

Haeckel Radiolaria Collection and the H.M.S. *Challenger* Plankton Collection

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Abstract Haeckel's (1887) famous monograph on Radiolaria from the Challenger Expedition reported 2775 new polycystine species; Although the majority of taxa were described from sediment samples, 25% of these were described from the Challenger plankton station materials. Haeckel neither designated any types or deposited any original slides, making a re-examination of the Challenger material essential. While most Challenger sample stations still have the corresponding sediment samples housed in the geological collections of the Natural History Museum London (NHM), no similar archive exists for plankton material. However, the Haeckel Radiolaria Collection is present and housed in the Micropalaeontology Section of the NHM in London. In order to determine the state and contents of the collection, joint research on Haeckel and Ehrenberg Collections and Types has been carried out for several years (Lazarus, 2000). The Haeckel Radiolaria Collection in the NHM consists of seven almost complete sets of 34 radiolarian “teaching” slides, which were prepared by Haeckel. In addition, many plankton radiolarian slides made from the Challenger and other plankton Stations with hand inscriptions by Haeckel himself are present in this collection. Haeckel's teaching slide sets and the additional slides stored at the London NHM are the only available original plankton materials left from the Challenger expedition still available for research purposes. They are of topotype status and an irreplaceable resource for designating new types for Haeckel Radiolaria. Images of all slides and selected radiolarian specimens in each slide were digitally captured and the location of all slides have been databased. The slides from 5 Challenger plankton Stations (Stations 236, 269, 270, 271 and 272) were examined and species identified using modern taxonomic concepts. A total of 88 polycystine species were identified and morphotypes of all these taxa are illustrated.

Key words: Haeckel, Radiolaria, H.M.S. *Challenger*, Plankton.

Introduction

Ernst Haeckel reported a total of 739 genera and 4318 species of Radiolaria (polycystines, acantharians and phaeodarians) in his report on Radiolaria in the “Challenger Scientific Results

volume 18”; of these 3508 new species were described (Haeckel, 1887). For radiolarian research, Haeckel used the various samples from soundings and dredge as well as plankton samples from surface to bathymetrical zones by tow-net. In particular, Haeckel noted in preface of the report that “The richest source of the Challenger materials is the Radiolarian ooze of the central Pacific Ocean (Stations 265 to 274). This remarkable deep-sea mud consists for the greater part of well-preserved siliceous shells of Polycystina (Spumellaria and Nassellaria). —especially for the study of the Acantharia and Phaeodaria, are the wonderful preparations stained with carmine and mounted in Canada balsam on the spot by Dr. John Murray (page ii in Haeckel, 1887).” Such radiolarian slides actually existed as a part of the Haeckel Radiolaria Collection at the Natural History Museum (NHM) in London. As a result, out of 3508 new radiolarian species, Haeckel described 2775 new species of polycystine Radiolaria; of these about 700 species were described from plankton materials. Since the original type materials used for the description of new radiolarian species by Haeckel (1887) were not deposited in any museum or left in his private collections (now preserved as the Haeckel-Haus) (Lazarus 2000; Sakai *et al.*, 2009), re-examination of original Challenger plankton slides will be essential for designation of neotypes for species originally described from plankton material.

Sources of Challenger and other topotype material

The NHM still curates, as part of the geologic collections, most of the original sediment samples collected during the Challenger expedition, and these can be used (together with teaching slide materials, below) for topotype material for any Haeckel taxon described from the sediments. The situation for plankton is much more difficult, as no similar archive of plankton material from the Challenger expedition has been preserved. To our knowledge there are only three main sources of plankton material that can be used as topotypes for re-examination and designation of types for Haeckel species: the Challenger plankton slides, mostly made on the ship, that are stored as part of the Haeckel Radiolaria Collection at the NHM; sets of teaching slides made by Haeckel which contain in part slides from original Challenger plankton collections, many also held in the Haeckel Radiolaria Collection of the NHM in London; and a privately held collection of original Haeckel radiolarian slides, many of Challenger plankton materials: the Benn Collection.

The Haeckel Radiolaria Collection

The Haeckel Radiolaria Collection is one of the important microfossil collections housed in the Micropalaeontology Section, Natural History Museum (NHM) in London. The collection is composed of two parts. The first consists of seven complete sets of 34 radiolarian teaching slides which were made by Ernst Haeckel in 1890. The other is the plankton slide collection consisting of many plankton radiolarian slides, which were made from H.M.S. *Challenger* plankton stations and other scientific expeditions. Many labels of the plankton preparations have handwritten taxon names by Haeckel himself.

The Haeckel Radiolarian Collection: Teaching Slides

Numerous standardised copies of radiolarian teaching slides were prepared and sold by Ernst Haeckel to Universities and various Museums for education purposes (Lazarus, 2000). The collections of the Natural History Museum in London consist of eight such sets, each of 34 radiolarian slides; seven of the sets are complete; one is an incomplete set. Two sets are registered

(91.1.31.1 to 91.1.31.35; 92.12.14.1 to 92.12.14.34), five are unregistered, and the rest are incomplete and unregistered. The slides are located and curated in Cabinet Nos. 78 to 83 at the Micropalaeontology Section, NHM (Figs. 1–3 in CD). A detailed location map and list of the collection is figured and tabulated in page 17–22 of Tanimura *et al.* (2006). Some examples of the teaching slides with radiolarian specimens are shown in figs. 1–6 in Aita *et al.* (2009). The slide labels are dated as 1890. Haeckel radiolarian teaching slides set are also present at the Museum für Naturkunde in Berlin and also at the Haeckel-Haus in Jena.

These radiolarian teaching slides sets were made from various source materials including general plankton samples, Challenger plankton and sediment samples (ooze), radiolarian ooze sample from other scientific expeditions, and Barbados radiolarian earth samples (Table 1). Of these 34 various locations, seven Challenger plankton Stations and fourteen Challenger sediment Stations were used. Geographically, the collection covers almost all oceans including the Southern Ocean. The geological ages of the materials in the teaching slides vary from Recent to Eocene.

Preservation of Radiolaria on the teaching slides is moderately to fairly good, in comparison to the preservation typical of recent plankton slides. However, in many of the teaching slides stored at the NHM, the state of mounting is very poor for observation, because the Canada balsam has flowed to the end and almost all of radiolarian tests have gathered at one end as an aggregate. This is a well known problem when Canada balsam slides are stored on edge for extended periods of time. As the slides are stored flat in the NHM today, it is not clear when this problem developed. The teaching slide sets stored in Berlin do not suffer from this problem. Living radiolarians including Polycystina, Acantharia and Phaeodaria prepared from the Challenger plankton stations are very limited and all such materials are extremely valuable. Examination all of the plankton slides of the teaching slides such as those stored in Berlin should be done in the future.

The Haeckel Radiolarian Collection: Challenger Plankton slides

There are approximately 350 recent radiolarian slides in the collections of the Micropalaeontology Section, Natural History Museum (NHM) in London. A locality list of these recent slides collection is available from the NHM paleontology curator and also as a digital file created during our research in 2004 to 2005. A copy of the list is included in Appendix 1 [A-1 in CD] in this volume. The recent radiolarian slides collection made from the H.M.S. *Challenger* plankton materials consists of almost 230 registered slides from about 80 Challenger stations out of 350 recent slides collection. These Challenger plankton radiolarian collections are grouped under each ocean area and located in the Cabinet Nos. 85 to 104 [Appendix 2, A-2 in CD].

These plankton slides were made directly by an onboard scientist like John Murray during the Challenger expedition as mentioned previously and also many slides were prepared later for research purpose by Ernst Haeckel. This interpretation is supported by the presence on many slides of hand written inscriptions by Haeckel himself.

The Benn Collection

Other than the material described above, stored primarily at the NHM, the only known original Haeckel radiolarian material is held privately by a descendant of Haeckel's family as a personal collection. The collection includes a total of 72 strewn slides consisting of many Challenger plankton radiolarian slides, some radiolarian teaching slides and slides from Messina. A detailed examination of this collection has been carried out (DBL) and will be published at a

later date. However, as the material is privately held it is not suitable to use for typification work.

In summary, the Challenger plankton radiolarian collection at the NHM, together with other duplicate teaching slides held in other museums, are the only openly available original plankton materials left from the Challenger expeditions. These plankton slide materials represent only a small portion of the total number of taxa described by Haeckel in his Challenger monograph (Lazarus, 2000). The rest of the preparations used for the taxonomic studies of Haeckel (1887) have never been identified, nor are there any indications that they were ever saved for future research purposes by Haeckel.

The H.M.S. *Challenger* original sediment samples

The original marine sediment samples taken from the H.M.S. Challenger Stations include dredge, trawl and sounding materials. Manganese nodules and shark teeth specimens used for the plates in the Challenger reports are also present in the collection. These Challenger original samples are now managed by the Mineralogy Department of the Natural History Museum (NHM) in London. The materials are separately curated at the NHM's storage facility in Wandsworth, south of London. Samples from each Station are bottled in various glass jars and used materials are stored in glass tubes within boxes. A small portion of the Challenger original samples are housed in the Palaeontology Department at the NHM. Most such samples are a part of the separate Brady and Earland collections of foraminifera. We confirmed that some unprocessed materials are present as well in these latter collections, although most are only washed residues of coarse-fraction material. Lastly some Challenger materials are contained in the Castracane diatom slide collection, kept in the Diatom Section of the Natural History Museum, London.

Our joint research project team (YA, KO, JY, and DL) visited the Wandsworth storage facility twice and selected and resampled to make radiolarian and diatom slides. From twenty samples out of a total of 27 taken, we made five sets of radiolarian strewn slides. They are from Stations 157, 225, 238, 241, 244, 253, 263, 265, 266, 267, 268, 270, 271, 272, 274, 295, 300, 332, 347 and 348 [Appendix 3, A-3 in CD]. Successively, additional 19 unprocessed samples from the Challenger sounding and dredge materials were resampled by DL and five sets of radiolarian strewn slides were made. These are from Stations 206, 220, 224, 231, 245, 247, 252, 256, 269, 285, 293, 296, 298, 302, 318, 323, 325, 335, and 338 [Appendix 4, A-4 in CD]. The radiolarian slide set is distributed and deposited in five institutions; NHM in London, MfN in Berlin, NMNS in Tokyo, Tohoku University and Utsunomiya University. Images of radiolarian taxa taken from the selected Challenger Stations and newly made original Challenger Station slides were digitally captured. Study of sediment material is still ongoing in order to understand sediment topotype material and to designate new types for Haeckel Radiolaria.

The Radiolarian Taxa of the H.M.S. *Challenger* Plankton Collection

We have begun the process of restudy of Haeckel's material by examining the collections stored in London and making a comprehensive location map and updated list of the collection (Tanimura *et al.*, 2006). Polycystine radiolarian species were identified from selected plankton slides from 5 Challenger Stations: 269, 270, 271, 272 and 236. The former four stations are located at central Pacific and the Station 236 is located at off Japan (Fig. 9). Each slide used is marked with the word "Surface" on the label. All morphotypes of the polycystine Radiolaria in these plankton slides were digitally captured. The taxa found are listed in Table 2, and images for

Table 1. List of Haeckel radiolarian teaching slides set housed in the Natural History Museum, London.

Rad. Coll. Nr. 1. Polycyttarien-Plankton. (Pelagisch.) Mediterraneum Messina. Haeckel
Rad. Coll. Nr. 2. Polycyttarien-Plankton. (Pelagisch.) Nörd. Atlant. Oc. Canaria. Haeckel
Rad. Coll. Nr. 3. Polycyttarien-Plankton. (Pelagisch.) Nörd. Atlant. Oc. Bamudas. Rabbe.
Rad. Coll. Nr. 4. Polycyttarien-Plankton. (Pelagisch.) Südl. Atlant. Oc. Trinidad. Rabbe.
Rad. Coll. Nr. 5. Polycyttarien-Plankton. (Pelagisch.) Südl. Ind. Oc. Madagascar. Rabbe.
Rad. Coll. Nr. 6. Polycyttarien-Plankton. (Pelagisch.) Nördl. Ind. Oc. Ceylon. Haeckel.
Rad. Coll. Nr. 7. Polycyttarien-Plankton. (Pelagisch.) Südl. Pacif. Oc. Elisabeth-I. Rabbe.
Rad. Coll. Nr. 8. Polycyttarien-Plankton. (Pelagisch.) Nördl. Pacif. Oc. Japan. Chall. 229
Rad. Coll. Nr. 9. Acantharien-Plankton. (Pelagisch.) Südl. Pacif. Oc. Patagon. Chall. 302
Rad. Coll. Nr. 10. Acantharien -Plankton. (Pelagisch.) Nörd. Atlant. Oc. Fär-Öer. Triton
Rad. Coll. Nr. 11. Phaeodarien-Plankton. (Pelagisch.) Nördl. Atlant. Oc. Fär-Öer. Triton
Rad. Coll. Nr. 12. Phaeodarien-Plankton. (Pelagisch.) Nördl. Pacif. Oc. Sandwich Chall. 256
Rad. Coll. Nr. 13. Phaeodarien-Plankton. (Pelagisch.) Südl. Pacif. Oc. Galapagos. Rabbe.
Rad. Coll. Nr. 14. Tiefsee-Kerat. Spongien-Skel. <i>Psammopemma radiolarium</i> C. Pacif. Chall. 272
Rad. Coll. Nr. 15. Tiefsee-Kerat. Spongien-Skel. <i>Cerelasma gyrosphaera</i> C. Pacif. Chall. 271
Rad. Coll. Nr. 16. Tiefsee-Kerat. Spongien-Skel. <i>Psammophyllum annectens</i> N. Pacif. Chall. 244
Rad. Coll. Nr. 17. Tiefsee-Kerat. Spongien-Skel. <i>Stannophyllum zonarium</i> C. Pacif. Chall. 271
Rad. Coll. Nr. 18. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 225 W. Pacif. 4475 Fd.
Rad. Coll. Nr. 19. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 226 W. Pacif. 2300 Fd.
Rad. Coll. Nr. 20. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 265 C. Pacif. 2900 Fd.
Rad. Coll. Nr. 21. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 266 C. Pacif. 2750 Fd.
Rad. Coll. Nr. 22. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 268 C. Pacif. 2900 Fd.
Rad. Coll. Nr. 23. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 270 C. Pacif. 2925 Fd.
Rad. Coll. Nr. 24. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 271 C. Pacif. 2425 Fd.
Rad. Coll. Nr. 25. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 272 C. Pacif. 2600 Fd.
Rad. Coll. Nr. 26. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 273 C. Pacif. 2350 Fd.
Rad. Coll. Nr. 27. Tiefseeschlamm. Radiol. Ooze Chall. Stat. 274 C. Pacif. 2750 Fd.
Rad. Coll. Nr. 28. Tiefseeschlamm. Rother Thon. Chall. Stat. 241 N. Pacif. 2300 Fd.
Rad. Coll. Nr. 29. Tiefseeschlamm. Rother Thon. Chall. Stat. 244 N. Pacif. 2900 Fd.
Rad. Coll. Nr. 30. Tiefseeschlamm. Rother Thon. Chall. Stat. 253 N. Pacif. 3125 Fd.
Rad. Coll. Nr. 31. Tiefseeschlamm. Diatom. Ooze Chall. Stat. 157 Antarct. 1950 Fd.
Rad. Coll. Nr. 32. Tiefseeschlamm. Radiol. Ooze Egeria. IV. 1887. Ind. Oc. 2711 Fd.
Rad. Coll. Nr. 33. Tiefseeschlamm. Radiol. Ooze Egeria. V. 1887. Ind. Oc. 2779 Fd.
Rad. Coll. Nr. 34. Fossile Radiolarien. Tertiär-Mergel von Barbados (Miocene Antillen)

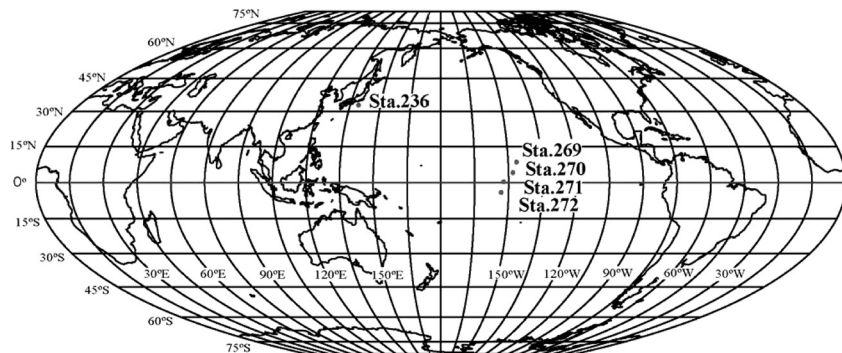
Fig. 9 Location of the H.M.S. *Challenger* Stations used in this study.

Table 2. Radiolarian species identified from the H.M.S. *Challenger* plankton slides Collection at the Natural History Museum in London.

H.M.S. <i>Challenger</i> Station Number	Equatorial Central Pacific				Off Japan
	Station 269	Station 270	Station 271	Station 272	Station 236
Latitude	5°54'00"N	2°34'00"N	0°33'00"S	3°48'00"S	34°58'00"N
Longitude	147°2'00"W	149°9'00"W	151°34'00"W	152°56'00"W	139°29'00"E
Collected Date of plankton-gathering	Aug. 31– Sep 1, 1875	Sep. 4, 1875	Sep. 6, 1875	Sep. 8, 1875	June 5, 1875
Registration number of NHM	90.4.3.10, 90.4.3.11, 90.4.3.12, 90.4.3.151, 90.4.3.152, 90.4.3.153, 90.4.3.154, 90.4.3.155, 90.4.3.156	90.4.3.16, 90.4.3.17, 90.4.3.13, 90.4.3.14, 90.4.3.15, 90.4.3.18, 90.4.3.145, 90.4.3.147, 90.4.3.148, 90.4.3.149, 90.4.3.150	90.4.3.131, 90.4.3.132	90.4.3.19, 90.4.3.20, 90.4.3.21, 90.4.3.22, 90.4.3.23, 90.4.3.24, 90.4.3.118	90.4.3.4
Abundance of Radiolaria Species / Nos. of slides examined	Few 9	Common 11	Abundant 2	Few 7	Rare 1
<i>Acanthodesmia muelleri</i> (Haeckel 1862)	X	X	X		
<i>Acanthodesmidae</i> gen. et sp. indet.		X	X	X	
<i>Actinomma arcadophorum</i> Haeckel 1887		X		X	
<i>Actinomma</i> (?) sp.			X		
<i>Actinosphaera capillacea</i> (Haeckel 1860)	X				
<i>Anthocyrtidium oxycephalis</i> (Haeckel 1887)	X				
<i>Arachnocorys circumtexta</i> Haeckel 1860		X			
<i>Arachnosphaera hexasphaera</i> Popofsky 1912		X	X		
<i>Arachnosphaera oligacantha</i> Haeckel 1860	X	X			
<i>Callimitra carolotae</i> Haeckel 1887		X			
<i>Centrocybus cladostylus</i> Haeckel 1887			X		
<i>Centrocybus octostylus</i> Haeckel 1887	X		X		
<i>Cladococcus arboreescens</i> Müller 1858		X			
<i>Cladococcus gaussi</i> (Popofsky 1912)	X				
<i>Clathrocanium coarctatum</i> Ehrenberg 1873a			X		
<i>Collosphaera tuberosa</i> (Haeckel 1887)	X			X	
<i>Conchellium capsula</i> Borget 1907 [Phaeodaria]				X	
<i>Dicranastrum furcatum</i> Haeckel 1887			X		
<i>Dicranastrum</i> cf. <i>furcatum</i> Haeckel 1887				X	
<i>Dicranastrum wyvillei</i> Haeckel 1887			X		
<i>Dicranastrum</i> sp.			X		
<i>Dictyocodon palladius</i> Haeckel 1887			X		
<i>Dictyocoryne angulata</i> Ehrenberg 1873a	X				
<i>Dictyocoryne elegans</i> (Ehrenberg 1873a)	X			X	
<i>Dictyocoryne muelleri</i> (Haeckel 1860)	X	X		X	X
<i>Dictyocoryne pacifica</i> (Ehrenberg 1873a)	X				
<i>Dictyocoryne profunda</i> Ehrenberg 1873a		X	X	X	X
<i>Didymocyrtis tetrathalamus tetrathalamus</i> (Haeckel 1887)		X	X		X
<i>Disolenia ascensionis</i> (Haeckel 1887)				X	
<i>Disolenia megalactis</i> (Ehrenberg 1873a)				X	
<i>Disolenia pandora</i> (Haeckel 1887)				X	
<i>Disolenia zanguebarica</i> (Ehrenberg 1873a)	X			X	

Table 2. Continued.

<i>Eucecryphalus coscinodiscus</i> (Haeckel 1887)			X	
<i>Flustrella arachnia</i> (Müller 1858)	X	X	X	X
<i>Flustrella</i> sp.				X
<i>Heliodiscus amphidiscus</i> (Müller 1858)	X	X		
<i>Heliodiscus asteriscus</i> Haeckel 1887	X		X	
<i>Heliosoma radians</i> Haeckel 1887	X			
<i>Hexacontium elegans</i> (Haeckel 1887)		X		
<i>Hexacontium octahedrum</i> (Haeckel 1887)			X	
<i>Hexacontium</i> sp.		X		
<i>Hexapyle dodecantha</i> Haeckel 1887		X		
<i>Hexapyle spinulosa</i> Chen et Tan 1989				X
<i>Lampromitra</i> (?) <i>hertwigi</i> (Haeckel 1887)			X	
<i>Lampromitra sinuosa</i> Popofsky 1913	X	X		
<i>Larcospira solaris</i> (Haeckel 1887)				X
<i>Leptosphaera minuta</i> Popofsky 1912 sensu Takahashi (1991)	X			
<i>Lithelius</i> sp.			X	
<i>Lithomelissa mediterranea</i> Müller 1858			X	
<i>Lithomelissa spinosissima</i> Tan et Chen 1976		X		
<i>Lophophaena hispida</i> (Ehrenberg 1862a)				X
<i>Lychnosphaera regina</i> Haeckel 1887		X	X	
<i>Myelastrum octocorne</i> Haeckel 1887			X	X
<i>Myelastrum</i> sp.			X	
Nassellaria gen. et sp. indet.	X			
<i>Nephrospyris paradictyum</i> Haeckel 1887		X		X
<i>Nephrospyris renilla</i> Haeckel 1887	X			X
<i>Octodendron cubocentron</i> Haeckel 1887				
<i>Octodendron</i> aff. <i>cubocentron</i> Haeckel 1887			X	
<i>Periarachnium myxobrachia</i> (Strelkov et Reshetnyak 1959)		X		X
<i>Periarachnium</i> aff. <i>venosus</i> (Haeckel 1887)	X			
<i>Peridium piriforme</i> Popofsky 1908 (?)			X	
<i>Peridium triclavigera</i> (Tan et Cheng 1976)				X
<i>Peridium spinipes</i> Haeckel 1887		X	X	X
<i>Peromelissa phalacra</i> Haeckel 1887				X
<i>Phorticium polykladum</i> Tan et Cheng 1976		X		X
<i>Platybursa cancellata</i> (Haeckel 1887) (= <i>Cantharospyris platybursa</i> Haeckel 1887)				X
<i>Plegmosphaera coronata</i> Hollande et Enjumet 1960		X	X	
<i>Plegmosphaera entodictyon</i> Haeckel 1887	X	X	X	
<i>Polysolenia lappacea</i> (Haeckel 1887)				X
<i>Pterocanium charybdeum</i> (Müller 1858) <i>trilobum</i> (Haeckel 1860)			X	
<i>Pterocanium praetextum praetextum</i> (Ehrenberg 1873a)		X		X
<i>Pterocorys fastuosus</i> (Ehrenberg 1873a)				X
<i>Pylolena hexagona</i> Chen et Tan 1989				X
<i>Pyloniidae</i> gen. et sp. indet.		X		
<i>Siphonosphaera socialis</i> Haeckel 1887	X			X
<i>Sphaerozoum fuscum</i> Meyen 1834		X		
<i>Spongaster tetras tetras</i> Ehrenberg 1862b		X		X
<i>Spongosphaera polycantha</i> Müller 1858			X	
<i>Spongosphaera streptacantha</i> Haeckel 1860	X	X	X	X
<i>Spongosphaera</i> aff. <i>streptacantha</i> Haeckel 1860		X		
<i>Spongotrochus brevispinus</i> Haeckel 1860		X		X
<i>Spongotrochus longispinus</i> Haeckel 1860				X
<i>Stichopilidium</i> (?) <i>kruegeri</i> (Popofsky 1908)				X

Table 2. Continued.

<i>Styptosphaera spongiacea</i> Haeckel 1887	X			X
<i>Tetrapyle octacantha</i> Müller 1858			X	
<i>Tetrapyle quadriloba</i> (Ehrenberg 1862b)	X			X
<i>Thalassosphaera bifurca</i> Haeckel 1887	X			
<i>Theocalyptra tricostatum</i> (Haeckel 1887)	X	X		
<i>Theophormis callipilium</i> Haeckel 1887	X		X	
<i>Tholospiridium cervicornis</i> Haeckel 1887 group				X
<i>Xiphosphaera</i> (?) <i>tesseractis</i> Dreyer 1913	X		X	

each taxon, labeled with the modern taxon name, presented on plates 1 to 44 [P-2 in CD]. As there is no published research work on these plankton radiolarian slides this is the first work to illustrate a substantial portion of the collection. These images make the content of this critical collection accessible to the international community of radiolarian specialists, and will provide the base for future revision of Haeckel's taxonomic concepts and designation of new types for his taxa.

Station 269: Plates 35 to 43

Challenger Station 269 is located at 5°54'0"N and 147°2'0"W (Fig. 9). Nine registered plankton slides made from the tow-net material of the surface ocean near the Challenger Station 269 were examined and all polycystine radiolarian specimens have been digitally captured. The date on the label is August 31 to September 1, 1875.

According to the Haeckel (1887) and "Summary of Results volume" of the Challenger expedition reports, 47 living radiolarian species have been recorded at the station, and 22 of these species were described as new. Our examination of these nine slides identified 30 polycystine radiolarian species, and only the species *Theocalyptra tricostatum* (Haeckel, 1887) (originally described as *Theopilium tricostatum*), is confirmed as present (pl. 42, figs. 2a–b) from the list of species on the surface plankton list for this Station by Haeckel (1887).

Station 270: Plates 1 to 14

Challenger Station 270 is located at 2°34'0"N and 149°9'0"W (Fig. 9). At Station 270, 87 radiolarian species were recorded from the sediments (*Globigerina* ooze) obtained by dredge at depth of 2925 fathoms, while a total of 87 living species reported from the surface.

Eleven registered plankton slides dated September 4, 1875 from this station were fully examined. Thirty-two polycystine species were identified; of these, 23 species are spumellarians and the rest (9) are nassellarians. The spumellarians are characterized by abundant *Spongosphaera streptacantha*, common *Flustrella arachnia*, *Arachnosphaera hexasphaera* and *Spongaster tetras*, and a few *Actinomma arcadophorum*.

Eighty seven living radiolarian species have been reported from the surface material at Station 270 and 44 of these were new species (Haeckel, 1887). Comparing our occurrence list with Haeckel's list identifies two taxa in common: *Hexapyle dodecantha* Haeckel 1887 (pl. 3, figs. 6a–b) and *Theocalyptra tricostatum* (Haeckel, 1887) (pl. 4, figs. 2a–b).

It is noteworthy that the species *Hexacantium elegans* (Haeckel, 1887) is present in Station 270 (Plate 9, figs. 1a–c, 2a–b). The species was originally described as *Hexacromyum elegans* Haeckel (see Plate 9, fig. 3). The illustrated specimens are almost identical in morphology to the original figure shown by Haeckel (1887).

Station 271: Plates 15 to 23

Challenger Station 271 is located at 0°33'0"S and 151°34'0"W (Fig. 9). Station 271 is very famous for producing numerous radiolarian species both from surface (plankton) and sediment materials. A total of 549 radiolarian species were reported from the bottom sediment (Globigerina ooze) obtained by dredge at depth of 2425 fathoms, while 342 living radiolarian species of Polycystina, Acantharia and Phaeodaria were recorded from the surface at this station (Haeckel, 1887). A total of 106 out of 293 polycystine species were described as new at the station.

The two registered plankton slides marked September 6, 1875 were examined. A total of 34 species were identified; 23 species are Spumellaria and 11 are Nassellaria. Abundant spumellarians such as *Archnosphaera hexasphaera* Popofsky, *Spongospaera streptacantha* Haeckel, *Plegmosphaera entodictyon* Haeckel and unusual porodiscids including *Dicranastrum furcatum* Haeckel, *Dicranastrum wyvillei* Haeckel, and *Myelastrum octocorne* Haeckel characterize the fauna at this station. Nassellarians such as *Pterocanium charybdeum trilobum* (Haeckel), *Dictyocodon palladius* Haeckel, *Theophormis callipilium* Haeckel, *Eucecryphalus coscinodiscus* (Haeckel), *Clathrocanium coarctatum* Ehrenberg are seen as well (Plate 16).

Comparing our occurrence list with Haeckel's surface radiolarian list from Station 271, we can match five species in this study that were recorded as new species in Haeckel (1887): *Centroculus octostylus* (pl. 21, figs. 3a–b), *Dicranastrum furcatum* (pl. 17, figs. 2a–c), *Myelastrum octocorne* (pl. 17, figs. 4a–b, pl. 23, figs. 4a–b), *Lychnosphaera regina* (pl. 15, fig. 5), and *Dictyocodon palladius* (pl. 16, figs. 2a–b).

Station 272: Plates 24 to 34

Challenger Station 272 is located at 3°48'0"S and 152°56'0"W (Fig. 9). Station 272 is also well-known to have numerous species both from the surface (plankton) and sediment materials. A total of 274 radiolarian species were reported from the bottom sediment (radiolarian ooze) taken by dredge at a depth of 2600 fathoms, while 127 living species were observed from the surface at this station (Haeckel, 1887).

Seven registered plankton slides, dated September 8, 1875, were examined. A total of 37 species were identified. Of these, 25 species belong to Spumellaria and 12 to Nassellaria. Common spumellarians at this station are *Flustrella arachnia*, *Collosphaera tuberosa*, *Spongospaera streptacantha*, and *Dictyocoryne elegans*; with rare *Dicranastrum* cf. *furcatum* and *Myelastrum octocorne*. Nassellarians include *Pterocanium praetextum praetextum*, *Nephrospyris paradictyum*, *Nephrospyris renilla*, *Stichopilidium* (?) *kruegeri*, *Lophosphaena hispida*, *Cantharospyris platybursa*, and *Pterocorys fastuosus*.

It is noteworthy that intact shells of *Periarachnium myxobrachia* (Strelkov and Reshetnyak 1959) embedded in a cylindrical gelatinous mass were observed by us from this station (Plate 30, figs. 5a–d; Plate 32, figs. 4a–b). The gelatinous body shows that there are numerous symbionts in it. It is the only nassellarian species in all radiolarian literatures known to have a gelatinous soft body. This species was originally described, almost 85 years after the H.M.S. *Challenger* expedition, from the western Pacific sector of the northern Tropics as *Sethoconus myxobrachia* by Strelkov and Reshetnyak (1959). Since then, however, only limited records of the siliceous shell have been reported in the literature (Petrushevskaya, 1971, 1981; Renz, 1974, 1976; Tang and Tchang, 1976; Takahashi, 1991; Nishimura and Yamauchi, 1984). This species was also illustrated by Petrushevskaya (1986, fig. 7-I, p. 18) who clearly showed the gelatinous body with a siliceous shell, but still with no photographs. Recently, Tan and Tchang (1999) reported the occurrence of the species from the East China Sea, but they showed only a sketched figure without

photographs (Fig. 5-255). Therefore, regarding the bizarre larger-sized species, it would be a first opportunity to be presented its distinct morphology with developed and matured shell embedded in a soft gelatinous body in photographic images.

Station 236: Plate 44

Station 236 is located off Omaezaki, Japan (Fig. 9). The exact location is 34°58'0"N and 139°29'0"E. A total of 28 radiolarian species was recorded from the surface at the station (Haeckel, 1887). A single registered slide dated of June 5, 1875 was examined. Four species were identified: *Dictyocoryne muelleri*, *Dictyocoryne profunda*, *Spongaster tetras tetras*, and *Styp-tosphaera spongiacea*.

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(Note: All the plates and other tables are prepared as the attachment in the CD at the back of the monograph.)