SHORT NOTE

Radiolarians from the British North-Polar Expedition (1875–1876): re-examination of the H. B. Brady (1878) collection

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Abstract
The earliest report on radiolarians from the Arctic Ocean (north of the Arctic Circle) was provided by H. B. Brady (1878). He documented the occurrences of 10 genera from soundings in northern Baffin Bay and north of Greenland, but he did not illustrate any specimens in his report. We have re-examined Brady's original slide collection, housed at the Natural History Museum, London (NHM), in order to refine his radiolarian identifications to species level. We have identified 11 radiolarian taxa in his slides, but some are definitely more characteristic of tropical oceans rather than high northern latitudes. We conclude that this is most likely due to sample contamination or misidentification of samples. Therefore, the actual occurrence of tropically affiliated radiolarians recorded from the Arctic is uncertain and should be regarded with suspicion.

Keywords: Arctic, British North-Polar Expedition (1875–1876), H. B. Brady, Radiolaria

Introduction
Henry Bowman Brady (1835–1891), a 19th-century English natural historian, reported on foraminifers and radiolarians (Protista) in sediments, collected by the British North-Polar Expedition (1875–1876) in northern Baffin Bay and the Arctic Ocean (Brady 1878). In Brady’s report a total of 10 genera of radiolarians (Actinomma, Dictyopodium, Euchitonia, Haliomma, Heliodiscus, Spongaster, Spongodiscus, Spongotrechus, Tetrapyle, and Trematodiscus) was identified from six sounding stations (Figure 1), representing the first report on radiolarians from north of the Arctic Circle.

Because Brady was not himself a radiolarian specialist, he sent the radiolarian material to Dr Ernst Haeckel, an eminent German professor of zoology who was an expert on radiolarian taxonomy. However, Haeckel did not identify any of the radiolarians to species level. As quoted by Brady (1878), he wrote: “…there was no great difficulty in assigning the various forms which were obtained to their generic types; but it was found impossible to determine the species satisfactorily from published authorities”. Brady did not figure any of...
the reported taxa, and therefore his work on radiolarians is nowadays considered of little or no taxonomic importance. However, the report is interesting from a biogeographical point of view. The radiolarians reported by Brady include some genera, *Tetrapyle*, *Spongaster*, and *Euchitonia*, more typical of lower latitudes, according to the modern distribution (e.g. Nigrini and Moore 1979; Lombari and Boden 1985). Haeckel’s opinion (in Brady 1878) was that these Arctic assemblages were similar to those from the equatorial Pacific region obtained by the H. M. S. *Challenger* Expedition.

No subsequent workers have reported any of the low latitude radiolarians such as *Tetrapyle*, *Spongaster*, and *Euchitonia* mentioned by Brady from the Arctic (e.g. Cleve 1899; Meunire 1910; Bernstein 1931, 1932, 1934; Hülsemann 1963; Tibbs 1967; Kruglikova 1989; Swanberg and Eide 1992; Bjørklund et al. 1998; Bjørklund and Kruglikova 2003;
Itaki et al. 2003). Bjørklund and Kruglikova (2003), who reported radiolarians in surface sediments widely collected from the Arctic areas, listed these low latitude taxa as a citation from Brady (1878), but they did not find such forms in their materials. However, radiolarian associations from northern Baffin Bay and off northern Greenland are still unknown due to few and very limited investigations in this area. Hence, it is unclear if the warm water radiolarians reported by Brady are actually local to this area, or simply a result of misidentification.

The original radiolarian slide collection of H. B. Brady, from the British North-Polar Expedition (1875–1876), is housed at the Natural History Museum, London (NHM). In order to clarify the identity of Brady’s Arctic radiolarians, we have tried to identify all specimens in the collection to species level, in accordance with the current taxonomic framework.

**Brady’s radiolarian taxa: what was his species concept?**

Brady originally reported radiolarians from six sounding stations: AA, B, F, J, K, and X. However, in the repository, the NHM, the collection is incomplete; five slides (one cavity and four Canada balsam mounted slides), originating from three stations, X, B, and F, are present, while the slides from Stations AA, J, and K are missing. One cavity slide and two Canada balsam mounts originated from Station X. There is one Canada balsam mount from each of Stations B and F.

The labels of the slides include generic names in addition to locality information: “Spongotrochus” at Station B; “Haliomma, Tetrapyle sp., Spongaster, Euchitonia, and Heliodiscus” at Station F; “Euchitonia” at Station X (Slide 1; strewn slide), and “Tetrapyle? and Spongotrochus” at Station X (Slide 3; cavity slide). However, the names of three genera reported by Brady (1878): Actinomma, Dictyopodium, and Trematodiscus, were not found.

In the collection a total of 35 radiolarian specimens was observed, from which 11 taxa were recognized: Spongotrochus glacialis Popofsky (Figures 2-1–2-5), Spongodiscidae gen. et sp. indet. (Figure 2-6), Dictyocoryne profunda Ehrenberg (Figures 2-9, 2-10), Dictyocoryne truncatum Ehrenberg (Figure 2-11), Euchitonia elegans (Ehrenberg ) (Figure 2-12), Spondaster tetras Ehrenberg (Figures 2-7, 2-8), Stylodictya sp. (Figure 2-13), Phorticium clevei Jørgensen (Figure 2-16), Tetrapyle sp. (Figure 2-17), Heliodiscus asteriscus Haeckel (Figures 2-14, 2-15), Hexacontium sp. (Figures 2-18–2-20). Details of radiolarians found in each slide are as follows (Table I).

Station B (off Cape Isabella, 220 fathoms, latitude 78°20’N). Eighteen specimens of Spongotrochus glacialis are mounted on the slide. Brady noted that it “contained more than one species of Spongotrochus” [the original].

Station F (between Walrus Shoal and Victoria Head, 8 September 1876, 57 fathoms, latitude 79°26’N). This slide contained a total of 14 radiolarian specimens, which included: Hexacontium sp. (three), Heliodiscus asteriscus (two), Spondaster tetras tetras (two), Dictyocoryne profunda (two), Dictyocoryne truncatum (one), Stylodictya sp. (one), Tetrapyle sp. (one), Phorticium clevei (one), and Spongodiscidae gen. et sp. indet. (one). Brady (1878) reported the following five genera of Radiolaria: Haliomma, Tetrapyle, Heliodiscus, Spongaster, and Euchitonia, and these genus names also appear on the slide labels. The possible correspondence between our names and these of Brady are as follows: Haliomma = Hexacontium sp.; Tetrapyle sp. = Tetrapyle sp. and Phorticium clevei; Spongaster = Spongaster
tetras tetras; Euchitonia = Dictyocoryne profunda and Dictyocoryne truncatum; Heliodiscus = Heliodiscus asteriscus.

Station X (Sounding, 11 May 1876, 72 fathoms, latitude 83°19′N). There are three slides from this station. Slide 1: one specimen of Euchitonia elegans Ehrenberg, possibly corresponding to the genus “Euchitonia” which Brady reported from this station. Slide 2: no radiolarians were found on this slide. Slide 3: this cavity slide contained two specimens assigned to the families Pylonidae and Spongodiscidae, corresponding respectively to the two genus names, Tetrapyle? and Spongotrochus, on the slide label.

Biogeographic problem

As mentioned in the introduction, some genera reported by Brady from north of the Arctic Circle are generally known only from low latitudes. Our re-examination confirms that the following taxa are certainly present in Brady’s collection: Euchitonia elegans, Spongaster tetras tetras, Dictyocoryne profunda, and Dictyocoryne truncatum. All of these species have their main distribution at low latitudes (e.g. Nigrini and Moore 1979; Lombari and Boden 1985). There is a possibility that these warm water species may exist in a restricted area north of Greenland. However, they have not been reported from the Arctic region in any publications following Brady’s work.

The H. B. Brady collection also included a single slide from the H. M. S. Challenger Expedition, Station 271. Brady (1878) wrote that the Arctic radiolarians were identical to those Haeckel found in the H. M. S. Challenger material from Stations 268–274 including Station 271, and that the species were typically found in sediments from the central Pacific, from about 8° north and south of the equator, at depths of 2400–2900 fathoms (4000–5300 m). Our observations confirm that all of the warm water species present in Brady’s Arctic radiolarian collection were also present on the slide from H. M. S. Challenger Station 271 from the equatorial Pacific. It suggests that the Arctic radiolarians in samples from Stations F and X might be the result of either contamination of material or inaccurate labelling of samples from Station 271.

For these reasons, we consider the first report of radiolarians from north of the Arctic Circle (Brady, 1878) to be doubtful, at least as far as Stations F and X are concerned. We
report this negative result in order to provide reliable information about the Arctic radiolarians. Conversely, the slide from Station B contains only *Spongotrochus glacialis*, a common species in higher latitudes. The species is not found on the slide from Station 271 from the equatorial Pacific.

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