale Hollande and Enjumet 11H-CC, E21/2 RN5 PI.04, fig. 11 Saturnalis circularis Haeckel 11H-CC, W43/1 RN5 PI.05, fig. 1 Cenosphaera sp. A 15H-CC, Q45/4 RN5 PI.05, fig. 2 Heliodiscus sp. B 15H-CC, X21/1 RN5 PI.05, fig. 3 Hexapyle dodecantha Haeckel 15H-CC, L15/2 RN5 PI.05, fig. 4 Frestradious on an analysis 15H-CC, D13/20 RN5	18H-CC, N15/3 RN4	
PI.04, fig. 8 Thecosphaera sp. E 25H-CC, T34/2 RN2 PI.04, fig. 9 Hexacontium sp. B 20H-CC, U27/3 RN3 PI.04, fig. 10 Hexacontium cf. arachnoidale Hollande and Enjumet 11H-CC, E21/2 RN5 PI.04, fig. 11 Saturnalis circularis Haeckel 11H-CC, W43/1 RN5 PI.05, fig. 2 Heliodiscus sp. B 15H-CC, X21/1 RN5 PI.05, fig. 3 Hexapyle dodecantha Haeckel 15H-CC, X21/1 RN5 PI.05, fig. 4 Fig. 3 Hexapyle dodecantha Haeckel 15H-CC, CP 12/0 RN5	18H-CC, H20/3 RN4	
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PI.04, fig. 10 Hexacontium cf. arachnoidale Hollande and Enjumet 11H-CC, E21/2 RN5 PI.04, fig. 11 Saturnalis circularis Haeckel 11H-CC, E21/2 RN5 PI.04, fig. 11 Saturnalis circularis Haeckel 11H-CC, W43/1 RN5 PI.05, fig. 1 Cenosphaera sp. A 15H-CC, Q45/4 RN5 PI.05, fig. 2 Heliodiscus sp. B 15H-CC, X21/1 RN5 PI.05, fig. 3 Hexapyle dodecantha Haeckel 15H-CC, L15/2 RN5 PI.05, fig. 4 Function on the second	20H-CC, U27/3 RN3	
PI.04, fig. 11 Saturnalis circularis Haeckel 11H-CC, W43/1 RN5 Nishimura and Yama PI.05, fig. 1 Cenosphaera sp. A 15H-CC, Q45/4 RN5 PI.05, fig. 2 Heliodiscus sp. B 15H-CC, X21/1 RN5 PI.05, fig. 3 Hexapyle dodecantha Haeckel 15H-CC, L15/2 RN5 PI.05, fig. 4 Fig. 7 Fig. 7 Fig. 7	11H-CC, E21/2 RN5	
PI.05, fig. 1 Cenosphaera sp. A 15H-CC, Q45/4 RN5 PI.05, fig. 2 Heliodiscus sp. B 15H-CC, X21/1 RN5 PI.05, fig. 3 Hexapyle dodecantha Haeckel 15H-CC, L15/2 RN5 PI.05, fig. 4 Fixed and the second sec	11H-CC, W43/1 RN5 Nishimura and Yamauchi, 1984	984
PI.05, fig. 2 Heliodiscus sp. B 15H-CC, X21/1 RN5 PI.05, fig. 3 Hexapyle dodecantha Haeckel 15H-CC, L15/2 RN5 Haeckel, 1887	15H-CC, Q45/4 RN5	
PI.05, fig. 3 Hexapyle dodecantha Haeckel 15H-CC, L15/2 RN5 Haeckel, 1887	15H-CC, X21/1 RN5	
154-CC $D12/O$ $D15$	15H-CC, L15/2 RN5 Haeckel, 1887	
	15H-CC, R12/0 RN5	
Pl.05, fig. 5 Cenosphaera sp. B 15H-CC, E12/0 RN5	15H-CC, E12/0 RN5	
PI.05. fig. 6 Heliodiscus sp. A 16H-CC. C46/0 RN5	16H-CC, C46/0 RN5	
PL05. fig. 7 Thecosphere sp. E 15H-CC N37/0 RN5	15H-CC, N37/0 RN5	
105. fig. 8 Hexacontium sp. C 15H-CC V37/3 RN5	15H-CC, V37/3 RN5	
105. fig. 9 / Axoprunum sp. A 15H-CC. Q45/4 RN5	15H-CC, Q45/4 RN5	
PI.05. fig. 10 Didymocyrtis violina (Haeckel) 18H-CC. P33/2 RN4 Sanfilippo et al. 198	18H-CC, P33/2 RN4 Sanfilippo <i>et al.</i> , 1985	
PI.05, fig. 11 Didymocyrtis tubaria (Haeckel) 17H-CC, T46/4 RN4 Sanfilipoo et al. 198	17H-CC, T46/4 RN4 Sanfilippo <i>et al.</i> , 1985	

Table 1 Explanation of Plates 1 to 18.

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	Spongurus cylindricus 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	Hexacontium pachydermum Jørgensen	13H-CC, Y40/1	RN5	Petrushevskaya and Kozlova, 1972
Pl.06, fig. 3	Hexalonche sp. A	21H-CC, S23/3	RN3	0 50
PI.06, fig. 4	Didymocyrtis prismatica (Haeckel)	25H-CC, D11/2	RN2	Sanfilippo <i>et al.</i> , 1985
PI.06, fig. 5	Didymocyrtis prismatica (Haeckel)	23H-CC, 031/0	RNZ	Sanfilippo <i>et al.</i> , 1985
PI.00, IIg. 0	Didymocyrtis tubaria (Haeckel)	16H-CC K41/2	RN5	Sanfilippo <i>et al.</i> , 1985
PI.00, fig. 7	Didymocyrtis Lubaria (Haeckel)	10H-CC 1 30/2	RN5	Sanfilippo <i>et al.</i> , 1985
PI06 fig 9	Didymocyrtis mammifera (Haeckel)	13H-2 104-106 cm D23/1	RN5	Sanfilippo <i>et al.</i> , 1985
PI.06, fig. 10	Didymocyrtis bassanii (Carnevale)	25H-CC Y43/0	RN2	Sanfilippo <i>et al.</i> , 1985
Pl.06, fig. 11	<i>Cladococcus dentata</i> (Mast)	17H-CC, 045/1	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	Larcopyle hayesi (Chen) group	19H-CC, W15/2	RN3	Lazarus <i>et al.</i> , 2005
Pl.07, fig. 4	Larcopyle hayesi (Chen) group	23H-CC, C26/0	RN2	Lazarus <i>et al.</i> , 2005
PI.07, fig. 5	Larcopyle sp. C	13H-2, 104-106 cm, M39/0	RN5	
PI.07, fig. 6	Lithelius sp. A	12H-4, 104-106 cm, X27/2	RND	Mataura 1006
PI07 fig. /	Larcopyle polyacaritha (Campbell and Clark)	17H-CC \$14/3		ivioloyama, 1990
PI07 fig. 0	Laicopyie sp. D Lithelius sp. A	16H-CC K31/1	RN5	
PI 07, fig. 10	<i>Lithelius</i> sp. A	15H-CC, Q43/3	RN5	
Pl.07. fig. 11	Lithelius sp. A	23H-CC. N37/1	RN2	
PI.07, fig. 12	Lithelius sp. C	25H-CC, J36/2	RN2	
Pl.07, fig. 13	Larcopyle sp. A	10H-CC, F22/2	RN5	
Pl.07, fig. 14	Larcopyle 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	Larcopyle titan (Campbell and Clark)	15H-CC, F40/0	RN5	Campbell and Clark, 1944
Pl.07, fig. 17	Actinomma sp. B	17H-CC, M44/2	RN4	
Pl.07, fig. 18	Larcospira moschkowskii Kruglikova	10H-CC, V23/0	RN4	Nigrini and Lombari, 1984
Pl.08, fig. 1	Stylodictya sp. A	<u>15H-CC, R43/2</u>	RN4	
Pl.08, fig. 2	Stylodictya sp. A	11H-CC, C14/4	RN4	
PI.08, fig. 3	Stylodictya sp. A	25H-CC, R36/0	RN2	Talashaahi 1001
PI.06, 11g. 4	Spongurus cylindricus Haeckel	1/H=0.0, 510/0 1/H=2, 105=107 am N10/2	RIN4	Comphall and Clark 1944
PI.08, fig. 5	Stylodictya camerina Campbell and Clark	25H-CC T36/2	RN2	Campbell and Clark, 1944
PI08 fig 7	Stylodictya sp. B	15H-CC U34/1	RN5	
Pl.08. fig. 8	Stylodictya camerina Campbell and Clark	15H-CC. Y32/3	RN5	Campbell and Clark, 1944
Pl.08, fig. 9	Amphymenium amphistylium 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	Porodiscus circularis 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	Phacodiscus sp. A	<u>11H-CC, T19/3</u>	RN5	
Pl.08, fig. 15	Dictyocoryne sp. B	16H-CC, V34/0	RN5	D 4000
PI.09, fig. 1	Spongasteriscus marylandicus Martin	25H-CC, D28/0	RN2	Palmer, 1986
PI.09, fig. 2	Hellodiscus sp. C	1/H-CC, E31/0	RN4	
PI.09, IIg. 3	Tetrapyle sp. A	17H-CC C37/1		
PI.09, fig. 4	Dictrocorvne malagaense (Campbell and Clark)	10H-CC G46/3	RN5	Campbell and Clark 1944
PI.09. fig. 6	Spongaster sp. A	13H-CC, J30/1	RN5	
Pl.09, fig. 7	Dictvocorvne sp. A	18H-CC, U32/0	RN4	
Pl.09, fig. 8	Spongopyle osculosa Dreyer	17H-CC, H46/4	RN4	Nigrini and Moore, 1979
Pl.09, fig. 9	Spongodiscus resurgens Ehrenberg	17H-CC, Q31/4	RN4	Petrushevskaya and Kozlova, 1972
Pl.09, fig. 10	Spongodiscus resurgens Ehrenberg	23H-CC, O44/4	RN2	Petrushevskaya and Kozlova, 1972
Pl.09, fig. 11	Spongodiscus resurgens Ehrenberg	23H-CC, O43/4	RN2	Petrushevskaya and Kozlova, 1972
Pl.09, fig. 12	Spongodiscus resurgens Ehrenberg	17H-CC, R29/2	RN4	Petrushevskaya and Kozlova, 1972
Pl.09, fig. 13	Excentrococcus annulatus Dumitrica	<u>16H-CC, H13/4</u>	RN5	Dumitrica, 1978
PI.09, fig. 14	Spongodiscus sp. B	16H-CC, C29/3	RN5	
PI.09, fig. 15	Spongodiscus sp. G	15H-CC, N21/3	RN5	O-ulat 1006
PI 10 fig. 10	Curtocansella tatranera Hacokol	201-00, 004/2 10H-CC 1123/0	RN5	Sakai 1980
PI 10, fig. 1	Cyrtocapsella tetrapera Haeckel	12H-4 104-106 cm W44/1	RN5	Sakai 1980
PI 10 fig 3	Cyrtocapsella japonica (Nakaseko)	17H-CC X10/1	RN4	Sakai 1980
Pl.10. fig. 4	Cyrtocapsella japonica (Nakaseko)	19H-CC, S42/4	RN3	Sakai, 1980
PI.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	Lithopera baueri Sanfilippo and Riedel	13H-2, 104-106 cm, X30/4	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.10, fig. 8	Stichocorys delmontensis (Campbell and Clark)	13H-CC, T33/1	RN5	Sanfilippo <i>et al.</i> , 1985
Pl.10, fig. 9	Lithopera renzae Sanfilippo and Riedel	15H-CC, L37/0	RN5	Sanfilippo <i>et al.</i> , 1985
PI.10, fig. 10	Stichocorys wolffii Haeckel	21H-CC, R41/1	RN3	Sanfilippo <i>et al.</i> , 1985
IPI.10. fig. 11	Lithopera thornburgi Sanfilippo and Riedel	10H-CC. U43/0	IRN5	ISanfilippo <i>et al.</i> , 1985

Plate no.	Species and species group	Location	Zone	Reference
Pl.10, fig. 12	Eucyrtidium sp. A	23H-CC, D38/0	RN2	
Pl 10 fig. 13	Stichocorvs armata (Haeckel)	19H-CC 40/3	RN3	Sanfilippo <i>et al.</i> 1985
Pl.10, fig. 14	Phormocvrtis alexandrae O'Connor	25H-CC, Z39/1	RN2	O'Connor, 1997b
PI 10 fig 15	Eucyrtidium sp. C	17H-CC N12/3	RN4	
PI 10 fig 16	Eucyrtidium cienkowskii Haeckel	10H-CC V9/3	RN5	Sakai 1980
Pl 10, fig. 17	Stichocorvs diaphanes (Sanfilippo and Riedel)	27H-CC C46/1	RN2	Sanfilippo <i>et al.</i> 1985
PI 11 fig. 1	Carpocanium cingulatum (Riedel and Sanfilippo)	18H-CC T15/0	RN4	Nigrini and Lombari 1984
PI 11 fig 2	Carpocanium bramlettei (Riedel and Sanfilippo)	15H-CC E44/1	RN5	Nigrini and Lombari, 1984
PI 11 fig 3	Carpocanium bramlettei (Riedel and Sanfilippo)	10H-CC 744/1	RN5	Nigrini and Lombari, 1984
PI 11 fig 4	Carpacanium sp. B	23H-CC T42/0	RN2	
DI 11 fig 5	Carpacanium kinugasansa Nishimura	10H-CC_\$34/1	RN5	Nishimura 1990
DI 11 fig. 6	Carpacanium kinugasense Nishimura		DNI2	Nichimura, 1000
PI 11 fig. 0	Sinhacamaa an D	174-00, K19/2		Nishihura, 1990
PI.11, IIg. 7	Siphocampe sp. D	17H-00, K16/3	RIN4	0'Company 1007h
PI.II, fig. 8	Sipnocampe grantmackiel O Connor	10H-00, L24/0	RND	O Connor, 1997b
PI.II, fig. 9	Botryostrobus sp. B	10H-CC, M43/0	RN5	
PI.11, fig. 10	Botryostrobus aquilonaris (Balley)	15H-CC, W38/2	RN5	Nigrini and Lombari, 1984
PI.11, fig. 11	Spirocyrtis subtilis Petrushevskaya	12H-4, 104-106 cm, D39/2	RN5	Nigrini and Lombari, 1984
PI.11, fig. 12	Siphostichartus corona (Haeckel)	10H-CC, E20/3	RN5	Nigrini and Lombari, 1984
PI.11, fig. 13	Botryostrobus sp. A	15H-CC, L37/0	RN5	
PI.11, fig. 14	<i>Theocamptra ovata</i> (Haeckel)	16H-CC, 242/0	RN5	Nigrini and Lombari, 1984
PI.11, fig. 15	Siphocampe 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	Phormostichoartus fistula Nigrini	15H-CC, M34/0	RN5	Nigrini and Lombari, 1984
Pl.11, fig. 18	Phormostichoartus fistula Nigrini	11H-CC, K40/0	RN5	Nigrini and Lombari, 1984
Pl.11, fig. 19	<i>Lithocampana</i> sp. A	17H-CC, X10/1	RN4	
Pl.11, fig. 20	Lithocampana sp. B	17H-CC, Y42/1	RN4	
Pl.11, fig. 21	Cycladophora conica Lombari and Lazarus	25H-CC, F36/4	RN2	Lombari and Lazarus, 1988
Pl.12, fig. 1	<i>Calocycletta caepa</i> Moore	16H-CC, N38/4	RN5	Nigrini and Lombari, 1984
PI.12, fig. 2	Calocycletta virginis (Haeckel)	17H-CC, T42/1	RN4	Nigrini and Lombari. 1984
Pl.12, fig. 3	Calocycletta serrata Moore	30H-CC, S38/0	RN2	Nigrini and Lombari, 1984
PI 12 fig 4	Calocycletta costata (Riedel)	14H-CC V39/4	RN5	Nigrini and Lombari 1984
PI 12 fig 5	Calocycletta robusta Moore	31H-CC X43/4	RN2	Nigrini and Lombari, 1984
DI 12 fig 6	Albetraccidium minzek Sanfilippe and Piedel	10H-CC 123/3	DN5	Sanfilinno and Riedal 1992
PI.12, fig. 0	Anthony stilling on A	254-CC V27/2	DNI2	
FI.12, IIg. 7	Anthocyrudium sp. A	25H-00, 137/3		
PI.12, fig. 8	Anthocyrtialum sp. B	25H-CC, 140/1	RINZ	
PI.12, fig. 9	Cyrtolagena sp. A	19H-CC, M26/4	RNJ	
PI.13, fig. 1	Lophocyrtis tanythorax (Sanfilippo and Riedel)	13H-2, 104-106 cm, W25/4	RN5	Sanfilippo and Riedel, 1970
Pl.13, fig. 2	Lophocyrtis tanythorax (Sanfilippo and Riedel)	15H-CC, S38/4	RN5	Sanfilippo and Riedel, 1970
Pl.13, fig. 3	<i>Cinclopyramis pacifica</i> (Nakaseko)	18H-CC, N12/4	RN4	Nakaseko, 1963
Pl.13, fig. 4	<i>Cinclopyramis 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	Lamprocyclas maritalis 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	Theocorys spongoconus Kling	27H-CC, C28/0	RN2	Nigrini and Lombari, 1984
Pl.14, fig. 4	Lamprocyclas sp. B	27H-CC, H49/3	RN2	
Pl.14, fig. 5	Theocorvs sp. A	17H-CC, J22/0	RN4	
PI 14 fig. 6	Clathrocanium atreta Sanfilippo and Riedel	25H-CC C45/1	RN2	Sanfilippo <i>et al.</i> 1973
PI 14 fig. 7	Lithomeliese sp. A	11H-CC D22/0	RN5	
PI 14 fig. 7	Lithomelissa sp. A	12H-4 104-106 cm M39/0	RN5	
DI 1/1 fig. 0	Lanbanhaana sp. A	11H-CC G19/0	DN5	
DI 1/1 fig. 10	Coratogyrtic op A	12H-4 104-106 cm K44/1	DNI5	
DI 1/1 fi~ 11	Lampropulac margatancic Comphell and Clark war A	16H-CC 110/3	DNIE	Campbell and Clark 1944
DI 1/1 fire 10	Linnanolla oppiga Detruchovekova	254-00 720/2	DNIO	Datruchovekave and Kerleye 1070
PI.14, IIg. 12		$23\Pi^{-}00, 120/3$		O'Oswaya 1007s
DI 14 5 14	Lophophaena Lekopua O Connor	1211-4, 104-100 cm, X30/2	CN7	
PI.14, fig. 14	Lopnopnaena tekopua O Connor	25H-CC, L40/4	RINZ	U Connor, 1997a
PI.14, fig. 15	Clathrocanium coarctatum Ehrenberg	10H-GG, 240/0	RN5	Takanashi, 1991
PI.15, fig. 1	Pterocanium audax (Riedel)	14H-2, 105-107 cm, G17/3	RN5	Nigrini and Lombari, 1984
PI.15, fig. 2	Pterocanium audax (Riedel)	23H=CC, J20/1	RN2	Nigrini and Lombari, 1984
PI.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	Lychnocanoma sp. A	23H-CC, E29/2	RN2	
Pl.16, fig. 3	Lychnocanoma sp. A	27H-CC, H41/1	RN2	
Pl.16, fig. 4	Lychnocanoma nodosum (Haeckel)	21H-CC, S28/4	RN3	Haeckel, 1887
PI.16, fig. 5	Lychnocanoma nodosum (Haeckel)	18H-CC, U41/3	RN4	Haeckel, 1887
Pl.16, fig. 6	Dictyophimus splendens (Campbell and Clark)	11H-CC, W43/1	RN5	Morley and Nigrini 1995
Pl.16. fig. 7	Dictyophimus sp. A	17H-CC D12/0	RN4	
PL16 fig 8	Valkvria pukapuka O'Connor	15H-CC W44/1	RN5	O'Connor 1997a
PI 16 fig 0	Valkyria pukapuka O'Connor	13H-CC D41/2	RN5	O'Coppor 1997a
DI 17 fi~ 1	Darcadospuris dentata Happikal	18H-CC 1111/0	RNI/	Sanfilinno <i>et al</i> 1085
DI 17 fi~ 0	Dereadespyris dericata Haconei	16H-3 140-151 am D44/0	DNE	Sanfilippo <i>et al.</i> , 1900
	Developmente atauatua (Riedel)	1011-3, 149-131 CM, D44/U	CIND	Santilippo <i>et al.</i> , 1960
டா. ட, ாg. 3	Dorcauospyris ateucnus (Enrenberg)	Z/NTU, U40/ I	RINZ	Sammippo <i>et al.</i> , 1985

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

Table 1 Continued.

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, Calocycletta caepa, Calocycletta robusta, Carpocanium cingulatum, Centrobotrys petrushevskayae, Collosphaera brattstroemi, Dendrospyris pannosa, Didymocyrtis laticonus, Didymocyrtis tubaria, Dorcadospyris alata, Eucoronis octopylus, Hexapyle dodecantha, Liriospyris parkerae, Lithopera thornburgi, Lophocyrtis tanythorax, Lychnocanoma elongata, Polysolenia spinosa, Pterocanium audax, Stichocorys armata, Stichocorys wolffii, Tholospyris anthophora, Trisolenia megalactis costlowi) and 31 cosmopolitan taxa (e.g. Actinomma robusta, Amphisphaera neptunus, Amphymenium amphistylium, Axoprunum bispiculum, Botryostrobus aquilonaris, Cinclopyramis pacifica, Cladococcus dentata, Cycladophora conica, Cyrtocapsella japonica, Dictyophimus splendens, Lamprocyclas margatensis, Larcopyle polyacantha, Lipmanella conica, Lophocyrtis aspera, Stylodictya *camerina*, *Theocamptra ovata*).

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References

- Bjørklund, K. R. and Goll, R. M. (1979) Internal skeletal structures of Collosphaera and Trisolenia: a case of repetitive evolution in the Collosphaeridae (Radiolaria). *Jour. Paleontol.*, **53**, 1293–1326.
- Campbell, A. S. and Clark, B. L. (1944) Miocene radiolarian faunas from southern California. *Geol. Soc. Amer., Spec. Pap.*, no. 51, 1–76.
- Caulet, J. P. (1986) Radiolarians from the southwest Pacific. In Kennett, J. P., von der Borch, C. C. et al., eds., Init. Repts. DSDP, 90, Washington (U.S. Government Printing Office), 835–861.
- Chavez, F. P. and Barber, R. T. (1987) An estimate of new production in the equatorial Pacific. *Deep-Sea Res. Pt. A*, **34**, 1229–1243.
- Clark, B. L. and Campbell, A. S. (1942) Eocene radiolarian faunas from the Mt. Diablo area, California. *Geol. Soc. Amer., Spec. Pap.*, no. 39, 1–112.
- Dumitrica, P. (1978) Badenian Radiolaria from Central Paratethys. In Brestenska, E., ed., Chronostratigraphie und Neostratotypen Miozän der Zentralen Paratethys,

6, VEDA, Bratislava, 231–261.

- Ehrenberg, C. G. (1873) Grössere Felsproben des Polycystinen-Mergels von Barbados mit weiteren Erläuterungen. K. Preuss. Akad. Wiss. Berlin, Monatsberichte, 1873, 213–263.
- Fiedler, P. C. and Talley, L. D. (2006) Hydrography of the eastern tropical Pacific: A review. Progress in Oceanography, 69, 143–180.
- Goll, R. M. (1969) Classification and phylogeny of Cenozoic Trissocyclidae (Radiolaria) in the Pacific and Caribbean basins, Part II. *Jour. Paleontol.*, 43, 322–339.
- Haeckel, E. (1887) Report on the Radiolaria collected by H.M.S. Challenger during the years 1873–1876. *Rep. Sci. Results Voy. H.M.S. Challenger, 1873–1876, Zool.*, 18, 1–1803.
- Haslett, S. and Funnell, B. M. (1996) Sea-surface temperature variation and palaeo-upwelling throughout the Plio-Pleistocene Olduvai subchron of the eastern equatorial Pacific: an analysis of radiolarian data from ODP sites 677, 847, 850 and 851. *In* Moguilevsky, A., Whatley, R., eds, *Microfossils and oceanic environments*, University of Wales, Aberystwyth-Press, Aberystwyth, United Kingdom, 155–164.
- Kamikuri, S. (2010) New late Neogene radiolarian species from the middle to high latitudes of the North Pacific. *Revue de Micropaléontologie*, **53**, 85–106.
- Kamikuri, S., Motoyama, I., Nishi, H. and Iwai, M. (2009) Evolution of Eastern Pacific Warm Pool and upwelling processes since the middle Miocene based on analysis of radiolarian assemblages: Response to Indonesian and Central American Seaways. *Palaeogeogr.*, *Palaeoclimatol.*, *Palaeoecol.*, **280**, 469–479.
- Keller, G. and Barron, J. A. (1983) Paleoceanographic implications of Miocene deep-sea hiatuses. *Geol. Soc. Amer.*, *Bull.* 94, 590–613.
- Kessler, W. (2006) The circulation of the eastern tropical Pacific: A review. *Progress in Oceanography*, 69, 181–217.
- Lazarus, D., Scherer, R. P. and Prothero, D. R. (1985) Evolution of the radiolarian species-complex Pterocanium: a preliminary survey. *Jour. Paleontol.*, 59, 183–220.
- Lazarus, D., Faust, K. and Popova-Goll, I. (2005) New species of prunoid radiolarians from the Antarctic Neogene. *Jour. Micropalaeontol.*, 24, 97–121.
- Lombari, G. and Lazarus, D. B. (1988) Neogene cycladophorid radiolarians from North Atlantic, Antarctic, and North Pacific deep-sea sediments. *Micropaleontology*, 34, 97–135.
- Molina-Cruz, A. (1977) Radiolarian assemblages and their relationship to the oceanography of the subtropical S. E. Pacific. *Marine Micropaleontol.*, 2, 315–352.
- Moore, T. C. Jr., Hutson, W. H., Kipp, N., Hays, J. D., Prell, W., Thompson, P. and Boden, G. (1981) The biological record of the ice-age ocean. *Palaeogeogr.*,

Palaeoclimatol., Palaeoecol., 35, 357-370.

- Morley, J. J. and Nigrini, C. (1995) Miocene to Pleistocene radiolarian biostratigraphy of North Pacific Sites 881, 884, 885, 886 and 887. *In* Rea, D. K., Basov, I. A., Scholl, D. W. and Allan, J. F., eds., *Proc. ODP*, *Sci. Res.*, 145, College Station, TX (Ocean Drilling Program), 55–91.
- Motoyama, I. (1996) Late Neogene radiolarian biostratigraphy in the subarctic Northwest Pacific. *Micropaleontology*, **42**, 221–262.
- Nakaseko, K. (1963) Neogene Cyrtoidea (Radiolaria) from the Isozaki Formation in Ibaraki Prefecture, Japan. *Sci. Rep., Osaka Univ., Gen. Stud.*, **12**, 165–198.
- Nigrini C. and Lombari, G. (1984) A guide to Miocene Radiolaria. Cushman Found. Foram. *Res., Spec. Pub.*, no. 22, S1-S102, N1-N206.
- Nigrini, C. and Moore, T. C., Jr. (1979) A guide to modern Radiolaria. Cushman Found. Foram. *Res., Spec. Pub.*, no. 16, S1-S142, N1-N106.
- Nishimura, A. and Yamauchi, M. (1984) Radiolarians from the Nankai Trough in the Northwest Pacific. *News Osaka Micropaleontol., Spec. Vol.*, no. 6, 1–148.
- Nishimura, H. (1990) Taxonomic study on Cenozoic Nassellaria (Radiolaria). Sci. Rep. Inst. Geosc. Univ. Tsukuba, Sect. B, Geol. Sci., 11, 69–172.
- O'Connor, B. (1997a) New radiolarian from the Oligocene and early Miocene of Northland, New Zealand. *Micropaleontology*, **43**, 63–100.
- O'Connor, B. (1997b) Lower Miocene Radiolaria from Te Koputa Point, Kaipara Harbour, New Zealand. *Micropaleontology*, **43**, 101–128.
- Palmer, A. A. (1986) Miocene radiolarian biostratigraphy, U.S. mid-Atlantic Coastal Plain. *Micropaleontology*, 32, 19–31.
- Pennington, J. T., Mahoney, K. L., Kuwahara, V. S., Kolber, D. D., Calienes, R., Chavez, F. P. (2006) Primary production in the eastern tropical Pacific: A review. *Progress in Oceanography*, **69**, 285–317.
- Petrushevskaya, M. G. and Kozlova, G. E. (1972) Radiolaria, Leg 14, Deep Sea Drilling Project. *In* Hayes, D. E., Pimm, A. C., *et al.*, *Init. Repts. DSDP*, 14, Washington (U.S. Govt. Printing Office), 495–648.
- Petrushevskaya, M. G. and Kozlova, G. E. (1979) Opisanie rodov i vidov radiolyarii. *Issledovaniya Fauny Morei*, 23, 86–157.
- Popofsky, A. (1917) Die Collosphaeriden der Deutschen Sudpolar-Expedition 1901–1903. Mit Nachtrag zu den Spumellarien und Nassellarien. Deutsche Sudpolar-Expedition 1901–1903, Zoologie II, 16, 235–278.
- Pälike, H., Nishi, H., Lyle, M., Raffi, I., Gamage, K., Klaus, A. and the Expedition 320/321 Scientists (2010) Expedition 320/321 summary. *In* Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A. and the Expedition 320/321 Scientists, *Proc. Integrated Ocean Drilling Program 320/321*, Tokyo (Integrated Ocean Drilling Program Management International,

Inc.), 1–141.

- Pälike, H., Nishi, H., Lyle, M. and the Expedition 320/321 Scientists (2012) A Cenozoic record of the equatorial Pacific carbonate compensation depth. *Nature*, 488, 609–614.
- Reynolds R. A. (1980) Radiolarians from the western North Pacific, Leg 57, Deep Sea Drilling Project. *In* Scientific Party, *Init. Repts. DSDP*, **56/57**, Washington (U.S. Govt. Printing Office), 735–769.
- Riedel, W. R. and Sanfilippo, A. (1978) Stratigraphy and evolution of tropical Cenozoic radiolarians. *Micropaleontology*, 24, 61–96.
- Sakai, T. (1980) Radiolarians from Sites 434, 435, and 436, Northwest Pacific, Leg 56, Deep Sea Drilling Project. *In Scientific Party, Init. Repts. DSDP*, 56/57, Washington (U.S. Govt. Printing Office), 695–733.
- Sanfilippo, A. and Caulet, J. -P. (1998) Taxonomy and evolution of Paleogene Antarctic and tropical Lophocyrtid radiolarians. *Micropaleontology*, **44**, 1–43.
- Sanfilippo, A. and Riedel, W. R. (1970) Post-Eocene "closed" theoperid radiolarians. *Micropaleontology*, 16, 446–462.
- Sanfilippo, A. and Riedel, W. R. (1992) The origin and evolution of Pterocorythidae (Radiolaria): A Cenozoic phylogenetic study. *Micropaleontology*, **38**, 1–36.
- Sanfilippo, A., Burckle, L. H., Martini, E. and Riedel, W. R. (1973) Radiolarians, diatoms, silicoflagellates and calcareous nannofossils in the Mediterranean

Neogene. Micropaleontology, 19, 209–234.

- Sanfilippo, A., Caulet, J.- P. and Riedel, W. R. (1978) Radiolaria from Mediterranean sediments, DSDP Leg 42A. In Hsu, K. J., Montadert, L., et al., Init. Repts. DSDP, 42A, Washington (U.S. Govt. Printing Office), 753–760.
- Sanfilippo, A., Westberg-Smith, M. J. and Riedel, W. R. (1985) Cenozoic radiolaria. *In* Bolli, H. M., Saunders, J. B. and Perch-Nielsen, K., eds., *Plankton Stratigraphy*, Cambridge University Press, Cambridge, UK, 631–712.
- Takahashi, K. (1991) Radiolaria: flux, ecology, and taxonomy in the Pacific and Atlantic. Ocean Biocoenosis Series, Woods Hole Oceanographic Institution, 1–303.
- Takemura, A. (1992) Radiolarian Paleogene biostratigraphy in the Southern Indian Ocean, Leg 120. *In* Wise, S. W., Jr., Schlich, R., *et al.*, *Proc. ODP, Sci. Res.*, **120**, College Station, TX (Ocean Drilling Program), 735–756.
- Zachos, J. C., Pagani, M., Sloan, L., Thomas, E. and Billups, K. (2001) Trends, rhythms, and aberrations in global climate 65 Ma to present. *Science*, **292**, 686–693.

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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Stylodictyidae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: *Trisolenia 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 Enjumet; 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: *Hexacontium* 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 amphistylium* 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 Lombari 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: Calocyclura 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.



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



Plate 18 Illustrations of the encountered radiolarians. 1, 2: *Tympanomma binoctonum* (Haeckel); 3, 4: *Tholospyris anthophora* (Haeckel); 5: *Dendrospyris pannosa* Goll; 6: *Tholospyris mammillaris* (Haeckel); 7: *Tholospyris kantiana* (Haeckel); 8: *Tympanomma tuberosum* (Haeckel); 9: *Liriospyris mutuaria* 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 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.