

Late autumn living radiolarian fauna from sub-tropical surface waters in the East China Sea off Sesoko Island, Okinawa, southwest Japan

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Abstract

Scanning electron microscopic images of about 60 radiolarian species from sub-tropical surface waters in the East China Sea are illustrated. This data set represents a late autumn radiolarian fauna around Sesoko Island, Okinawa, southwest Japan. Dominant species include *Collosphaera tuberosa* Haeckel, *Diplosphaera hexagonalis* Haeckel, *Arachnospaera myriacantha* Haeckel, *Rhizosphaera trigonacantha* Haeckel, *Actinosphaera capillacea* (Haeckel), *Spongospaera streptacantha* Haeckel, *Hexacontium hostile* Cleve, *Tetrapyle octacantha* Müller, *Didymocyrtis tetrathalamus tetrathalamus* (Haeckel), *Flustrella dujardinii* Haeckel, *Spongaster tetras tetras* Ehrenberg, *Spongodiscus biconcavus* Haeckel, *Dictyocoryne truncatum* (Ehrenberg), *Dictyocoryne profunda* Ehrenberg, *Euchitonia elegans* (Ehrenberg), *Acanthodesmia vinculata* Müller, *Pseudocubus obeliscus* Haeckel, *Peromelissa phalacra* Haeckel, *Lophophaena hispida* (Ehrenberg), *Pterocanium praetextum praetextum* (Ehrenberg), *Spirocyclitis scalaris* Haeckel, and *Botryocyrtis scutum* (Harting).

Key words: living Radiolaria, Kuroshio Current, East China Sea, Sesoko Island, Okinawa

Introduction

The Okinawa plankton workshops known as “Radiolarian Tours” have been conducted annually since 1997 at the Sesoko Station of the Tropical Biosphere Research Center, University of the Ryukyus in Motobu Town, Okinawa. More than 100 plankton specialists and students have participated in the workshops for research and discussion on marine plankton. This activity includes sampling by a research vessel, microscopic observations, and an introduction to a wide variety of techniques for living plankton research. Several scientific results have been obtained from the workshops (Suzuki and Sugiyama, 2001; Takahashi et al., 2003; Suzuki, 2005; Sugiyama et al., 2008). Some radiolarian species have already been reported (Matsuoka, 1993) but the majority have not been illustrated. This paper shows scanning electron microscopic images of the near complete radiolarian assemblage encountered in a late autumn season and can be used as a pictorial guidebook for “Radiolarian Tours” together with the previous publications devoted to the methods and instruments for living radiolarian study (Matsuoka, 2002, 2007).

Materials

Living radiolarians were collected using a 44-µm opening plankton net from a research vessel at a site about 3 km

south of the Sesoko Station in Motobu Town, Okinawa (Fig. 1). Plankton sampling was conducted on December 1st and 4th in 2006 (samples 20061201 and 20061204, respectively) by short duration (ca. 3 min.) surface tows in the East China Sea influenced by the warm-water Kuroshio Current. The plankton samples were placed in ca. 50% sulfuric acid for a day to eliminate the organic matter from radiolarian skeletons. Following this, residues were rinsed and dried. Radiolarian specimens were picked from the dried residues and mounted on aluminum stubs for observation by a scanning electron microscope (SEM, JEOL JSM-5310LV). Two hundred sixty SEM images were taken for each sample.

Radiolarian fauna

Table 1 lists radiolarian species from samples 20061201 and 20061204; SEM images of the radiolarian faunas are illustrated in Fig. 2 and Fig. 3, respectively.

Forty-six radiolarian species were identified in sample 20061201. Abundant and commonly occurring species include *Collosphaera tuberosa* Haeckel, *Arachnospaera myriacantha* Haeckel, *Rhizosphaera trigonacantha* Haeckel, *Actinosphaera capillacea* (Haeckel), *Spongospaera streptacantha* Haeckel, *Hexacontium hostile* Cleve, *Tetrapyle octacantha* Müller, *Didymocyrtis tetrathalamus tetrathalamus* (Haeckel),

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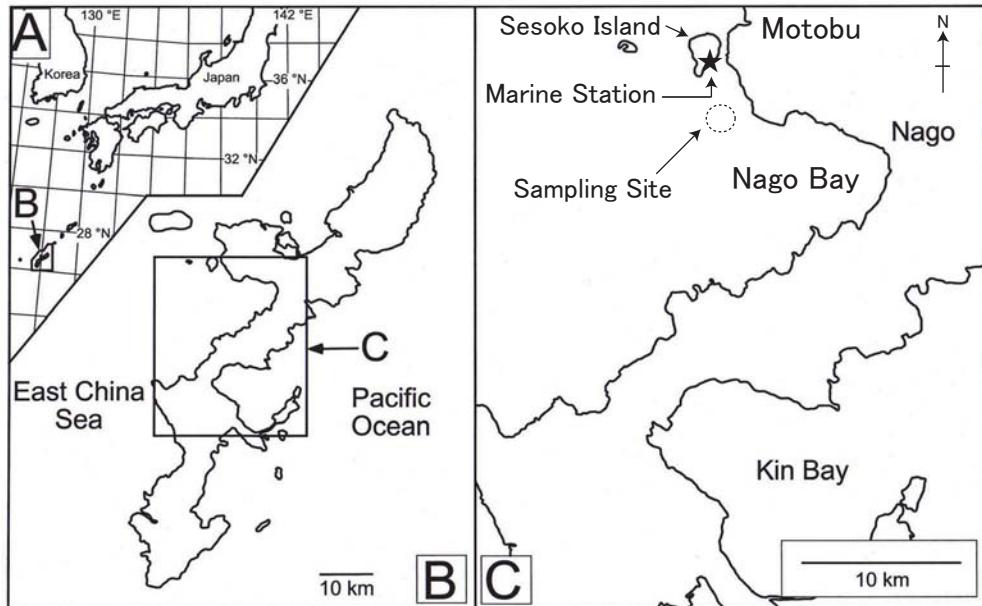


Fig. 1. Index map showing the sampling site.

Flustrella dujardinii Haeckel, *Spongaster tetras tetras* Ehrenberg, *Spongodiscus biconcavus* Haeckel, *Dictyocoryne truncatum* (Ehrenberg), *Dictyocoryne profunda* Ehrenberg, and *Euchitonia elegans* (Ehrenberg).

Forty-one radiolarian species were recovered from sample 20061204. Abundant and commonly occurring species include *Diplosphaera hexagonalis* Haeckel, *Actinosphaera capillacea* (Haeckel), *Hexacodium hostile* Cleve, *Tetrapyle octacantha* Müller, *Didymocystis tetrathalamus tetrathalamus* (Haeckel), *Spongaster tetras tetras* Ehrenberg, *Dictyocoryne profunda* Ehrenberg, *Euchitonia elegans* (Ehrenberg), *Acanthodesmia vinculata* Müller, *Pseudocubus obeliscus* Haeckel, *Peromelissa phalacra* Haeckel, *Lophophena hispida* (Ehrenberg), *Arachnocorys pentacantha* Popofsky, *Pterocanium praetextum praetextum* (Ehrenberg), *Spirocystis scalaris* Haeckel, and *Botryocystis scutum* (Harting).

Both samples are similar in species diversity; however, specific compositions are slightly different. Spumellarian and entactinarian taxa are more common in sample 20061201, while nassellarian species are richer in sample 20061204. Dominant species in both samples are *Tetrapyle octacantha* Müller, *Didymocystis tetrathalamus tetrathalamus* (Haeckel), *Spongaster tetras tetras* Ehrenberg, *Dictyocoryne profunda* Ehrenberg, and *Euchitonia elegans* (Ehrenberg).

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plankton sampling. Sample 20061201 was collected by T. Kurihara and K. Kimoto; SEM images were taken by E. Tomokiya. The manuscript was reviewed by E.S. Carter and N. Suzuki who gave the author useful comments on the manuscript. Constructive remarks on radiolarian taxonomy and identification from N. Suzuki and K. Ogane greatly improved this article. This work is supported by a Grant-in-Aid for Scientific Research no. 18340156 of the Japan Society of Promotion of Science.

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Table 1. List of radiolarian species obtained in samples 20061201 and 20061204. Codes for abundance are as follows: XXXX abundant, XXX common, XX few, X rare.

SPUMMELLARIA & ENTACTINARIA	20061201	20061204
<i>Collosphaera tuberosa</i> Haeckel	XXXX	XX
<i>Plegmosphaera lepticali</i> Renz	XX	XX
<i>Styptosphaera spongiacea</i> Haeckel	XX	XX
<i>Plegmosphaera pachypila</i> Haeckel	XX	
<i>Cladococcus bifurcus</i> Haeckel	X	
<i>Diplosphaera hexagonalis</i> Haeckel	X	XXX
<i>Cladococcus cervicornis</i> Haeckel	XX	
<i>Arachnospaera myriacantha</i> Haeckel	XXX	
<i>Spongospaera helioides</i> Haeckel	X	
<i>Actinoma archadophorum</i> Haeckel	XX	
<i>Rhizospaera trigonacantha</i> Haeckel	XXX	XX
<i>Hexalonche amphisiphon</i> Haeckel	X	
<i>Actinosphaera capillacea</i> (Haeckel)	XXXX	XXX
<i>Spongospaera streptacantha</i> Haeckel	XXX	X
<i>Hexacontium hostile</i> Cleve	XXX	XXX
<i>Hexacromyum elegans</i> Haeckel		XX
<i>Thecosphaera inermis</i> (Haeckel)	X	
<i>Lithelius alveolina</i> Haeckel		X
<i>Tetrapyle octacantha</i> Müller	XXXX	XXXX
<i>Larcospira quadrangula</i> Haeckel	X	
<i>Tholospira cervicornis</i> Haeckel	X	XX
<i>Didymocyrtis tetrathalamus cornatus</i> (Haeckel)	X	
<i>Didymocyrtis tetrathalamus tetrathalamus</i> (Haeckel)	XXXX	XXXX
<i>Frustrella dujardini</i> Haeckel	XXX	XX
<i>Spongaster tetras irregularis</i> Nigrini	XX	
<i>Spongaster tetras tetras</i> Ehrenberg	XXX	XXX
<i>Spongodiscus biconcavus</i> Haeckel	XXXX	XX
<i>Myelastrum trinibrachium</i> Takahashi	X	
<i>Dictyocoryne truncatum</i> (Ehrenberg)	XXXX	XX
<i>Dictyocoryne profunda</i> Ehrenberg	XXXX	XXXX
<i>Amphirhopalum ypsilon</i> Haeckel	X	
<i>Euchitonia elegans</i> (Ehrenberg)	XXXX	XXXX
NASSELLARIA		
<i>Zygocircus productus</i> (Hertwig)		X
<i>Acanthodesmia vinculata</i> Müller	XX	XXXX
<i>Lophospyris pentagona pentagona</i> (Ehrenberg)		XX
<i>Pseudocubus obeliscus</i> Haeckel		XXX
<i>Verticillata pinanatum</i> (Haeckel)		X
<i>Callimitra emmae</i> Haeckel		X
<i>Peromelissa phalacra</i> Haeckel	XX	XXXX
<i>Lophophaena cylindrica</i> (Cleve)	X	XX
<i>Lophophaena hispida</i> (Ehrenberg)	X	XXXX
<i>Arachnocorys pentacantha</i> Popofsky	X	XXX
<i>Arachnocorys araneosa</i> Haeckel	X	XX
<i>Eucecryphalus sestrodiscus</i> (Haeckel)	XX	XX
<i>Theocorys veneris</i> Haeckel	XX	
<i>Pterocanium praetextum praetextum</i> (Ehrenberg)	XX	XXX
<i>Pterocanium trilobum</i> Haeckel	X	X
<i>Lipmanella dictyoceras</i> (Haeckel)	X	XX
<i>Lipmanella pyramidale</i> Popofsky	X	
<i>Eucyrtidium hexagonatum</i> Haeckel	XX	X
<i>Litharachnum eupilium</i> (Haeckel)		X
<i>Pterocorys zancleus</i> Müller		XX
<i>Pterocorys campanula</i> Haeckel		XX
<i>Theocorythium trachelium trachelium</i> (Ehrenberg)	XX	
<i>Anthocyrtidium ophirensse</i> (Ehrenberg)	XX	X
<i>Carpocanium amphora</i> (Haeckel)	X	
<i>Spirocyrta scalaris</i> Haeckel		XXX
<i>Botryocyrta scutum</i> (Harting)		XXX

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Table 2. Explanation of Figs. 2 and 3.

20061201		20061204	
<i>Collosphaera tuberosa</i> Haeckel	Fig. 2-1	<i>Collosphaera tuberosa</i> Haeckel	Fig. 3-1
<i>Plegmosphaera lepticali</i> Renz	Fig. 2-2	<i>Plegmosphaera lepticali</i> Renz	Fig. 3-2
<i>Styptosphaera spongiacea</i> Haeckel	Fig. 2-3	<i>Arachnospaera myriacantha</i> Haeckel	Fig. 3-3
<i>Plegmosphaera pachypila</i> Haeckel	Fig. 2-4	<i>Diplosphaera hexagonalis</i> Haeckel	Fig. 3-4
<i>Cladococcus bifurcus</i> Haeckel	Fig. 2-5	<i>Stylosphaera melpomene</i> Haeckel	Fig. 3-5
<i>Diplosphaera macrodorus</i> (Haeckel)	Fig. 2-6	<i>Hexacromy whole</i> Haeckel	Fig. 3-6
<i>Diplosphaera hexagonalis</i> Haeckel	Fig. 2-7	<i>Hexacontium hostile</i> Cleve	Fig. 3-7
<i>Cladococcus cervicornis</i> Haeckel	Fig. 2-8	<i>Hexacontium</i> sp.	Fig. 3-8
<i>Arachnospaera myriacantha</i> Haeckel	Fig. 2-9	<i>Actinosphaera capillacea</i> (Haeckel)	Fig. 3-9
<i>Spongospaera helioides</i> Haeckel	Fig. 2-10	<i>Plegmosphaera pachypila</i> Haeckel	Fig. 3-10
<i>Actinomma archadophorum</i> Haeckel	Fig. 2-11	<i>Spongospaera streptacantha</i> Haeckel	Fig. 3-11
<i>Rhizospaera trigonacantha</i> Haeckel	Fig. 2-12	<i>Octodendron</i> sp.	Fig. 3-12
<i>Hexalonche amphisiphon</i> Haeckel	Fig. 2-13	<i>Rhizospaera trigonacantha</i> Haeckel	Fig. 3-13
<i>Hexalonche amphisiphon</i> Haeckel	Fig. 2-14	<i>Rhizospaera trigonacantha</i> Haeckel	Fig. 3-14
<i>Actinosphaera capillacea</i> (Haeckel)	Fig. 2-15	<i>Sponguridae?</i> gen. et sp. indet.	Fig. 3-15
<i>Spongospaera streptacantha</i> Haeckel	Fig. 2-16	<i>Litheius alveolina</i> Haeckel	Fig. 3-16
<i>Hexacontium hostile</i> Cleve	Fig. 2-17	<i>Tetrapyle octacantha</i> Müller	Fig. 3-17
<i>Hexacontium</i> sp.	Fig. 2-18	<i>Tholospira cervicornis</i> Haeckel	Fig. 3-18
<i>Thecosphaera inermis</i> (Haeckel)	Fig. 2-19	<i>Hexapyle</i> sp.	Fig. 3-19
<i>Tholospira</i> sp.	Fig. 2-20	<i>Didymocystis tetrathalamus tetrathalamus</i> (Haeckel)	Fig. 3-20
<i>Tetrapyle octacantha</i> Müller	Fig. 2-21	<i>Didymocystis tetrathalamus tetrathalamus</i> (Haeckel)	Fig. 3-21
<i>Larcospira quadrangula</i> Haeckel	Fig. 2-22	<i>Didymocystis tetrathalamus tetrathalamus</i> (Haeckel)	Fig. 3-22
<i>Didymocystis tetrathalamus cornutus</i> (Haeckel)	Fig. 2-23	<i>Didymocystis tetrathalamus tetrathalamus</i> (Haeckel)	Fig. 3-23
<i>Didymocystis tetrathalamus tetrathalamus</i> (Haeckel)	Fig. 2-24	<i>Didymocystis tetrathalamus tetrathalamus</i> (Haeckel)	Fig. 3-24
<i>Sponguridae?</i> gen. et sp. indet.	Fig. 2-25	<i>Didymocystis tetrathalamus tetrathalamus</i> (Haeckel)	Fig. 3-25
<i>Sponguridae?</i> gen. et sp. indet.	Fig. 2-26	<i>Didymocystis tetrathalamus tetrathalamus</i> (Haeckel)	Fig. 3-26
<i>Flustrella dujardinii</i> Haeckel	Fig. 2-27	<i>Spongodiscus</i> sp.	Fig. 3-27
<i>Spongodiscus</i> sp.	Fig. 2-28	<i>Stylodictya arachinia</i> (Müller)	Fig. 3-28
<i>Spongaster tetras irregularis</i> Nigrini	Fig. 2-29	<i>Flustrella dujardinii</i> Haeckel	Fig. 3-29
<i>Spongaster tetras tetras</i> Ehrenberg	Fig. 2-30	<i>Spongodiscidae</i> gen. et sp. indet.	Fig. 3-30
<i>Spongodiscus biconcavus</i> Haeckel	Fig. 2-31	<i>Spongodiscus biconcavus</i> Haeckel	Fig. 3-31
<i>Myelastrum trinibrachium</i> Takahashi	Fig. 2-32	<i>Spongaster tetras tetras</i> Ehrenberg	Fig. 3-32
<i>Dictyocoryne truncatum</i> (Ehrenberg)	Fig. 2-33	<i>Dictyocoryne profunda</i> Ehrenberg	Fig. 3-33
<i>Dictyocoryne profunda</i> Ehrenberg	Fig. 2-34	<i>Dictyocoryne truncatum</i> (Ehrenberg)	Fig. 3-34
<i>Amphirhopalum ypsilon</i> Haeckel	Fig. 2-35	<i>Euchiton elegans</i> (Ehrenberg)	Fig. 3-35
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-36	<i>Zygocircus productus</i> (Hertwing)	Fig. 3-36
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-37	<i>Acanthodesmia vinculata</i> Müller	Fig. 3-37
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-38	<i>Lophospyris pentagona pentagona</i> (Ehrenberg)	Fig. 3-38
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-39	<i>Lophospyris pentagona pentagona</i> (Ehrenberg)	Fig. 3-39
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-40	<i>Pseudocubus obeliscus</i> Haeckel	Fig. 3-40
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-41	<i>Verticillata pinanatum</i> (Haeckel)	Fig. 3-41
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-42	<i>Callimitra emmae</i> Haeckel	Fig. 3-42
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-43	<i>Arachnocorys pentacantha</i> Popofsky	Fig. 3-43
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-44	<i>Arachnocorys pentacantha</i> Popofsky	Fig. 3-44
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-45	<i>Arachnocorys araneosa</i> Haeckel	Fig. 3-45
<i>Euchiton elegans</i> (Ehrenberg)	Fig. 2-46	<i>Peromelissa phalacra</i> Haeckel	Fig. 3-46
<i>Euchiton</i> sp.	Fig. 2-47	<i>Lophophaeina cylindrica</i> (Cleve)	Fig. 3-47
<i>Acanthodesmia vinculata</i> Müller	Fig. 2-48	<i>Lophophaeina hispida</i> (Ehrenberg)	Fig. 3-48
<i>Peromelissa phalacra</i> Haeckel	Fig. 2-49	<i>Lipmanella</i> (?) sp.	Fig. 3-49
<i>Lophophaeina</i> sp.	Fig. 2-50	<i>Litharachnium eupilum</i> (Haeckel)	Fig. 3-50
<i>Lophophaeina cylindrica</i> (Cleve)	Fig. 2-51	<i>Pterocanium praetextum praetextum</i> (Ehrenberg)	Fig. 3-51
<i>Lophophaeina hispida</i> (Ehrenberg)	Fig. 2-52	<i>Pterocanium trilobum</i> (Haeckel)	Fig. 3-52
<i>Arachnocorys pentacantha</i> Popofsky	Fig. 2-53	<i>Pterocanium</i> sp.	Fig. 3-53
<i>Arachnocorys araneosa</i> Haeckel	Fig. 2-54	<i>Pseudodictyophimus gracilipes</i> (Bailey)	Fig. 3-54
<i>Eucecrysphalus sestrodiscus</i> (Haeckel)	Fig. 2-55	<i>Eucecrysphalus sestrodiscus</i> (Haeckel)	Fig. 3-55
<i>Theocorys veneris</i> Haeckel	Fig. 2-56	<i>Lampromitira</i> (?) sp.	Fig. 3-57
<i>Pterocanium praetextum praetextum</i> (Ehrenberg)	Fig. 2-57	<i>Lipmanella dicyoceras</i> (Haeckel)	Fig. 3-58
<i>Pterocanium trilobum</i> Haeckel	Fig. 2-58	<i>Eucyrtidium hexagonatum</i> Haeckel	Fig. 3-59
<i>Lipmanella dictyoceras</i> (Haeckel)	Fig. 2-59	<i>Pterocorys zancleus</i> (Haeckel)	Fig. 3-60
<i>Lipmanella pyramidale</i> Popofsky	Fig. 2-60	<i>Pterocorys campanula</i> Haeckel	Fig. 3-61
<i>Eucyrtidium hexagonatum</i> Haeckel	Fig. 2-61	<i>Anthocyrtidium ophirens</i> (Ehrenberg)	Fig. 3-62
<i>Theocorythium trachelium trachelium</i> (Ehrenberg)	Fig. 2-62	<i>Spirocysts scalaris</i> Haeckel	Fig. 3-63
<i>Anthocyrtidium ophirens</i> (Ehrenberg)	Fig. 2-63	<i>Botryocysts scutum</i> (Harting)	Fig. 3-64
<i>Carpocarium amphora</i> (Haeckel)	Fig. 2-64		

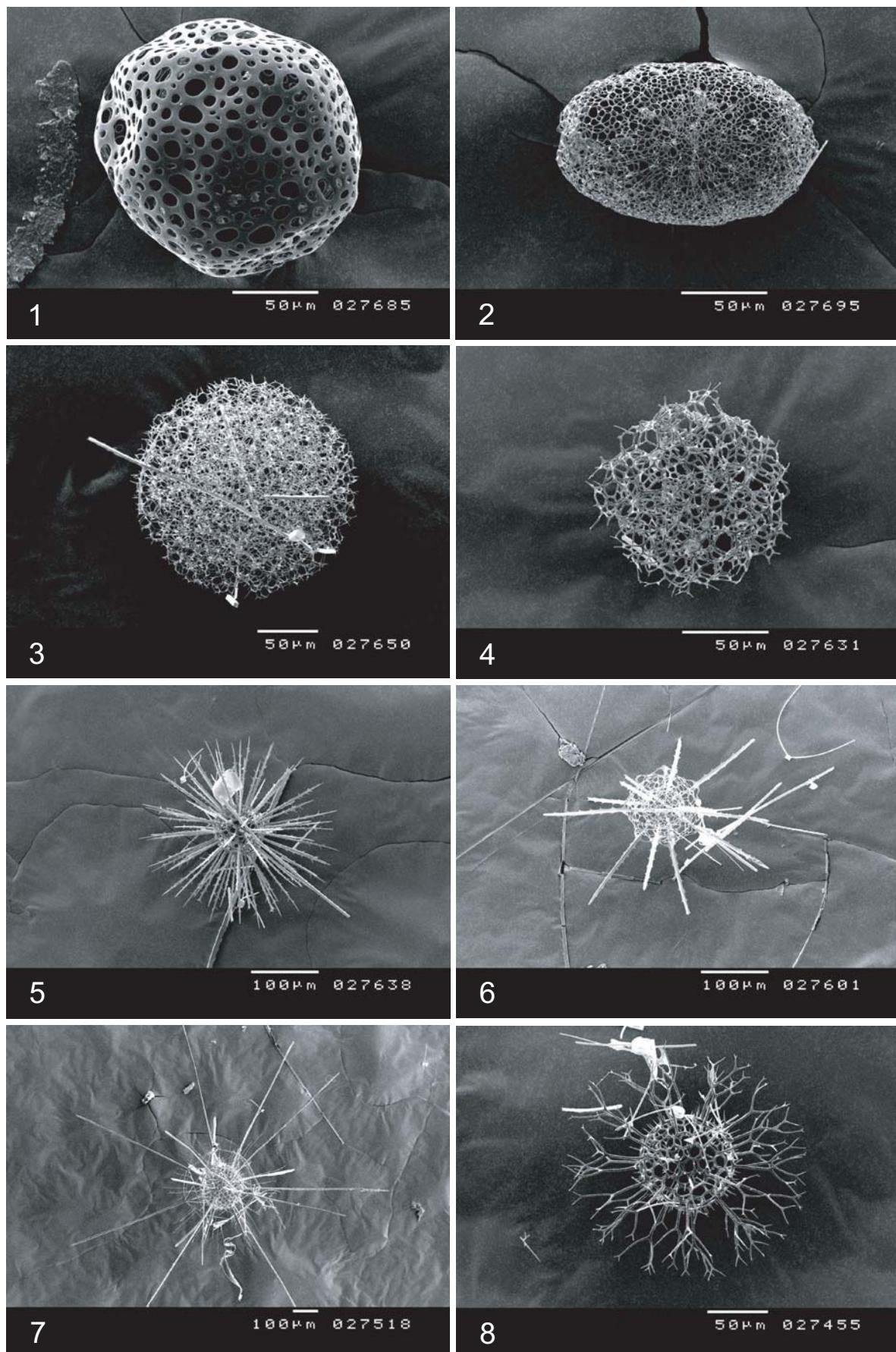


Fig. 2-1 Scanning electron microscopic images of radiolarian skeletons from sample 20061201. For explanation of each image see Table 2.

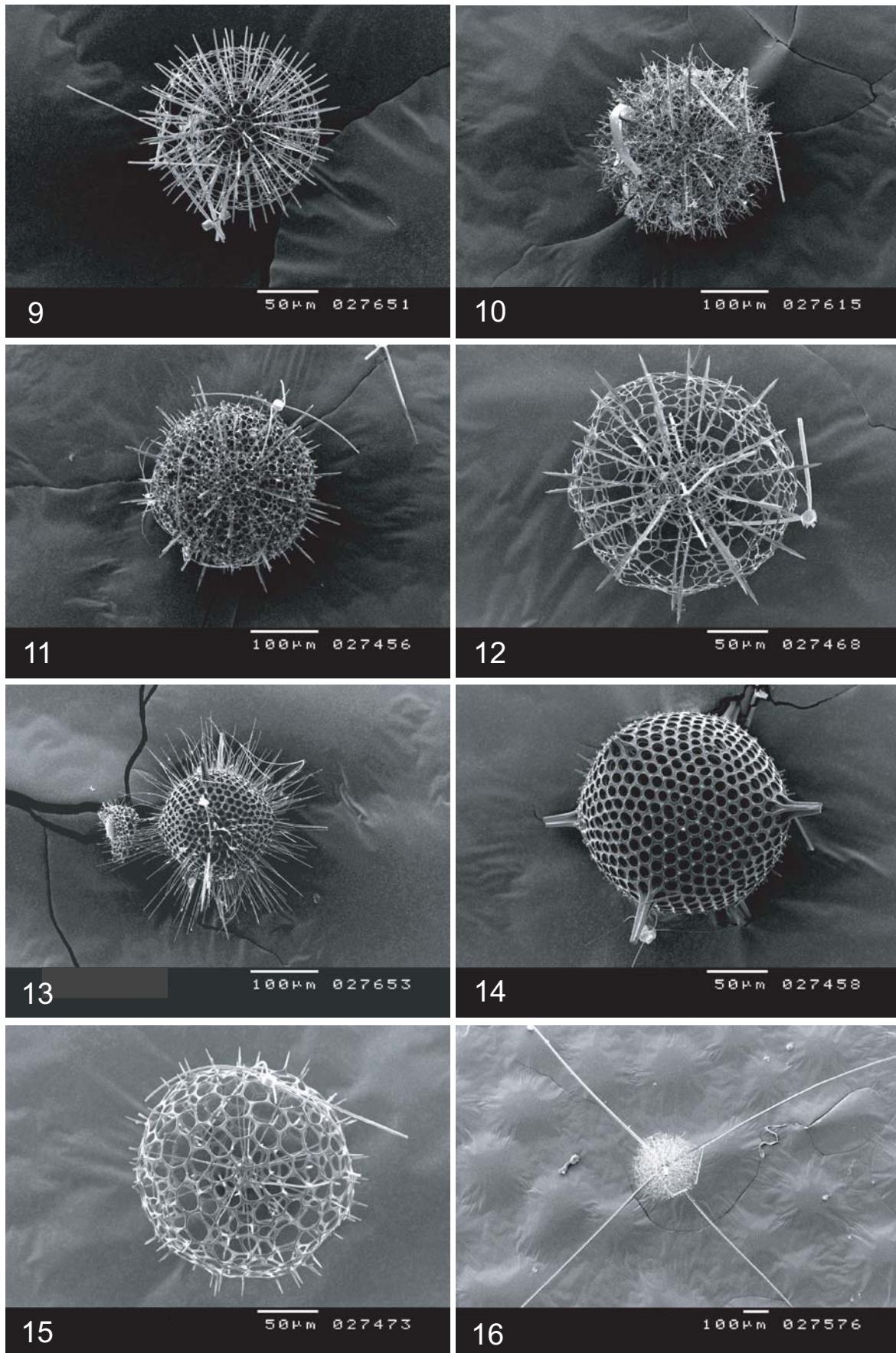


Fig. 2-2

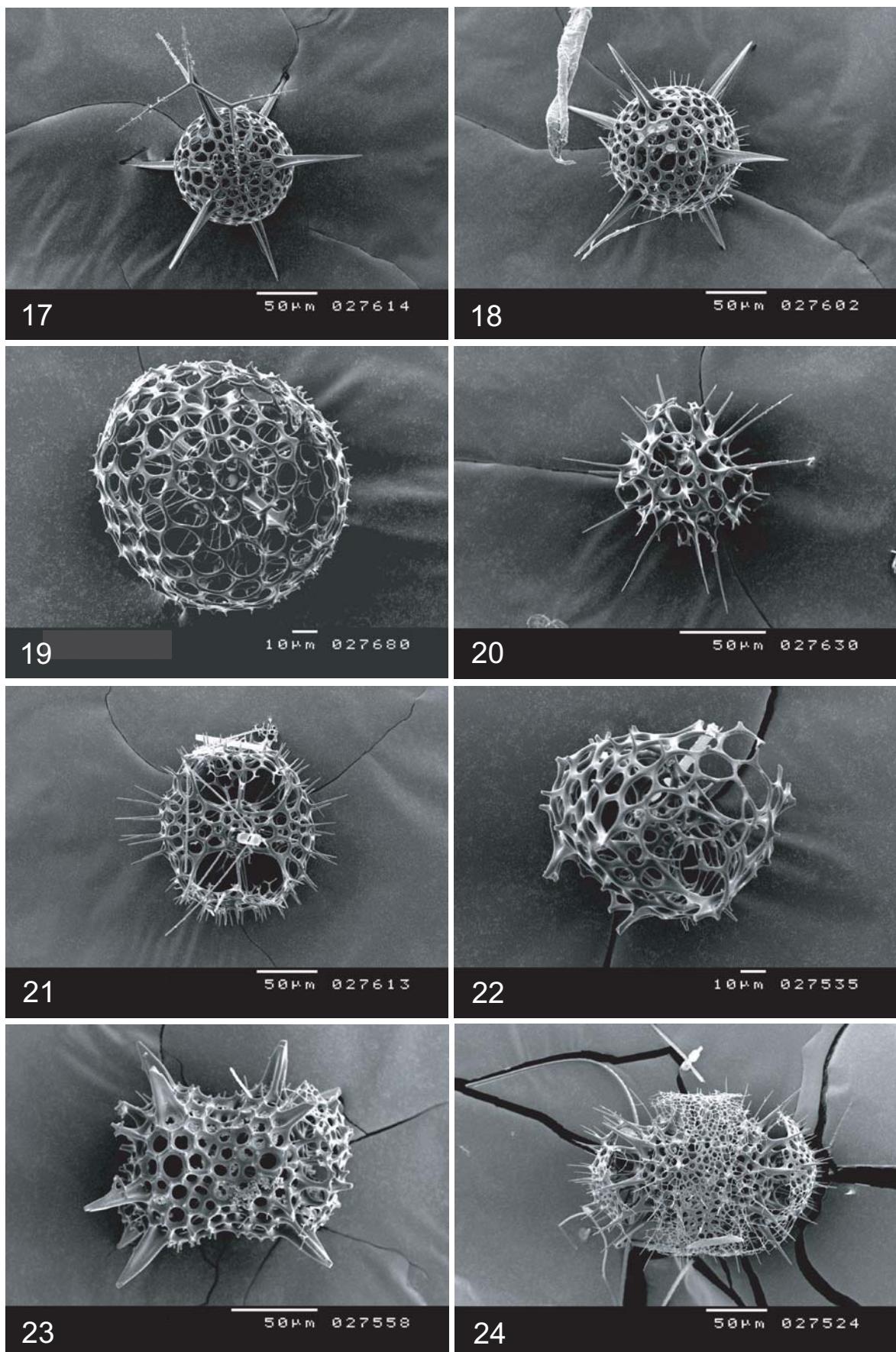


Fig. 2-3

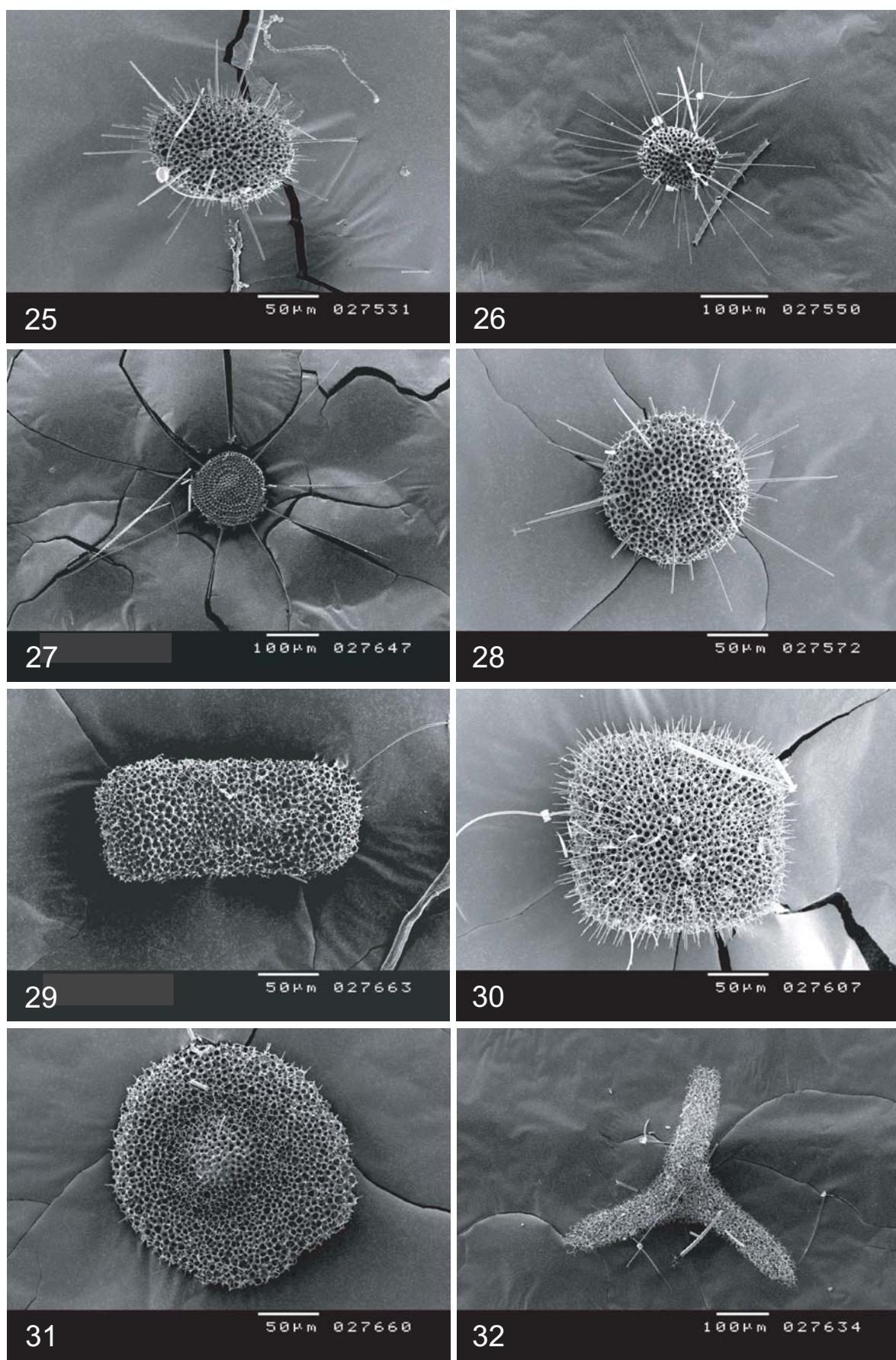


Fig. 2-4

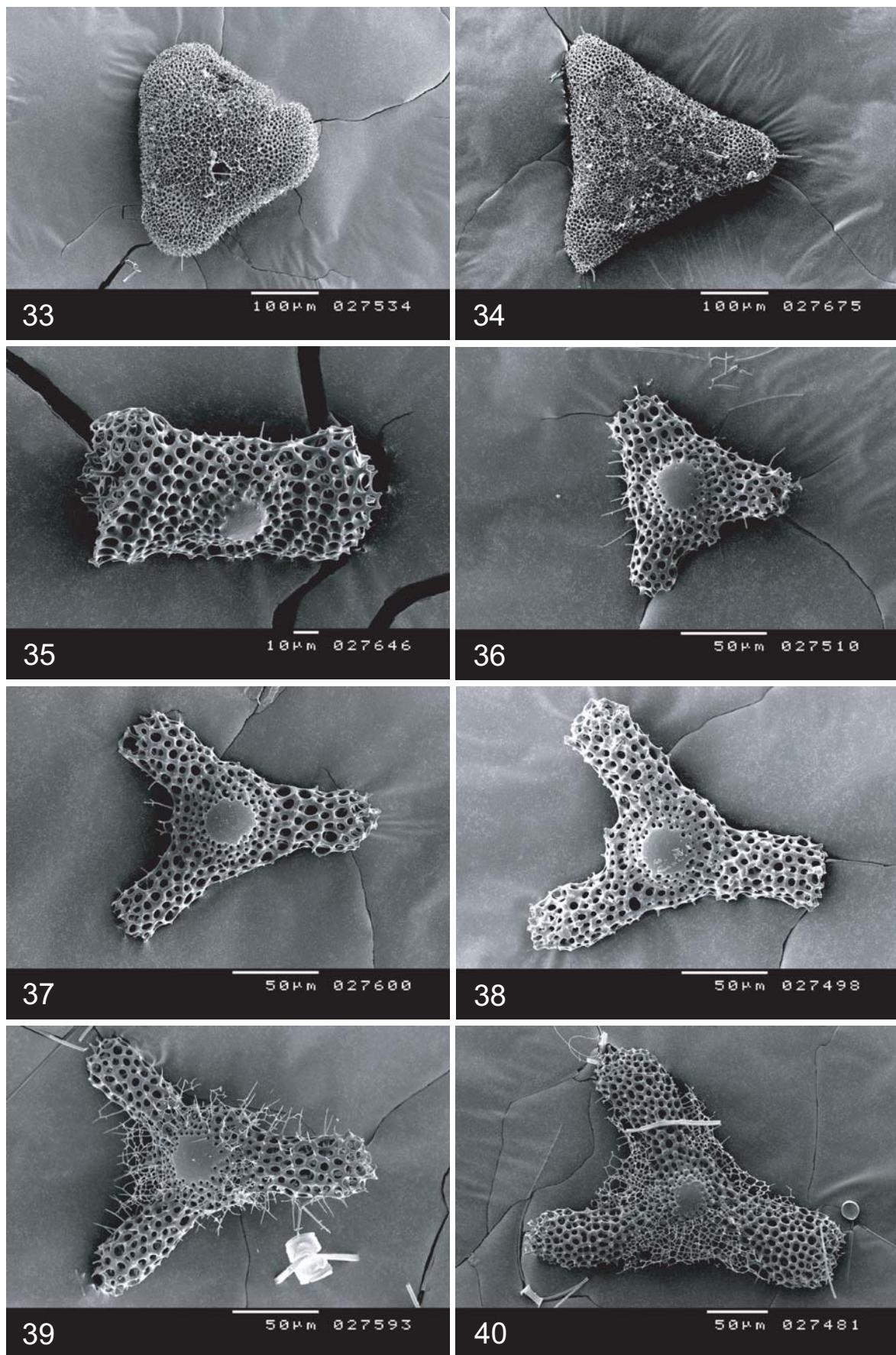


Fig. 2-5

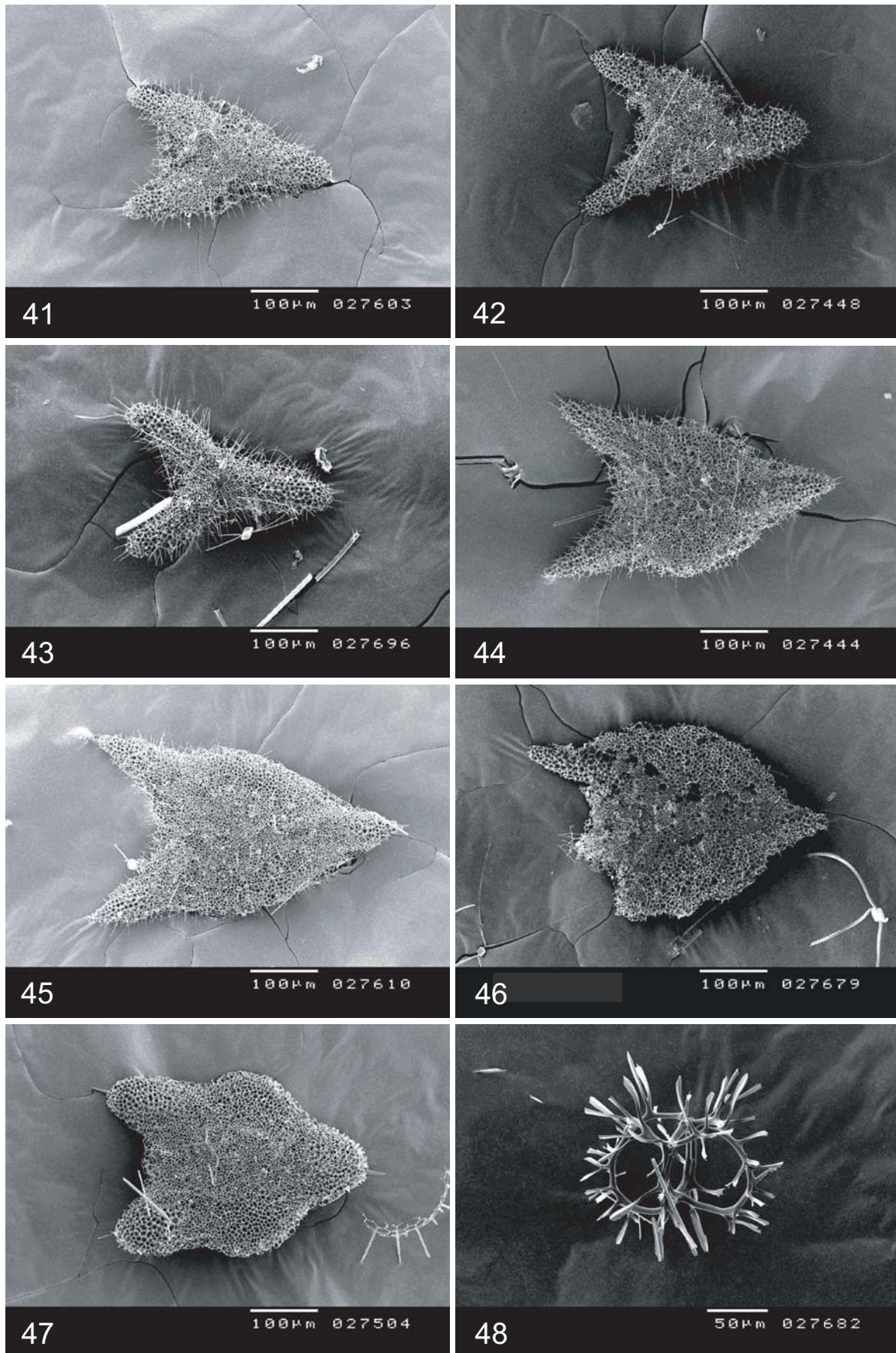


Fig. 2-6

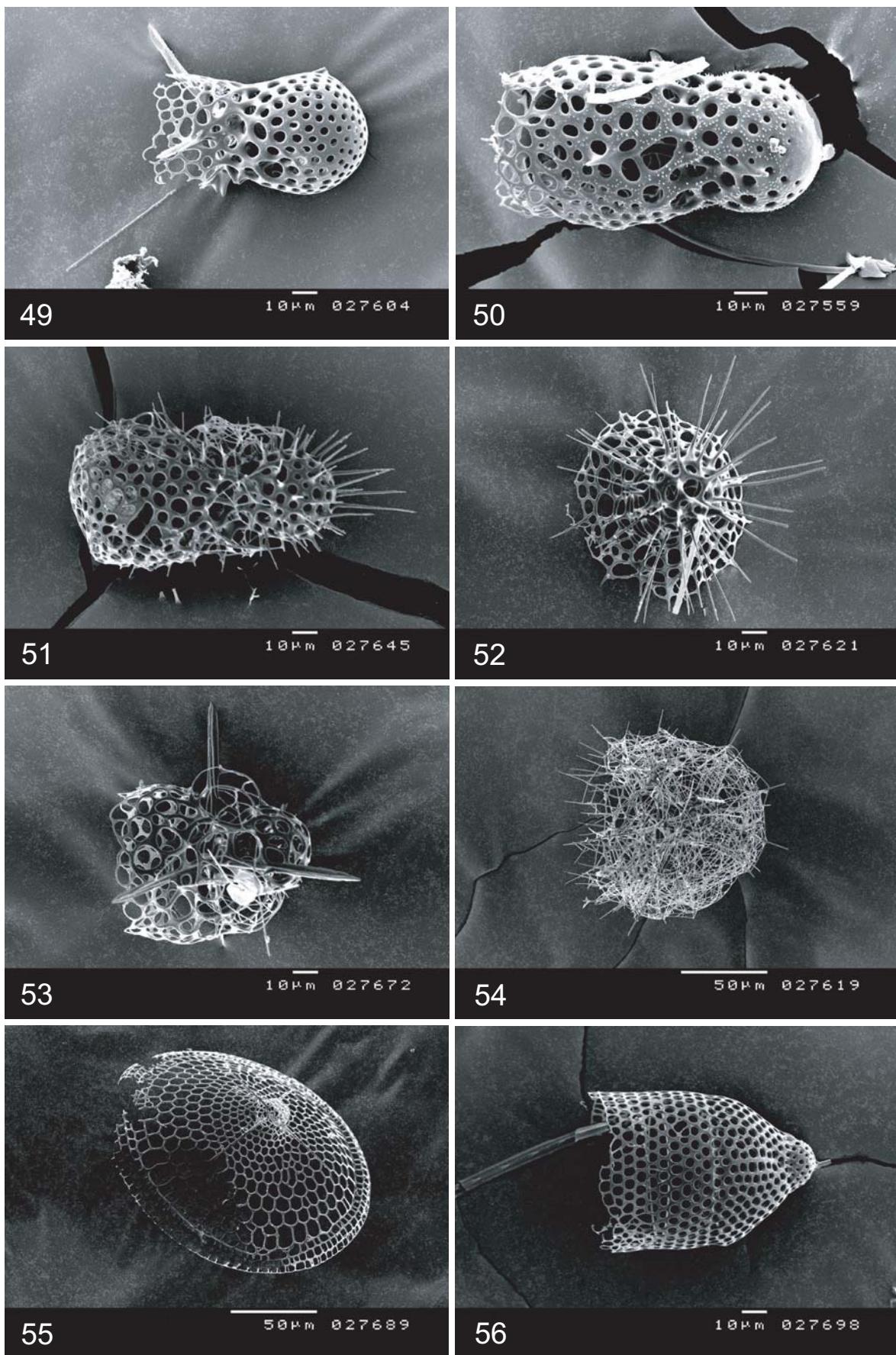


Fig. 2-7

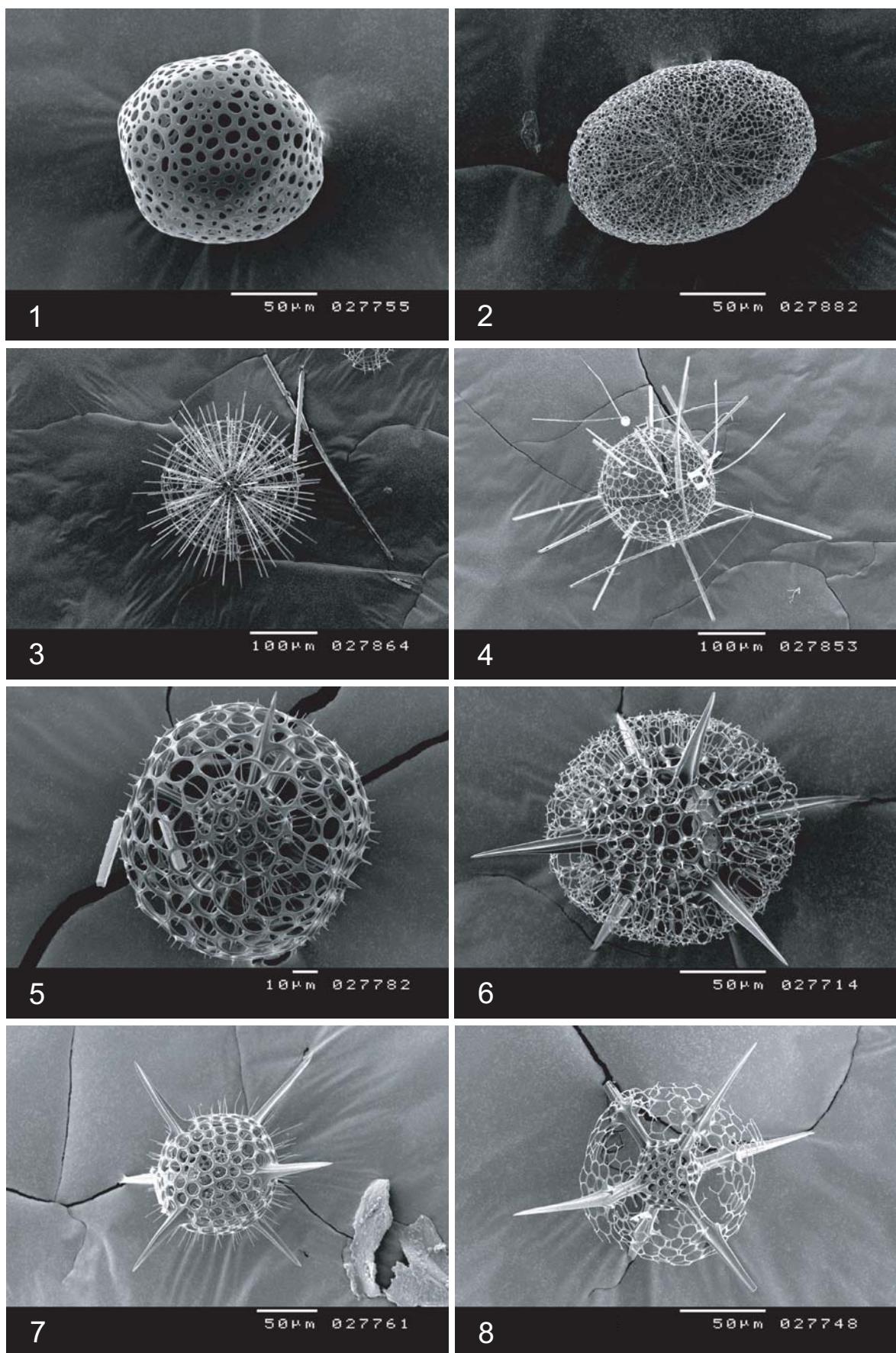


Fig. 3-1. Scanning electron microscopic images of radiolarian skeletons from sample 20061204. For explanation of each image see Table 2.

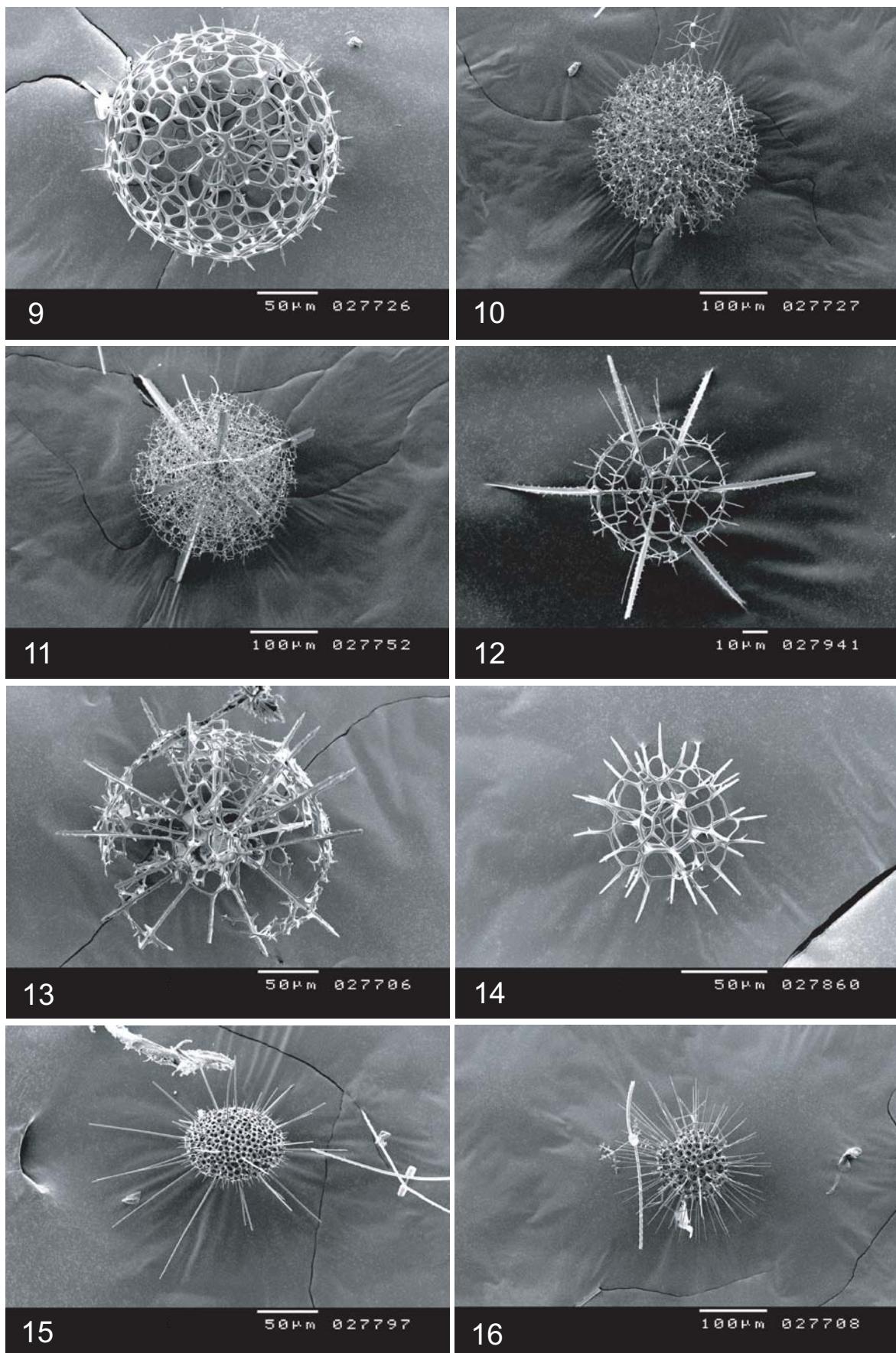


Fig. 3-2

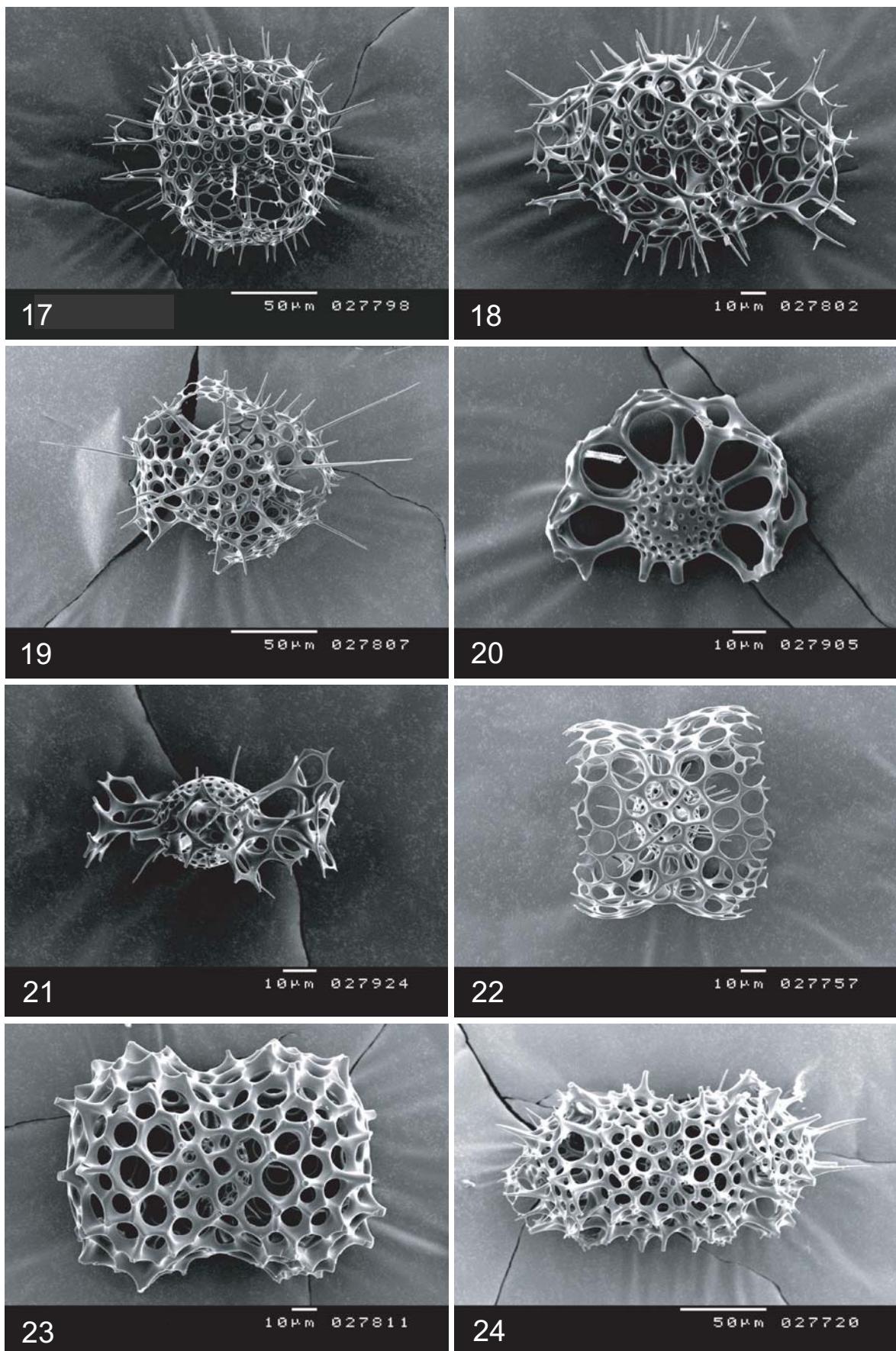


Fig. 3-3

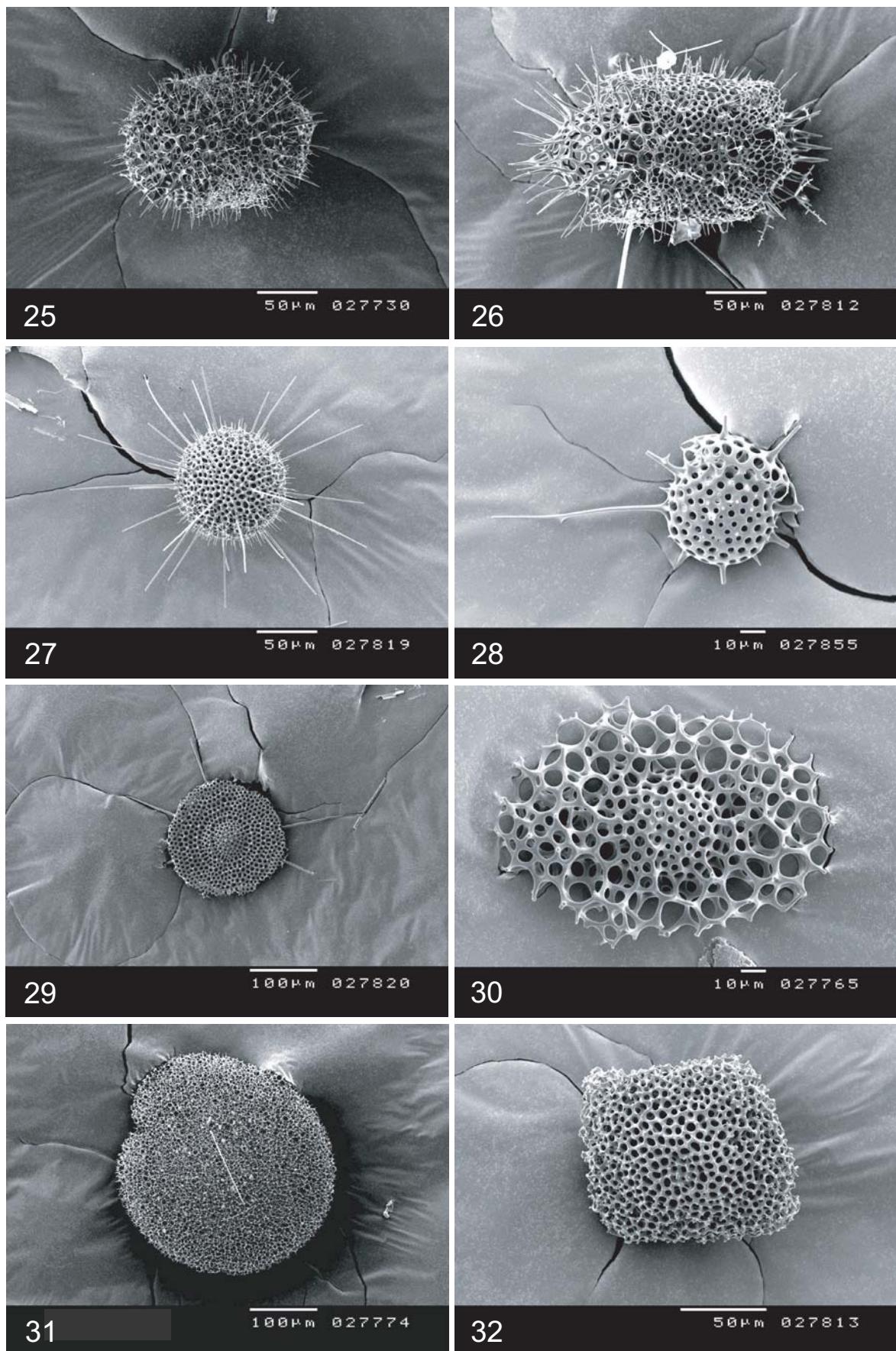


Fig. 3-4

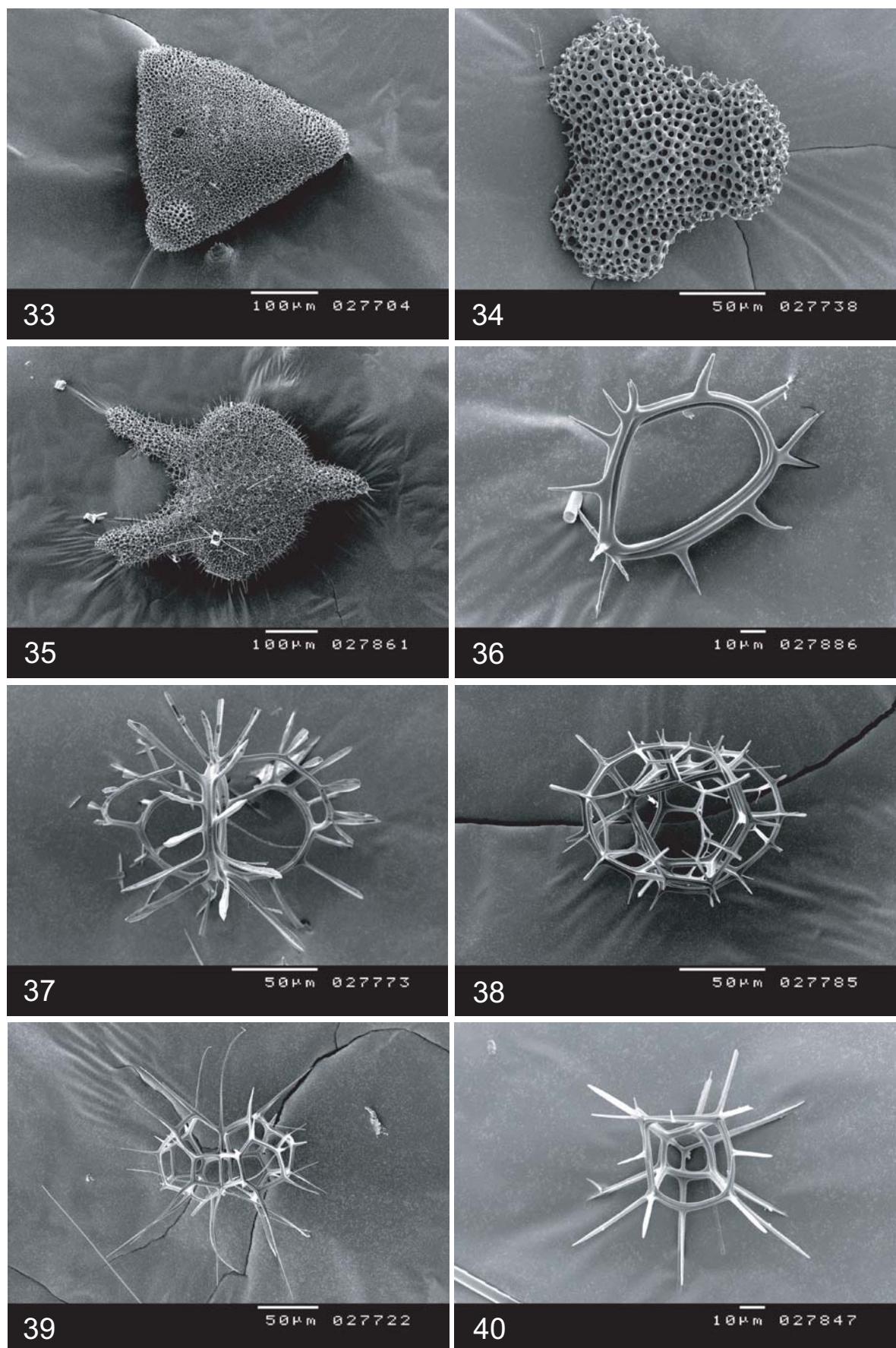


Fig. 3-5

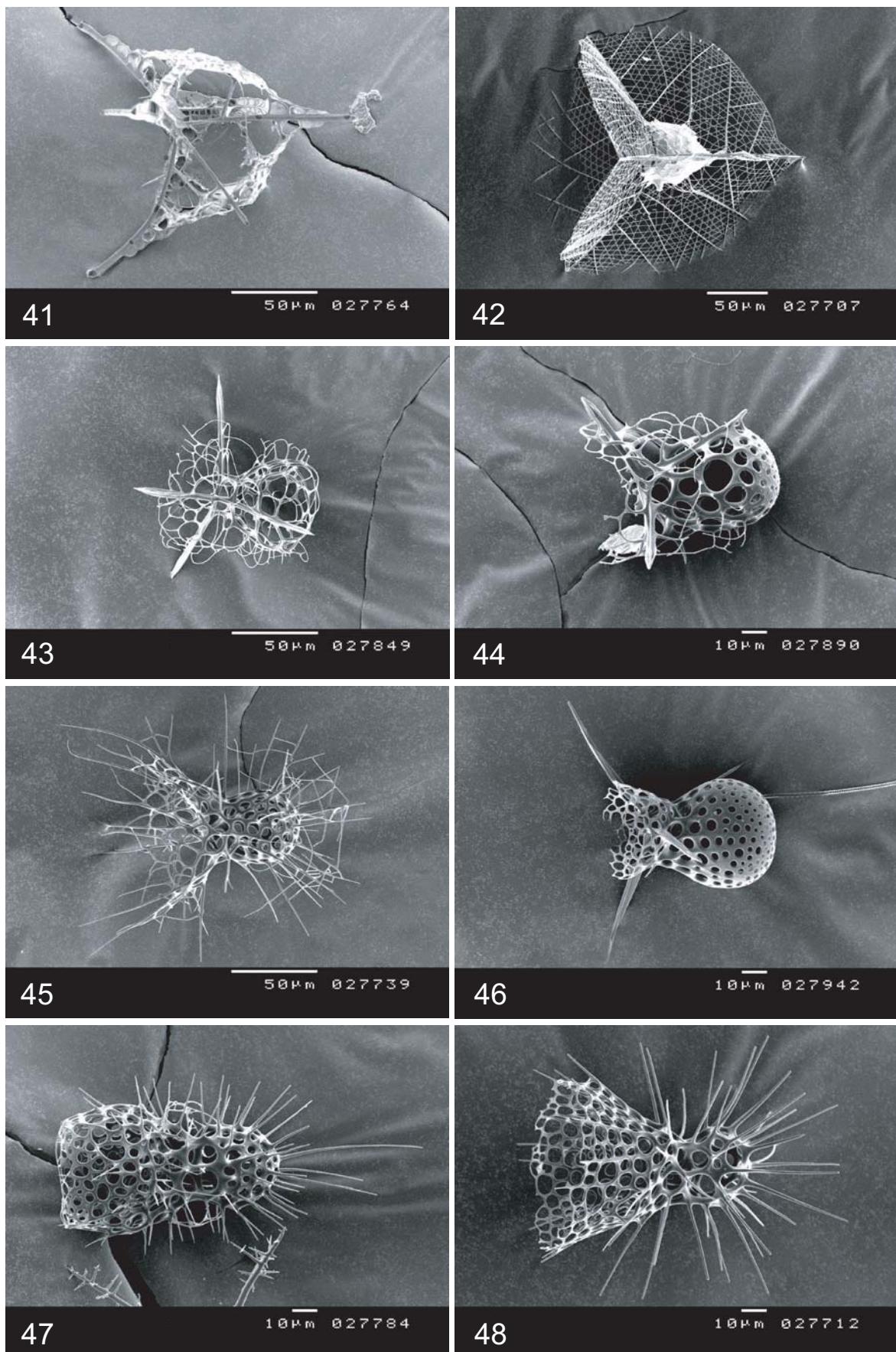


Fig. 3-6

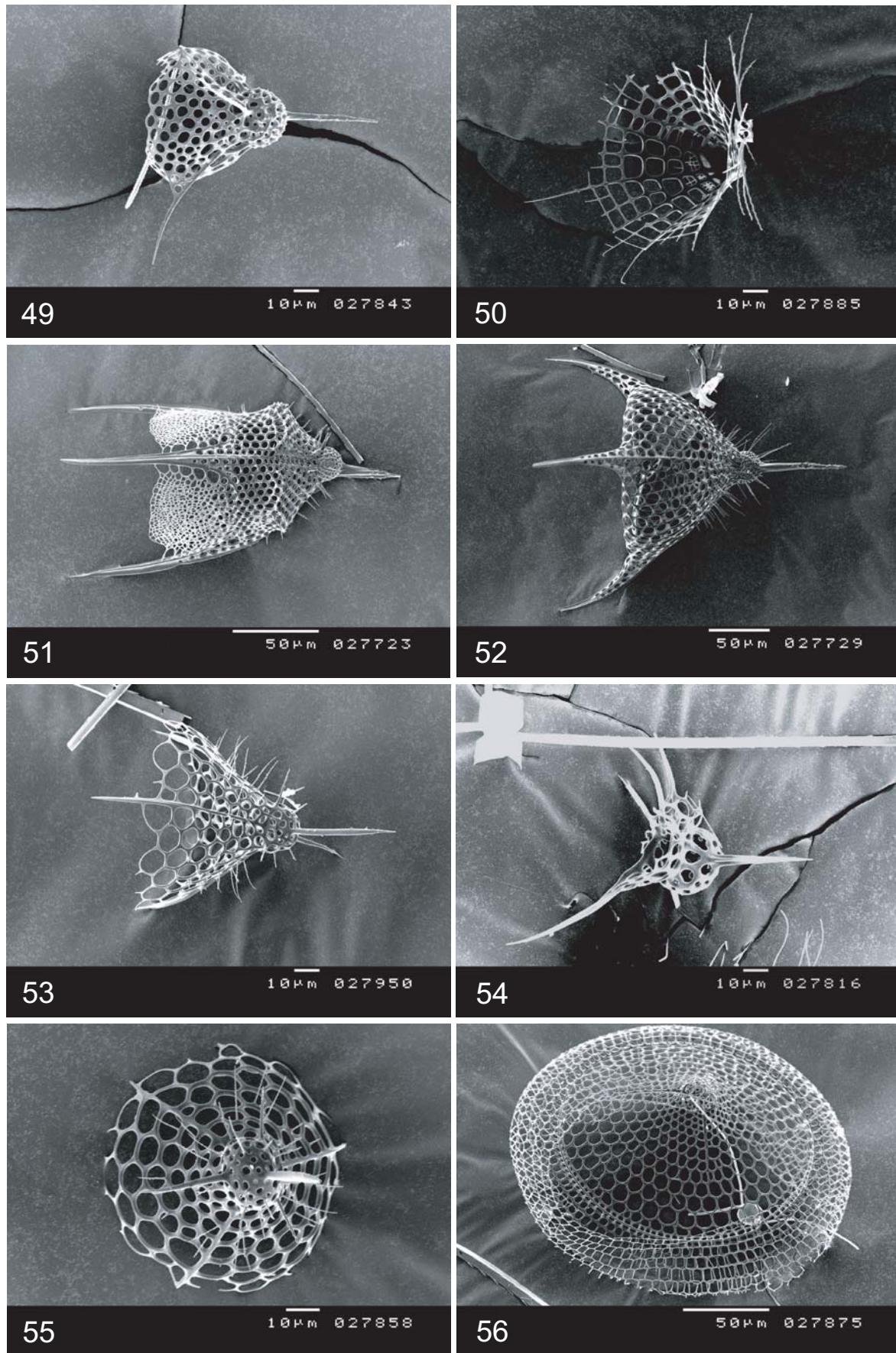


Fig. 3-7

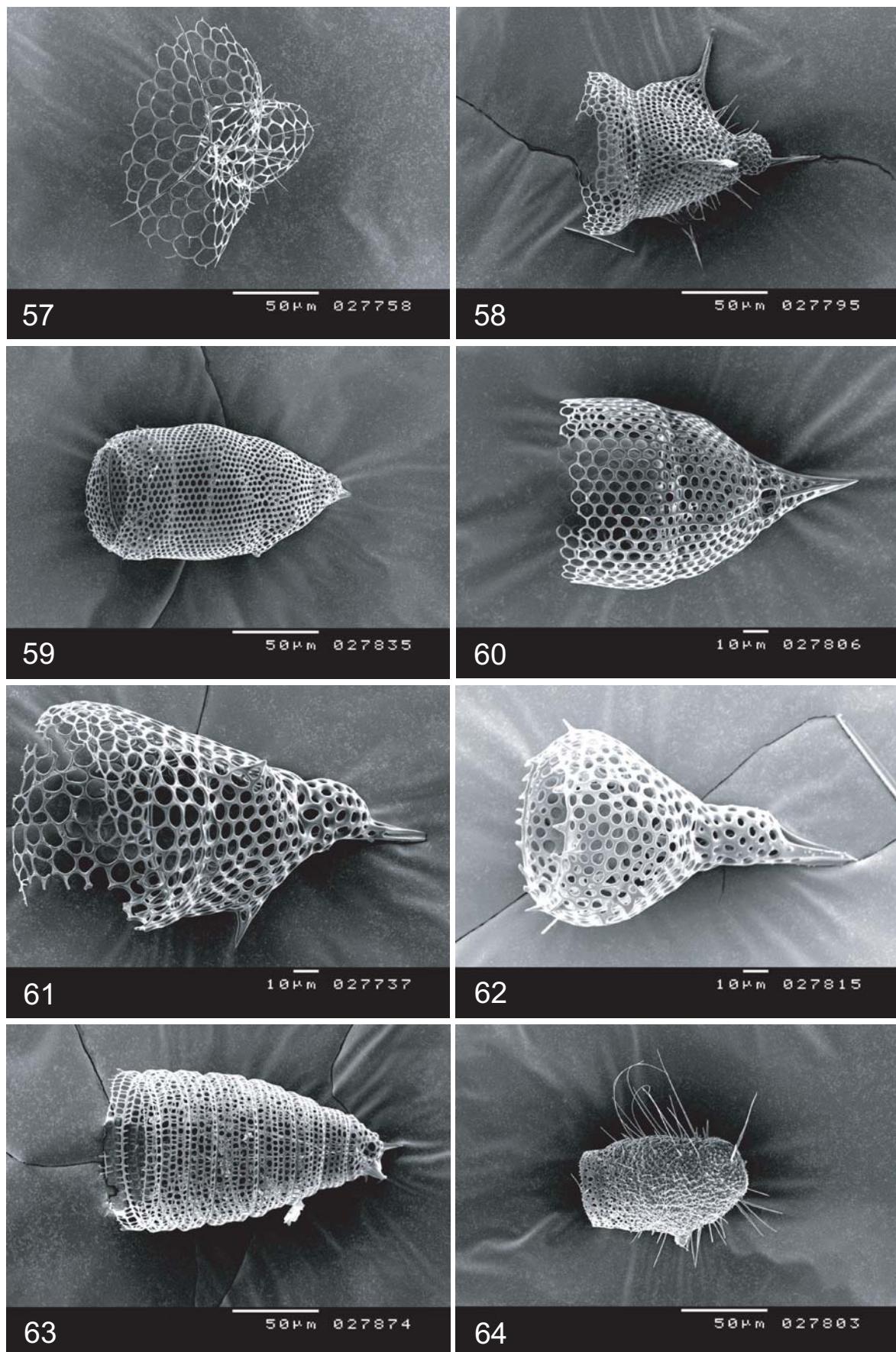


Fig. 3-8

