Marine Micropaleontology 72 (2009) 26–48

Contents lists available at ScienceDirect

Marine Micropaleontology

journal homepage: www.elsevier.com/locate/marmicro

Endemism and speciation in the polycystine radiolarian genus *Actinomma* in the Arctic Ocean: Description of two new species *Actinomma georgii* n. sp. and *A. turidae* n. sp.

Svetlana B. Kruglikova [a], Kjell R. Bjørklund [b], Øyvind Hammer [b], O. Roger Anderson [c,*]

[a] *P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovsky Prospect 36, 117883 Moscow, Russia*
[b] *Natural History Museum, Department of Geology, University of Oslo, PO Box 1172 Blindern, 0318 Oslo, Norway*
[c] *Biology, Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York 10964, USA*

ARTICLE INFO

Article history:
Received 13 September 2008
Received in revised form 21 February 2009
Accepted 28 February 2009

Keywords:
Biogeography
Ecology
Evolution
Micropaleontology
Oceanography
Population biology

ABSTRACT

Evidence, based on the species and high rank taxa composition and level of domination, skeletal morphological diversity and distributional data of radiolaria from sediment samples, is presented in support of a hypothesis of endemism for the Arctic polycystine fauna, especially arctic actinommids, as presented in the Discussion section. The arctic assemblages have low diversity, few species and very high level of domination of Actinommidae and Cannobotryidae. Two new endemic species, *Actinomma georgii* and *A. turidae,* are described based on their unique skeletal morphology. Although the geographic origins of these novel actinommids cannot be determined precisely based on existing knowledge of radiolarian reproductive processes and population biology, the preponderance of evidence presented here suggests that the unique features of the Arctic Ocean environment may contribute to elevated local speciation, and that the remarkable variability in skeletal morphology of Arctic Ocean actinommids may be enhanced by strong environmental selection pressures favoring relatively rapid speciation of polycystines in this high latitude oceanic regime. These actinommid species, including *Actinomma boreale,* without a 4th shell, are considered to be endemic and reproducing within the Arctic Ocean, suggesting that the two new species are environmentally adapted only to the particular environment of the Arctic Ocean. By contrast, *A. boreale* without a 4th shell is likely less adapted to this oceanic regime.

1. Introduction

In the Arctic Ocean, polycystines have been studied since the pioneering work by Meunier (1910), Bernstein (1932, 1934), Bogorov (1946), Hülsemann (1963), and Tibbs (1967). These authors studied only plankton samples, and consequently the radiolarian assemblages recovered were of restricted value as they only depicted the polycystines present at the time of sampling, and therefore could not give exact information about the species composition and their abundance during the rest of the year. In more recent years Kruglikova (1982, 1988, 1989), Bjørklund and Kruglikova (2003) studied the radiolarian fauna in the surface sediments of the Arctic Ocean, while Itaki et al. (2003) studied both plankton and sediment samples from the Chukchi and Beaufort Seas. To facilitate interpretation of the geography, we have included Fig. 1, showing the general bathymetry and the names of basins, ridges and oceans mentioned in the running text.

We estimate that at present there are 64 polycystine radiolarian species (19 spumellarians, 45 nassellarians) in the Arctic Ocean (Barents, Kara, Laptev, and Chukchi Seas, in addition to the Nansen, Amundsen, Makarov, and Canada Basins). An essential part of these species was found in our study of the surface sediments of the High Arctic Basins and the marginal seas. From our list of 64 species, 23 polycystine radiolarian species have been identified in plankton samples (Bjørklund and Kruglikova, 2003, Table 2).

It was earlier reported (Hülsemann, 1963; Kruglikova 1982, 1988, 1989) that the polycystines of the Arctic can be referred to three species complexes: arctic-boreal, bipolar, and cosmopolitan. Stepanjants et al. (2006) proposed that bipolarity in itself is not only a biogeographical phenomenon, but is in addition strongly influenced by ecological conditions. Species with an interrupted distribution in the tropical zone are classified as “Bipolar species TYPE 1”. Some polycystines are widely distributed in the Arctic Ocean, in the Arctic-Boreal area, and in the Antarctic zones, but these are also species with an uninterrupted distribution in the tropical zone. These species are usually referred to the group of cosmopolitan species, but they certainly have an ecological preference for the temperate zones of both hemispheres. Here they have their highest abundance, as opposed to

---

* Corresponding author. Fax: +1 845 365 8150.
E-mail address: ora@LDEO.columbia.edu (O.R. Anderson).

0377-8398/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.marmicro.2009.02.004

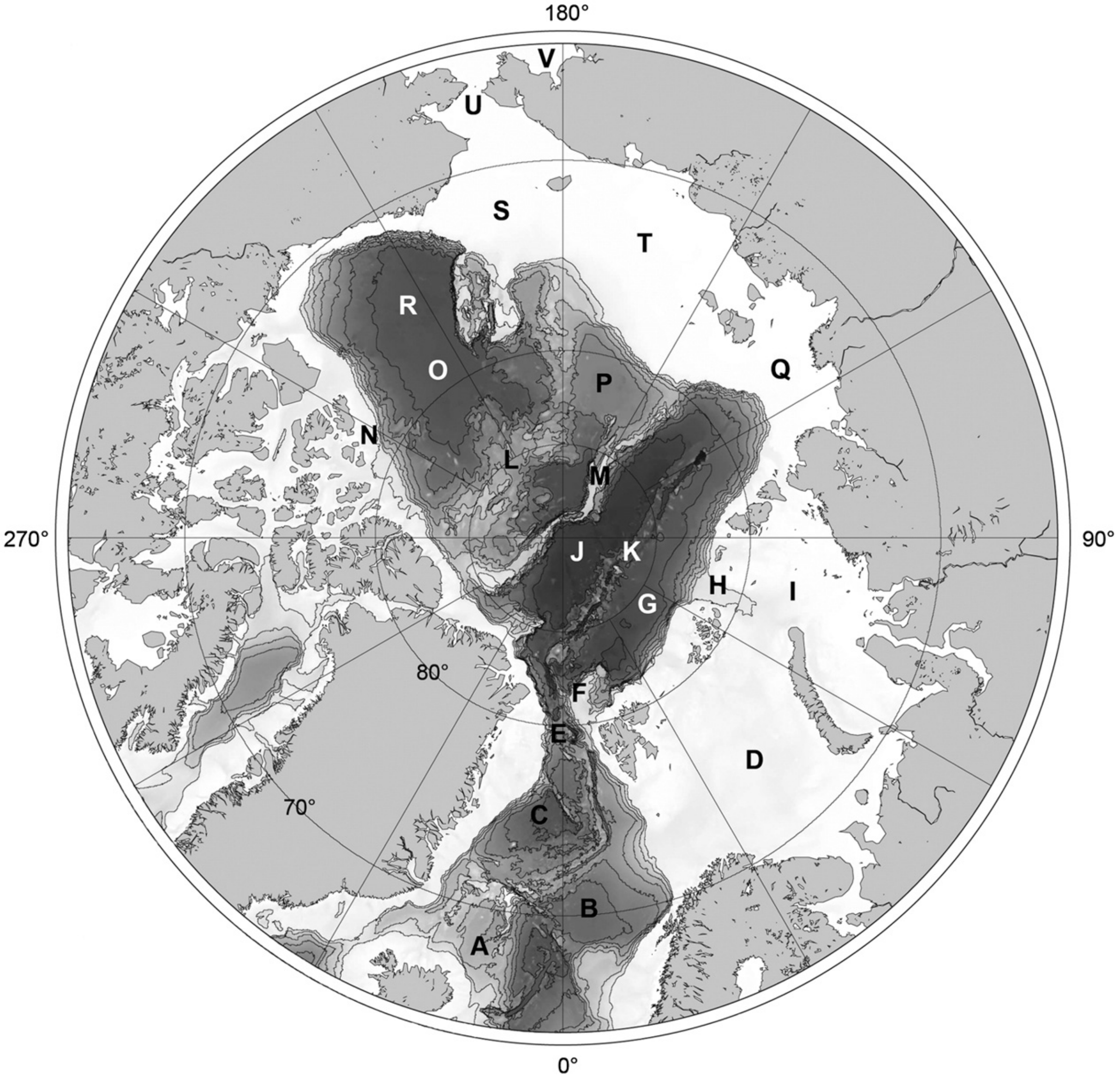

Fig. 1. Map of the Arctic Ocean and surrounding areas. Bathymetric grid data from Jakobsson et al. (2008). A: Iceland Sea. B: Norwegian Sea. C: Greenland Sea. D: Barents Sea. E: Fram Strait. F: Yermak Plateau. G: Nansen Basin. H: St. Anna Trough. I: Kara Sea. J: Amundsen Basin. K: Nansen-Gakkel Ridge. L: Alpha Ridge. M: Lomonosov Ridge. N: Canadian shelf. O: Canadian Basin. P: Makarov Basin. Q: Laptev Sea. R: Beaufort Sea. S: Chukchi Sea. T: East Siberian Sea. U: Bering Strait. V: Gulf of Anadyr.

the tropics. Some of these common species are *Corocalyptra craspedota* (Jørgensen), *Pseudodictyophimus gracilipes* (Bailey), *Cycladophora davisana* (Ehrenberg), *Lithomitra arachnea* (Ehrenberg), *Artostrobus annulatus* (Bailey) and others (see Bogorov, 1946; Hülsemann, 1963; Kruglikova, 1999; Bjørklund and Kruglikova, 2003). As was earlier supposed by Bogorov (1946), plankton species with this type of distribution also can be found submerged at great depths and polycystina are classified by us (Stepanjants et al., 2006) as “Bipolar species TYPE 2”. In spite of many species being in common between the Arctic Ocean and other cold-water areas of the World Ocean, the recent polycystine fauna of the Arctic Ocean is “endemic” in its unique faunal composition (i.e., quantitative ratios between species are the same as between high rank taxa). The distinctive feature of this fauna is the high dominance of a few species and high rank taxa up to 90–95% — the families Actinommidae and Cannobotryidae. Such high dominance of these two groups in one assemblage does not occur in any basins of the World Ocean.

The distinctive feature of this fauna is the high dominance of three species of the genus *Actinomma* (plus an *Actinomma* group of different morphotypes) and one species of the genus *Amphimelissa*, comprising up to 90–95% of the species composition, in the families Actinommidae and Cannobotryidae; while members of the family Spyridae are absent and members of the family Discoidea are rarely found. We recognize, however, that changes in species composition due to dissolution is always a consideration in doing faunal analyses from deep-sea sediments, but we have no specific evidence of dissolution of the polycystines that we are dealing with in this paper. While we do not observe any evident signs of dissolution on the surface of our actinommid shells, in some cases the set of medullary shells are more loosely organized. Our plates give a good presentation of the preservation quality of the *Actinomma* species present in our material. Actinommids are sufficient in number and quality to validate our descriptions of the two new and endemic species in the Arctic Ocean. Moreover, our research focuses on the taxonomy of some new species, the degree of actinommid endemism in the Arctic Ocean and possible rates of speciation, all of which appear to have occurred after the last glaciation. Therefore, we do not believe that dissolution effects would be a serious problem for our interpretations.