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New distribution records of the Arctic bryozoan *Uschakovia gorbunovi* Kluge, 1946 in the Barents and Greenland Seas

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Abstract

The bryozoan *Uschakovia gorbunovi* was initially characterized as a constituent member of benthic communities of the Kara and East-Siberian Seas. The academic literature reports this species in the Barents Sea, but without accurate information on sampling locations. Also, there are no previous records of this species in the northern Greenland Sea near Svalbard. Our analysis of benthic collections obtained during the past two decades revealed the occurrence of four distribution records of *Uschakovia gorbunovi* within the Barents and Greenland Sea specifying its distribution: one in the northwestern part of the area and three others in the waters surrounding Svalbard. The new distribution records may be related to inadequate sampling efforts or the expansion of this Arctic species into the Barents Sea, which may be due to either natural processes such as ocean currents, or introduction by mobile benthic species such as snow crabs.

Introduction

Bryozoans comprise a distinct group of aquatic organisms that form colonies composed of interconnected individuals. The Bryozoa predominantly inhabit marine environments, with various species distributed across all oceans, ranging from the littoral zone to abyssal depths (Ryland, 2005). Bryozoans play a significant ecological role in marine ecosystems by contributing to temperate and tropical carbonate sediments (Taylor *et al.*, 2015), serving as a food source for other marine species (Lidgard, 2008), and providing three-dimensional structures, attachment surfaces, and nursery grounds for various marine organisms, some of which have commercial importance (Wood and Probert, 2013; Taylor *et al.*, 2015). Due to their limited mobility, bryozoans have developed diverse adaptations and life-history traits to thrive in different environmental conditions (Ryland, 2005). This characteristic makes them valuable indicators for assessing habitat conditions (Pagès-Escolà *et al.*, 2018).

Information regarding the distribution and spatial patterns of biodiversity, both for benthic organisms in general and specifically for bryozoans, is important for monitoring long-term changes in the marine environment and mitigating anthropogenic impacts on the ocean (Cusson *et al.*, 2007; Cook *et al.*, 2018). The most comprehensive source for the diversity and distribution of Arctic bryozoans is a monograph by Kluge, originally published in Russian in 1962, and later translated into English and republished in 1975 (Kluge, 1962, 1975). Subsequent research has updated species lists and furnished new distribution records of Bryozoa in Arctic seas (Gontar and Denisenko, 1989; Denisenko, 2000, 2003, 2009, 2020, 2022a, 2022b; Gontar *et al.*, 2001; Kukliński, 2002; Kukliński and Hayward, 2004; Kuklinski and Taylor, 2006).

Uschakovia gorbunovi is a bryozoan species belonging to the order Cheilostomatida, suborder Flustrina, superfamily Buguloidea, and family Bugulidae. It was initially described by Kluge in 1946 (Kluge, 1946), based on benthic surveys conducted along the continental slope of the Kara and East-Siberian Seas (on the Novosibirsk shallow water) at depths spanning from 64 to 698 m during the late 1930s. *Uschakovia gorbunovi* has been confirmed to exist in Arctic seas through subsequent surveys (Gontar and Denisenko, 1989; Denisenko, 2011, 2022a) as well as in Iceland waters in the Greenland Sea (Micael *et al.*, 2022; Denisenko, 2022b). Hayward (1994) recorded this species in the southeastern Faroes at depths of 610–1400 m in 1987 (Cook, 2001). Denisenko (2022b) recently reported the occurrence of this species in the Barents Sea, but did not provide data on collection locations. Additionally, there is no information on the distribution of this species in the northern part of the Greenland Sea. New data on the distribution of this species can provide valuable insights into its ecology and expand our knowledge of the ways in which fauna formed and spread in former geological times.

The main objective of our study is to document new distribution records of *Uschakovia gorbunovi* in the Barents and Greenland Seas.

Materials and methods

In this study we used a dataset comprising more than 1500 benthic samples collected during 45 marine benthic surveys conducted in the Barents, Kara, and Laptev Seas over the past two decades (2003–2022). At each site three replicate samples were collected aboard research

Table 1. Characteristics of the sampling stations with records of *Uschakovia gorbunovi* in the study area

No.	Month	Year	Location	Latitude, N	Longitude, E	Depth, m	Temperature, °C	Salinity	Sediments at sampling station
1	Sep	2005	Svalbard, Barents Sea	77°29,944	27°27,721	155	1.31	34.97	Sandy silt, clay
2	Jul	2017	Svalbard, Barents Sea	77°49,144	30°50,385	234	−1.29	34.79	Silty clay
3	Nov	2019	Makarov Strait, Barents Sea	78°44,730	66°41,869	343	−0.20	34.90	Sandy silt, clay
4	Nov	2019	Svalbard, Greenland Sea	79°33,022	8°44,134	331	4.46	35.00	Sand, stones, shell

vessels at depths of 30–680 m using a Van Veen grab (0.1 m^2 sampling area). The collected samples were washed through a 0.5 mm sieve and fixed with 4% neutral-buffered formalin. Alongside the benthic samples, environmental variables such as water temperature and salinity were also measured using standard devices such as CTD profilers at each sampling location.

The identification of bryozoans was undertaken using an MBS-10 stereomicroscope, following the guidelines outlined in the above mentioned monograph (Kluge, 1962). A total of four colonies of *Uschakovia gorbunovi* were found in the samples (Table 1). The first finding of this species dates back to 2005, with subsequent records spanning from 2017 to 2019 (Table 1). All colonies were attached to small pebbles.

One bryozoan colony was photographed with a Cannon EOS DSLR camera for reference.

Results and discussion

Three colonies of *Uschakovia gorbunovi* were collected in Svalbard waters (two in the Barents Sea and one in the northern part of the Greenland Sea), while one was collected in the Makarov Strait, an area situated between Franz Josef Land and Novaya Zemlya in the northeastern Barents Sea (Figure 1).

According to the initial description by Kluge (1946, 1962), a colony of *Uschakovia gorbunovi* is erect and arises from an ancestrula that is anchored by rhizoids, which then leads to the emergence of several founding zooids that exhibit the same ability to develop rhizoids. This erect, branched part of the colony develops from either one zooid or a compact sequence of linking zooids, which display an extraordinary degree of elongation. The branches of autozooids are grouped in alternating pairs and triads, before transitioning into a quadriserial configuration and subsequently undergoing bifurcation. This primary branch divides several times, creating a cluster of four to six branches. Autozooids possess a long, tubular, proximal gymnocyst that expands distally to surround an elongated opesia. Outward-facing zooids are equipped with a bipartite opesia, wherein the distal part is covered by a frontal membrane that surrounds operculum, and the proximal part is composed of the swollen bases of a pair of long, partially cuticular spines. In contrast, the inward-facing zooids show no spines, but they have an elongated opesia. Avicularia arise from the proximal gymnocyst of both zooid types; the subrostral chamber is significantly elongated and expands distally, forming a terminally hooked, acute rostrum. The presence of ovicells remains unidentified within this species.

Unlike Kluge (1946), who recorded a fully developed colony (as suggested from his initial description and illustration), we were able to photograph a small colony consisting of either a young developing colony (according to its small size) or a fully developed colony with only one linking zooid (Figure 2).

Founding zooids, spines, and ancestrulae were likely missed during grab sampling – a process that may preclude successful collection of intact, delicate colonies of deep-water bryozoans

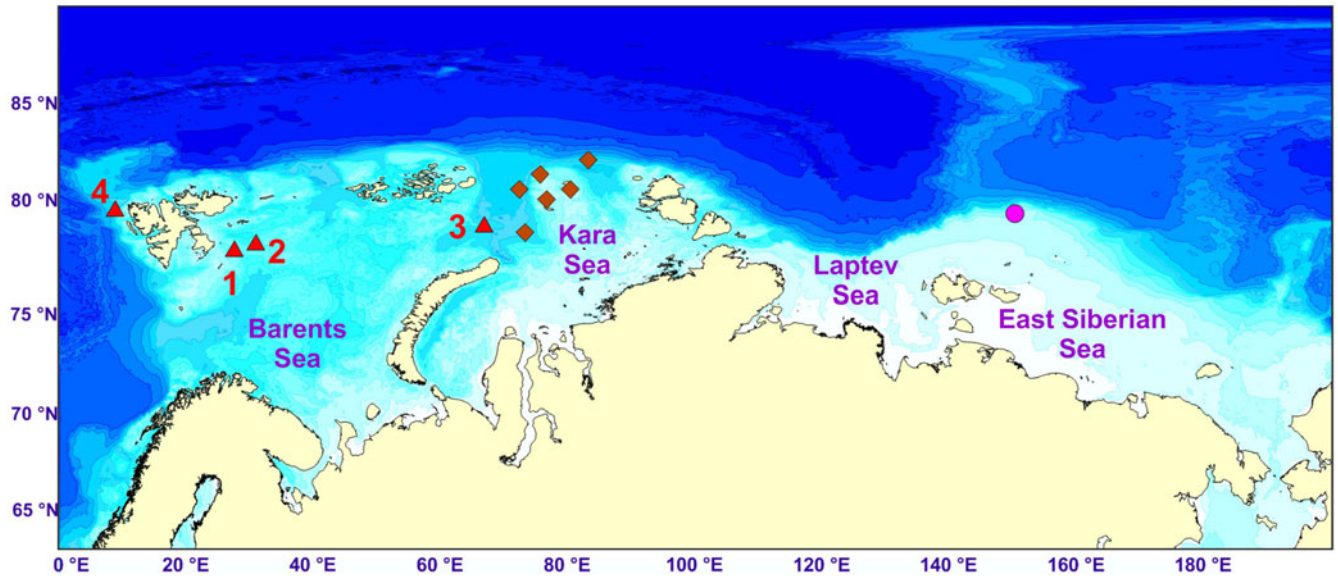

Figure 1. Records of *Uschakovia gorbunovi*. Pink circle – initial finding by Kluge (1946) in the East Siberian Sea, orange diamonds – initial findings by Kluge (1946) in the Kara Sea, red triangles – present findings in the northern Barents Sea (the numbers correspond to those in Table 1).

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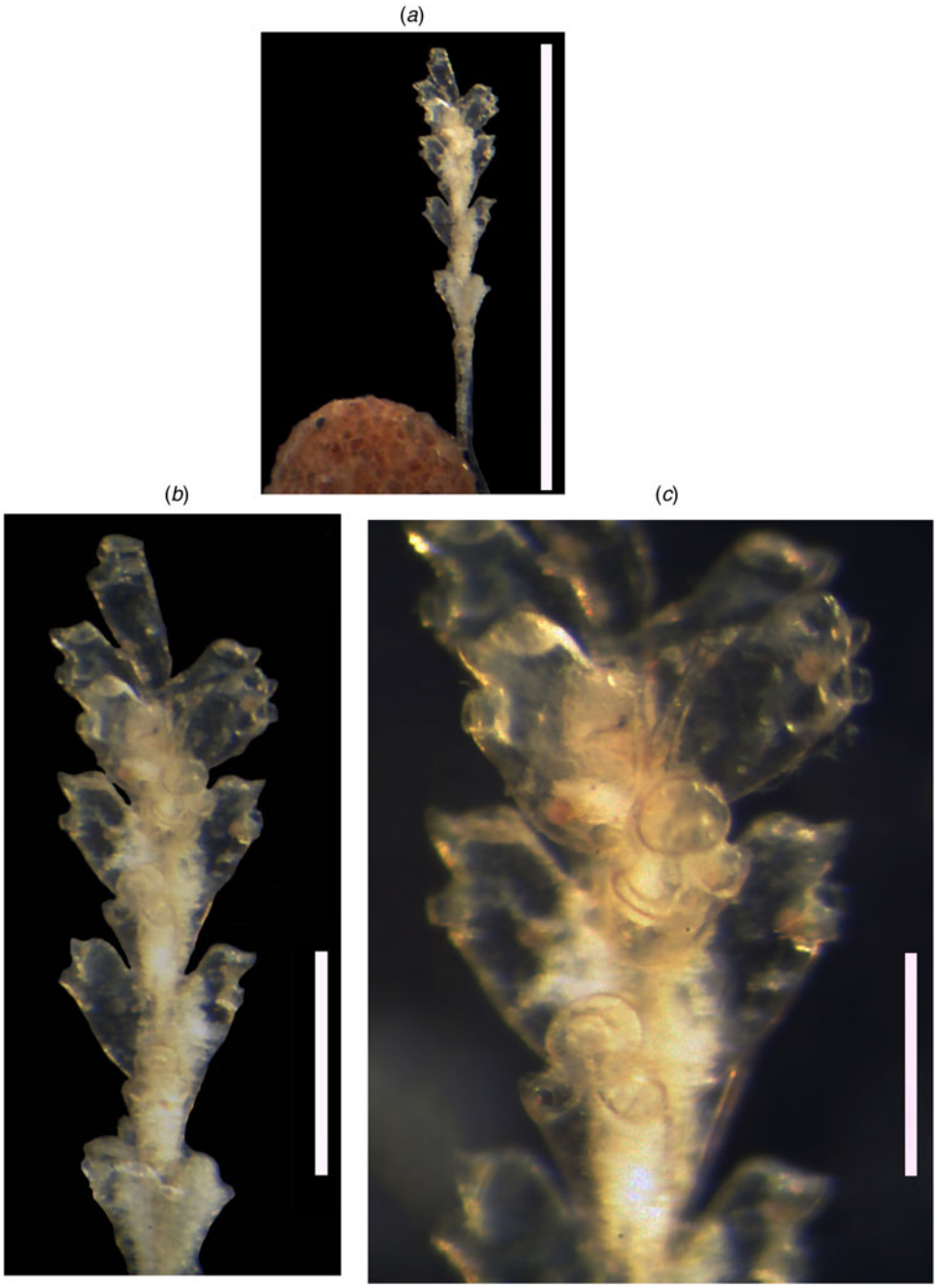

Figure 2. *Uschakovia gorbunovi* Kluge, 1946 from the Barents Sea, 2017. (a) – general colony view, scale bar 5 mm, (b) – distal part of the colony, scale bar 0.5 mm, (c) – details of the colony, scale bar 0.5 mm.

with thinly calcified zooids. Unfortunately, the other three colonies found in the study area were severely damaged and also exhibited small sizes.

The length of our photographed colony was 5 mm. The lengths of the other colonies were 8 mm (No. 1), 4 mm (No. 3), and 4.5 mm (No. 4). Kluge (1962) did not provide the total length of his colonies, while Cook (2001) described a colony with a length of 10 mm in the waters of the Faroe Islands and noted that the maximum length of the colonies from the Faroes was 15 mm. The zooids of the Barents Sea colony were yellowish in colour, with a length ranging from 0.75 to 0.87 mm and a width of 0.25 mm. These measurements coincide with the range observed by Kluge (1962): 0.75–1.40 mm in length and 0.25 mm in width. Cook (2001) revealed autozooids lengths ranging from 0.76 to 0.83 mm.

Kluge reported that *Uschakovia gorbunovi* is a high-Arctic species that occurs at temperatures ranging from −0.90 to −1.40°C, while Micael *et al.* (2022) recorded this species at −1.8 to −6.0°C. Our findings fall within this range (Table 1).

The frequency of Atlantic water inflows into high-latitude regions of the Barents Sea has been increasing (Frolova *et al.*, 2007; Matishov *et al.*, 2012; Kortsch *et al.*, 2015; Dvoretsky *et al.*, 2023), resulting in stronger ocean currents and wind forcing (Matishov *et al.*, 2009, 2012), may facilitate the range extensions of bryozoans. This phenomenon has been observed in both high and lower latitude areas of the Barents Sea over the past decade (Evseeva *et al.*, 2022; Evseeva and Dvoretsky, 2023, 2024; Dvoretsky and Dvoretsky, 2024). It can be hypothesized that *Uschakovia gorbunovi* was transported into the Barents Sea through the influx of cold Arctic waters from the Kara Sea between Franz Josef Land and Novaya Zemlya. This current then flows westward across the northern Barents Sea along the eastern slope of the Spitsbergen Bank, where it merges with the

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East Spitsbergen Current (Jakobsen and Ozhigin, 2011). This circulation pattern provides a plausible explanation for the new distribution records of this bryozoan in the northern part of the Barents Sea. However, there emerges a question concerning the lack of early findings of *Uschakovia gorbunovi* in Svalbard waters, particularly since the species was discovered in the Faroe Islands based on a collection made in 1987. The bryozoan fauna in the shallow-water Svalbard area has been extensively studied (Gulliksen *et al.*, 1999; Gontar *et al.*, 2001; Kukliński, 2002; Palerud *et al.*, 2004). *Uschakovia gorbunovi*, which prefers deeper waters, was not found in collections prior to 2005, possibly due to insufficient sampling efforts in the open sea waters near the Svalbard Archipelago. Several bryozoan species have expanded their range through boat bottoms, ship hulls, and ballast water tanks (López Gappa *et al.*, 2010; Ryland *et al.*, 2011; Loxton *et al.*, 2017; Anderson *et al.*, 2022). However, this pathway is only relevant for coastal species. In the case of the deep-water *Uschakovia gorbunovi*, a more likely scenario is their distribution via mobile benthic species, such as the invasive snow crab *Chionocetes opilio*. This species was first recorded in the Barents Sea in 1996 (Dvoretsky and Dvoretsky, 2015), and adult snow crabs reached the Kara Sea in 2012 (Zimina, 2014). The migration of snow crabs in the opposite direction may have promoted the range extension of *Uschakovia gorbunovi* into the Barents Sea. Previous research has shown that snow crabs are suitable hosts for deep-sea bryozoans (Savoie *et al.*, 2007) and that invasive crabs can contribute to the spread of their epibionts within the new area of occurrence (Dvoretsky and Dvoretsky, 2022, 2023).

Our study provides a basis for further monitoring of bryozoan fauna in Arctic seas under changing environmental conditions and a reference point for tracking the range expansion of bryozoans at high latitudes.

Data availability. The authors confirm that the data supporting the findings of this study are available within the article.

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Competing interest. None.

Ethical standards. Not applicable.

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