Re-finding of sipunculoids (Sipuncula) in the Kola Bay's area of the Barents Sea in 2017-2018

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Abstract. Sipunculoid fauna of the Kola Bay was first described by K. M. Deryugin in 1915 on the benthos samples collected using a dredge and Sigsbee trawl. Further studies of zoobenthos applying quantitative methods (Petersen grab), conducted by V. I. Zatsepin in the 1930s revealed the presence of dense colony of these invertebrates in the water area of the Kola Bay. Further, the foundation of new towns and settlements, infrastructure development, construction of port and industrial facilities, military and naval bases on the bay's coast led to the rapid integrated pollution of the water area and bottom sediment, which consequently caused the rapid regression of Sipuncula colonies. In 2003, near the village Mishukovo, the latest instance of worms related to the phylum Sipuncula was detected. Further large-scale benthic surveys conducted in the southern, middle and Northern bends of the Kola Bay, indicated a complete lack sipunculoids in the study area. New Sipuncula settlements, according to the survey conducted in 2017-2018 in the Kola Bay, make assertions about the significant reduction of human-induced impact on the fauna of the bay.

1. Introduction
Phylum Sipuncula comprises 156 species [1]; protostome nonsegmented marine worms that are related to coelomate invertebrate animals. The most part of sipunculoids are random detritovores, thus their distribution depends on the qualitative composition of the soil and near-bottom salinity, allowing to use them as markers of soil contamination level.

In the Kola Bay, in 1908-1909 K. M. Deryugin [2] identified 6 species of these invertebrates: Nephasoma a. abyssorum (Koren & Danielssen, 1876), Golfingia elongata (Keferstein, 1862), G. m. margaritacea (Sars, 1851), G. V. vulgaris (de Blainville, 1827), N. eremita (Sars, 1851) and Phascolion s. strombus (Montagu, 1804), the latter four of them formed dense clusters in the bay, with the exception of the freshened southern part of the southern bend. In the 30s, V. I. Zatsepin carried out benthic study in the water area [3], providing the conclusions that coincided with the results obtained by K. M. Deryugin. Further, the foundation of new towns and settlements, the development of their infrastructure, the construction of port-industrial facilities and naval bases on the bay's coast caused the rapid integrated pollution of the water and bottom sediments, which, in turn consequently resulted in the rapid regression of Sipuncula settlements. At the end of the 80s of the past century, they completely disappeared in the water of the southern part, and by the end of the 90s, in the middle and northern parts, individual isolated specimens of these invertebrates were recorded at the stations (at that time they were determined only by phylum, due to the lack of specialists). And finally, in 2003, in
the area of the village Mishukovo two samples of *N. eremita* were taken at a depth of 30 m, it was the last recorded case of sipunkuloids detection in the Kola Bay. Further large-scale benthic surveys conducted in 2005 — the southern part, 2006 — the middle part, and 2012 — the middle and northern parts, proved the complete absence of sipunculoids in the studied water area.

2. Study area
The Kola Bay is the largest bay on the Murmansk coast. Its length from north to south is approximately 55 km, the width in the estuary is 6 km. Representing a typical fjord in relief, the bay is separated from the open sea by an underwater barrier with depths not exceeding 150 m. The northern part of the Kola Bay has depths up to 300-380 m, the middle part - up to 200 m and the southern - prevailing depths of less than 50 m. Almost all the interior of the bay is filled with clay and silt, only in its southern and middle parts sands can be found. Rocky soils and soils with bottom-stone material of different fractions are widespread throughout the bay.

3. Materials and methods
Benthos samples were collected in 2 stages:

1. In October 2017, on the Dalnie Zelentsy research vessel during the comprehensive monitoring expedition of MMBI at 13 stations, in 3-fold repetition (39 samples) along the Kola Bay at depths ranged from 11 to 208 m.

2. In the middle of January 2018, in the area of the village Belokamenka, at 5-fold repetition, at the site and 8 stations (40 samples) from the board of the “Diver Pechkurov» dive boat, at depths ranged 30-80 m. Three stations were located on the right and left banks and two of them - in the central part (Fig. 1).

![Figure 1. The work area and the location of the stations and the site in the Kola Bay](image-url)
Zoobenthos samples were taken using a Van Veen bottom grab, capture area is 0.1 m². Further processing of the samples was carried out according to the standard method [4].

4. Results
Throughout the Kola Bay, with the exception of stations 12-14, petroleum products and slags are recorded in the samples, as well as household waste is also found in the samples from the southern and middle parts of the bay. The state of bottom sediments of the southern and partially middle (stations 4 and 5) bends differs significantly from other areas in the signs of recovery processes and a large amount of detritus, which indicates significant eutrophication of waters [5].

In the southern part of the bay and partially in the middle part (station 1-5) sipunculoids are absent in the samples. In the middle part, in the site area, one specimen of *N. a. abyssorum* and *P. s. strombus*, as well as 19 specimens of *G. v. vulgaris* were found. The biomass at the stations varied from 0.001 ± 0.0001 to 0.027 ± 0.003 g / m² and in averaged was 0.006 ± 0.004 g / m². The density varied from 2 ± 0.2 to 14 ± 1.2 ind./m² and in average was 5.25 ± 0.4 ind./m². The second settlement of sipunculoid worms was detected in the northern part (vv. 9, 12-14). There were found 7 specimens of *Ph. s. strombus*, 6 specimens of *N. a. abyssorum* and 1 belonged to *N. eremita*. The biomass varied from 0.005 ± 0.001 to 0.217 ± 0.058 g / m² and in average was 0.075 ± 0.020 g / m². The density ranged from 3.3 ± 0.9 to 33 ± 8.8 ind./m², in average was 10.8 ± 2.9 ind./m².

5. Discussion:
It should be noted that at the beginning of the 20th century the collection of the material was carried out using a trawl, in 1930-1990 quantitative methods using «Petersen» and «Ocean-50» grabs (capture area - 0.25 m²), and since 2000, with a Van Veen dredger, capture area is 0.1 m² (Fig. 2).

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**Figure 2.** "Ocean-50" (left) and Van Veen (right) grabs. Photo by Evgeniy Garbul

Therefore, it is very difficult to assess changes in the reduction of macrozoobenthos colonies, since monitoring was actually performed using three different methods. Moreover, «Ocean-50» grab is more than triple catchable than Van Veen grab [6, 7] in case of sandy soils, in silt and clay (most of the Kola Bay), due to a deeper penetration into the soil, the difference is significantly greater. Nevertheless, until 1940, the most common species of sipunculoids (*P. s. strombus*, *G. m. margaritacea*), together with other 20-30 mass species of polychaetes, bivalves, and echinoderms, formed the basis of the biomass fauna [2, 3]. In the following decades, a serious degradation of this group occurred (Fig. 3).
Figure 3. Long-term dynamics of the benthos structure of the Kola Bay. For the period of 1989, the data are presented solely the southern half of the bay

To understand what changed, 1 station of the section "Kola Meridian "should be studied thoroughly. This section consists of 10 standard stations along the Meridian 33°30’ of East longitude at intervals of half a degree up to 74° North latitude. Station 1 is located at the outlet of the Kola Bay. According to average long-term data, it has the lowest quantitative indicators, that is apparently associated with a significant level of chemical contamination in soil [8, 9]. Our study in 2000-2013 showed that compared to other stations quantitative indicators of sipunculoids from station 1 of the Kola Meridian [10] are significantly depleted and almost twice less in all quantitative indicators.

However, benthos survey of this section in 2015 revealed a coincidence of the quantitative indicators of the sipunculid worms from station 1 with the other stations of the Kola Meridian, caused by a decrease in anthropogenic impact on the biota from the Kola Bay.

Analyzing sipunculids settlement in the southern and middle parts of the Kola Bay, it can be noted that considerably lower average biomass and density were recorded in the middle part of the Bay. It can be explained by the fact that only young specimens Sipuncula were recorded there. As mentioned above, the sipunculids settlements from the medium part of the Kola Bay is represented mainly by the species G. v. vulgaris. Reproduction of this species, and phylum P. s. strombus by planktonic larvae occurs in September. After the mid-January survey, a quite viable new sipunculoid settlement existing for about three months was found. Thus, the reduction of the Kola Bay's pollution could be observed.

As already mentioned, the history of the Bay experienced a period of growth of towns and development of the industrial facilities. Currently, there is an opposite trend characteristic of almost all coastal towns and settlements of Russia. According to the census of population from 1991 to 2019 only in the city of Murmansk its population decreased from 473000 to 292465 people. In fact, this means downsizing and closure of industrial facilities, reduction of waste and significant reduction in the volume of wastewater discharged to the Kola Bay.

Additionally, it can be noted that according to the materials of the monitoring of the Kola Bay [5], in the waters of the bay the emergence of a typical sea cucumber that has long been absent was reported.

Thus, the colonization of the Kola Bay with selective (holothuria) and nonselective (sipunculoid) detritivores in recent years, indicates a significant decrease in the contamination of the water area and the predominance of the self-purification process.

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