JOINT HAECKEL and EHRENBERG PROJECT: Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, edited by Y. Tanimura and Y. Aita, pp. 1–5. National Museum of Nature and Science Monographs, No. 40, Tokyo 2009

Joint Haeckel and Ehrenberg Project "Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy": a Summary

Yoshihiro Tanimura[1], Akihiro Tuji[2], Yoshiaki Aita[3], Noritoshi Suzuki[4], Kaoru Ogane[4] and Toyosaburo Sakai[3]

[1] Department of Geology and Paleontology, National Museum of Nature and Science, 3–23–1 Hyakunin-cho, Shinjuku-ku, Tokyo 169–0073, Japan
[2] Department of Botany, National Museum of Nature and Science, 4–1–1, Amakubo, Tsukuba 305–0005, Japan
[3] Department of Geology, Faculty of Agriculture, Utsunomiya University, Utsunomiya 321–8505, Japan
[4] Institute of Geology and Paleontology, Graduate School of Science, Tohoku University, 6–3 Aoba Aramaki, Aoba-ku, Sendai 980–8578, Japan
Corresponding Author: Yoshihiro Tanimura (tanimura@kahaku.go.jp)

Abstract As an introduction to this volume, the results of the reexamination of C. A. F. Castracane's diatom collection and E. H. Haeckel's radiolarian collection in the Natural History Museum in London, C. G. Ehrenberg's diatom and radiolarian collections in the Museum für Naturkunde at the Humboldt University in Berlin, and Haeckel's radiolarian collection from Messina in the Ernst-Haeckel Haus in Jena are summarized.

Key words: Reexamination, C. A. F. Castracane, E. H. Haeckel, C. G. Ehrenberg, Microfossil Collections

Introduction

In studies on the documentation of biodiversity through the geologic past to recent times and on geological age assignments and reconstruction of paleoceanographic environments by microfossils, classifications based on "types" are the main means for a common understanding of "species." Conte Francesco Castracane degli Antelminelli (1817–1899) described about 260 new diatom species and varieties from the materials collected during the voyage of the H.M.S. *Challenger*. Ernst Heinrich Haeckel (1834–1919) described 3,500 new radiolarian species from the *Challenger* Expedition and reported about 60 new living radiolarian species from the Mediterranean Sea at Messina. Christian Gottfried Ehrenberg (1795–1876) described a thousand new diatom species and nearly 500 radiolarian species from material derived from all over the world. In those days, however, the concept of "types" was not yet fully developed, and many species described by them have been ignored or even regarded as synonyms.

With careful curation, Castracane's diatoms and Haeckel's Radiolaria from the materials collected through the *Challenger* Expedition, the microfossil and microalgal collections of Ehrenberg, and Haeckel's radiolarian collection from Messina are housed in the Natural History Museum (NHM) in London, the Museum für Naturkunde at Humboldt University in Berlin, and the Ernst-Haeckel Haus in Jena, respectively, as historical and scientific legacies of these great scien-

tists of the 19th century.

As one of the extensive activities of the Micropaleontological Reference Centers, the Joint Haeckel and Ehrenberg Project, "*Taxonomic reexamination of the Ehrenberg and Haeckel microfossil collections and reconstruction of the taxonomic image database of type specimens*," was conducted for 2 years during fiscal years 2004 and 2005. During the reexamination, we accomplished the following: a list of all of Castracane's diatom slides in the NHM, and designation of types for the species described by him; designation of types for diatom species described by Ehrenberg to clarify Japanese diatom endemism; a list of the type species of 134 radiolarian genera whose type species were selected from Ehrenberg's species by later authors; a list of all of Haeckel's radiolarian slides in the NHM, and capture by digital imaging of all radiolarian slides and selected radiolarian specimens in the slides from Haeckel's collection; identification and illustration of modern radiolarians from slides from the five *Challenger* plankton stations; capture by digital imaging of all of the specimens prepared by Haeckel from Messina in the Ernst-Haeckel Haus; and capture by digital imaging of Neogene polycystine radiolarians and Paleogene-Neogene polycystine radiolarians of Barbados from the Ehrenberg Collection.

As a result of the above achievements, we have provided scientists with an open database of Castracane, Haeckel, and Ehrenberg types/collections of diatoms and radiolarian taxa.

H.M.S. *Challenger* Expedition Collection in the NHM, London

Castracane (1886) described 259 new diatom taxa from the mud and plankton samples collected during the voyage of the H.M.S. *Challenger* [T-2 on CD]. Castracane's diatom collection consisting of 143 microscope slides from the voyage is housed in the NHM, London. We listed all diatom preparations prepared by him from the *Challenger* Expedition materials [T-1 on CD].

Tuji *et al*. (2009) examined the collection for type slides, and discovered 17 type specimens. Details of their type status and illustrations are provided in Tuji *et al*. (2009) [P-1 Tuji *et al*., 2009, Pl. 1–10, on CD].

No other slide collection exists of Castracane's *Challenger* material. Some of the original material collected during the *Challenger* Voyage is retained in the Mineralogy Department, NHM, and we prepared 27 diatom slides from newly collected subsamples from the original material. Specimens on the slides should be considered as isotype material in future studies (Tuji *et al*., 2009) [A-3 on CD].

Haeckel (1887) named and described 2,775 new polycystine radiolarian species from *Challenger* Expedition materials. Haeckel's radiolarian collection is housed in the Micropalaeontology Section of the NHM in London. The collection consists of seven sets of 34 radiolarian "teaching" slides prepared by him and many plankton radiolarian slides made from the *Challenger* and other plankton stations. The teaching slide sets and the plankton slides are the only available plankton materials left from the *Challenger* Expedition still available for research purposes, but some of the teaching slides are poorly preserved (Aita *et al*., 2009).

Aita *et al*. (2009) listed all of Haeckel's radiolarian microscope slides in the NHM (Table 1 in Aita *et al*., 2009) and prepared a locality list of recent slides and location map of the slides [A-1 and -2 on CD]. They digitally captured images of all the slides and selected radiolarian specimens from each slide [P-2, Aita *et al*., 2009, Pl. 1–46; P-6, Aita *et al*., 2009, Figs. 1–8, both on CD] and identified modern radiolarians based on the slides from the five *Challenger* plankton stations: 269, 270, 271, 272, and 236 (Table 2 in Aita *et al*., 2009).

A nearly complete set of the original material collected during the *Challenger* Voyage is

housed in the Mineralogy Department, NHM, and we prepared 46 radiolarian slides based on newly collected subsamples from the original material. They are of topotype status and invaluable resources for designating new types for Haeckel's Radiolaria (Aita *et al*., 2009). [A-3 and -4, for slide preparation procedure A-5, on CD].

E. H. Haeckel's Radiolarian Collection in the Ernst-Haeckel Haus

Haeckel (1860a, 1860b, 1862) named and described 59 new polycystine radiolarian species from Messina, and the slides examined by him are housed in the Ernst-Haeckel Haus in Jena, Germany. The slides are kept in two wooden boxes labeled "Messina 1859." Sakai *et al*. (2009) found 16 species described by Haeckel and one species named by Müller from slides in the two boxes. Sakai *et al*. (2009) digitally captured images of all the specimens from Messina in the boxes [P-3, Sakai *et al*., 2009, Pl. 1–23, on CD]. Further examination of Haeckel's original slides is still needed for taxonomic stability (Sakai *et al*., 2009).

C. G. Ehrenberg's Collection in the Museum für Naturkunde at Humboldt University, Berlin

Ehrenberg named and described a thousand diatom species that were mostly newly described in *Mikrogeologie* (Ehrenberg, 1854). To understand Japanese diatom endemism, Tuji (2009) examined seven diatom species (*Cocconeis lineata*, *Cocconeis placentula*, *Gallionella sculpta*, *Gomphonema subtile*, *Gomphonema vibrio*, *Navicula rhomboides*, *Stephanodiscus sinensis*) described by him using the materials in the Ehrenberg Collection, and designated lectotypes and epitypes for these seven taxa.

In addition to the history and status information of the Haeckel and Ehrenberg radiolarian collections, Lazarus and Suzuki (2009) provided a list of the correct dates regarding the publication of Ehrenberg's papers, based on the printing date given in the original journal volumes (Table 1 in Lazarus and Suzuki, 2009).

Ehrenberg named and described a total of 501 radiolarian species belonging to 71 genera (Suzuki, 2009). The Ehrenberg Collection in the Museum für Naturkunde at Humboldt University includes the type specimens of 486 radiolarian species. Suzuki (2009) reviewed Ehrenberg's studies on polycystine radiolarians and listed the type species of 134 genera whose type species are selected from Ehrenberg's species by later authors (Table 1 in Suzuki, 2009). Using Ehrenberg's original taxonomic drawings and the index volumes prepared by his daughter, Clara Ehrenberg, Suzuki *et al*. (2009b) and Ogane *et al*. (2009) digitally captured about 1150 radiolarian specimens from the Ehrenberg Collections. Suzuki *et al*. (2009a) examined and illustrated all the remaining Neogene polycystine radiolarian specimens examined by Ehrenberg [P-4, Suzuki *et al*., 2009b, Pl. 1–77, on CD]. These specimens are candidate lectotypes (Suzuki *et al*., 2009b). However, they did not designate types so as to avoid taxonomic confusion caused by a rigid application of the International Code of Zoological Nomenclature (ICZN). Ehrenberg (1846) examined "Barbados Earth," and reported 282 species from the sample. Ogane *et al*. (2009) found 250 species from the collection, reexamined the species, and digitally captured images of each species [P-5, Ogane *et al*., 2009, Pl. 1–98, on CD].

Lazarus (1998) and Lazarus and Jahn (1998) documented detailed procedures on how to find specimens examined by Ehrenberg, and Suzuki *et al*. (2009a) additionally provide a guide for scientists on "how to find target specimens."

Remarks

We produced images of thousands of diatoms and radiolarian specimens digitally captured from the C. A. F. Castracane, E. H. Haeckel, and C. G. Ehrenberg Collections in the 254 plates in this volume, and listed all of Castracane's diatom slides and all of Haeckel's radiolarian slides in the NHM. In addition to these, we prepared 73 diatom and radiolarian slides from the *Challenger* Expedition materials.

For precise usage of the scientific names of diatoms and radiolarian species described by Castracane, Haeckel, and Ehrenberg, we provide scientists with digital images of the species as an open database in this volume, and provide them with some collection lists for easy access to the collections. To avoid confusion on taxonomic name usages, typification of the new taxa has not been performed except for Castracane's diatom specimens in the NHM and seven of Ehrenberg's diatom specimens in the Ehrenberg Collection.

Acknowledgments

We thank the curators and researchers in the Natural History Museum in London, the Wandsworth storage facility of the Natural History Museum, the Museum für Naturkunde at Humboldt University in Berlin, and the Ernst-Haeckel Haus in Jena for providing full access to the C. A. F. Castracane, E. H. Haeckel, and C. G. Ehrenberg Collections. Without their cooperation, this project would not have been possible.

References

Aita, Y., N. Suzuki, K. Ogane, T. Sakai, D. Lazarus, J. Young & Y. Tanimura, 2009. Haeckel Radiolaria Collection and the H.M.S. Challenger Plankton Collection. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 35–45.

Castracane, C. A. F., 1886. Report on the Diatomaceae collected by H.M.S. Challenger during the years 1873–1876. *Rep. Sci. Res. Voy. H.M.S. Challenger 1873–1876, Bot.*, **2**, 1–178, 30 pls.

Ehrenberg, C. G., 1846. Über eine halibiolithische, von Herrn R. Schomburgk entdeckte, vorherrschend aus mikroskopischen Polycystinen gebildete, Gebirgsmasse von Barbados. *Ber. Königl. Preuß. Akad. Wiss. Berlin*, **1846**: 382–385.

Ehrenberg, C. G., 1854. Mikrogeologie. Voss, Leipzig, 374 pp.

Haeckel, E., 1860a. Über neue, lebende Radiolarien des Mittelmeeres und legte die dazu gehörigen Abbildungen. *Monat. Königl. Preuß. Akad. Wiss. Berlin*, **1860**: 794–817.

Haeckel, E., 1860b. Fernere Abbildungen und Diagnosen neuer Gattungen und Arten von lebenden Radiolarien des Mittelmeeres. *Monat. Königl. Preuß. Akad. Wiss. Berlin*, **1860**: 835–845.

Haeckel, E., 1862. Die Radiolarien (Rhizopoda Radiolaria). Eine Monographie. Tafel 1. Reimer, Berlin, 572 p.

Haeckel, E., 1887. Report on the Radiolaria collected by H.M.S. Challenger during the years 1873–1876. *Rep. Sci. Res. Voy. H.M.S. Challenger 1873–1876, Zool.*, **18**: 1–1803.

Lazarus, D. B., 1998. The Ehrenberg Collection and its curation. *In* W. D. M., Huxley, R. (ed.), Christian Gottfried Ehrenberg (1795–1876), The Man and His Legacy. Special Publication of the Linnean Society, 14–29, Academic Press.

Lazarus, D. & R. Jahn, 1998. Using the Ehrenberg collection. *Diatom Res.*, **13**: 273–291.

Lazarus, D. & N. Suzuki, 2009. Introduction to the reexamination of the Haeckel and Ehrenberg radiolarian collections. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 23–34.

Ogane, K., N. Suzuki, Y. Aita, T. Sakai & D. Lazarus, 2009. Ehrenberg's radiolarian collections from Barbados. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg

Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 97–106.

Sakai, T., N. Suzuki, K. Ogane, D. Lazarus, O. Breidbach & T. Bach, 2009. Haeckel's Messina radiolarian collection housed in the Ernst-Haeckel-Haus. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 47–54.

Suzuki, N., 2009. Radiolarian studies by Christian Gottfried Ehrenberg (1795–1876) and the value of his species as type species of genera. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 55–69.

Suzuki, N., D. Lazarus, K. Ogane, Y. Aita & T. Sakai, 2009a. General results of reexamination of Ehrenberg's radiolarian collections: with instruction on efficient methods to find microfossils from the collection. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 71–86.

Suzuki, N., K. Ogane, Y. Aita, T. Sakai & D. Lazarus, 2009b. Rexamination of Ehrenberg's Neogene radiolarian collections and its impact on taxonomic stability. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 87–96.

Tuji, A., 2009. Examination of type materials and typification of seven diatoms described by C. G. Ehrenberg. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 13–21.

Tuji, A., D. M. Williams, P. A. Sims & Y. Tanimura, 2009. An Illustrated Catalogue of Type Specimens from the H.M.S. Challenger Voyage in Castracane's Slide Collection in the Natural History Museum, London. *In* Y. Tanimura & Y. Aita (eds.), Joint Haeckel and Ehrenberg Project, Reexamination of the Haeckel and Ehrenberg Microfossil Collections as a Historical and Scientific Legacy, National Museum of Nature and Science Monographs, **40**: 7–11.