Distribution of Polychaete Communities along the Novaya Zemlya Archipelago

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Abstract. The species composition and quantitative characteristics of polychaete communities have been analyzed along the western coast of the Novaya Zemlya archipelago based on the materials collected in the expeditions of Murmansk Marine Biological Institute (MMBI) in 2006, 2007, and 2019. Three faunistic complexes have been identified in the study area in accordance to the changing environmental conditions northwards along the western coast of the Novaya Zemlya. The species composition and structure of polychaete communities depended on the structure of bottom sediments, depth, and the hydrodynamics of the near-bottom water layer. The polychaete fauna of the studied area has been compared with the literature data; particularly, we have observed as well the dominance of the detritus feeder Spiochaetopterus typicus, which role increased in the deep water areas on silty sands and silty clays rich in detritus. In the area of the Novaya Zemlya shallow waters, unfavorable habitat conditions for the detritus-feeders existed on rough sands with active hydrodynamics, which led to a decrease in the biomass of polychaetes and to a change in the dominant species

Introduction
The Novaya Zemlya archipelago is located at the border of the interaction of the Atlantic and Arctic waters. This archipelago represents a natural barrier to the mixing of the bottom fauna of the Barents and Kara Seas. Novaya Zemlya, being the eastern border of the Barents Sea, is also the eastern limit of the distribution of the Gulf Stream waters, particularly, its northeastern branches [1]. The archipelago consists of two large islands — the northern Severny Island and the southern Yuzhny Island, — separated by the narrow Matochkin Shar Strait. Novaya Zemlya Bank is the underwater elevation with the depths of 55—160 m, it extends north-eastwards and is separated from the Northern Island of Novaya Zemlya by the northern Novaya Zemlya Trench [2]. The coastline of Novaya Zemlya, with the exception of the southern part of the eastern coast, is heavily indented by the bays that extend far to the land. The coastline is mostly presented by the fjords; this preconditions both the diversity of habitats and the complex structure of the coastal ecosystems. About half of the Northern Island area is occupied by glaciers, which also affect marine ecosystems by runoff of the fresh cold water, carrying the particulate matter and glacial suspension [1]. The peculiarity of the geographical position and the hydrological regime of the Novaya Zemlya archipelago attracts the most interest to study the species composition and distribution of bottom communities in this area.

Polychaetes are the forage object for fish, bottom-dwelling organisms, as well as for red king crab Paralithodes camtschaticus and snow crab Chionoecetes opilio. Recently, there has been an increase
in the abundance of snow crab in the north-eastern Barents Sea and at the south-western area of the Novaya Zemlya archipelago, having a strong effect on bottom biocenoses [3].

Studies of zoobenthos in the coastal areas of Novaya Zemlya are performed since 1880 [4]. Nowadays, zoobenthos along the Novaya Zemlya archipelago has been studied in detail [2, 3, 5, 6, 7, 8], but data on the species composition and quantitative distribution of polychaetes are scarce for this area. Therefore, the study aims to assess the features of the polychaete distribution along the western coast of the Novaya Zemlya archipelago.

[1] Materials and methods

The material studied was 50 quantitative samples withdrawn from board of the research vessel Dalnie Zelentsy at 17 stations during the integrated expedition of the Murmansk Marine Biological Institute in 2006, 2007, 2019 (Fig. 1). Zoobenthos samples were taken from using a Van Veen bottom grab (capture area, 0.1 m²), in 3-fold repetition. Further processing of the samples was carried out according to the standard hydrobiological method [9]. To determine the groups of stations with similar species compositions we used cluster analysis based on the Bray–Curtis similarity coefficient [10]. The relative metabolic rate was used as a measure of abundance to determine the dominant species group [11].

Figure 1. Schematic map of the benthos stations and the distribution of the faunal complexes along the Novaya Zemlya archipelago (the first digits are the station no; the last digits are year of the material collecting).

[2] Results

In the study area, 114 polychaete taxa were identified, of which 97, down to the species level. Species richness ranged from 21 to 40 species per station (Table 1). High species diversity was observed in sandy shallows near the Matrochkin Shar Strait, in the western Novaya Zemlya Trench at a depth of 200 m, and at the northernmost tip of the Novaya Zemlya Island at a depth of 106 m. Low species diversity was noted at a depth of 105 m in the northern part of the archipelago on coarse-grained sands with viscous clay and stones.
Table 1. Quantitative parameters of the polychaete communities along the Novay Zemlya Archipelago

| Station no./year | Depth (m) | Temperature (°C) | The number of species | Biomass, g/m² | Abundance, ind./m² | Dominant species (in terms of metabolism) |
|------------------|-----------|------------------|----------------------|---------------|-------------------|------------------------------------------|
| 19_06            | 60        | -0.37            | 33                   | 54.3±3.5      | 3040±860          | Spio arctica                             |
| 20_06            | 161       | 0.56             | 37                   | 160±23.3      | 2535±250          | Spiochaetopterus typicus                  |
| 21_06            | 138       | 0.22             | 34                   | 190±43        | 3230±1113         | Spiochaetopterus typicus                  |
| 22_06            | 199       | -1.83            | 31                   | 116±50        | 2675±885          | Spiochaetopterus typicus                  |
| 23_06            | 154       | -1.57            | 22                   | 32±13         | 655±130           | Spiochaetopterus typicus                  |
| 24_06            | 149       | -0.77            | 26                   | 51±9          | 1170±206          | Spiochaetopterus typicus                  |
| 25_06            | 107       | -1.13            | 31                   | 37±10         | 1797±34           | Lumbrineris fragilis                      |
| 26_06            | 79        | 0.05             | 24                   | 31.3±19       | 800±56            | Spiochaetopterus typicus                  |
| 54_07            | 161       | 0.75             | 26                   | 71±30         | 835±215           | Nephtys paradoxa                          |
| 55_07            | 159       | 0.82             | 32                   | 26±8.7        | 870±25            | Spiochaetopterus typicus                  |
| 56_07            | 203       | -1.28            | 35                   | 82.3±5.5      | 1660±100          | Spiochaetopterus typicus                  |
| 57_07            | 130       | 1.25             | 40                   | 72±25         | 2395±745          | Spiochaetopterus typicus                  |
| 59_07            | 65        | 0.65             | 40                   | 29±8.3        | 3223±1300         | Chone duneri                              |
| 61_07            | 77        | 1.38             | 24                   | 4.6±1.1       | 520±195           | Nephtys longosetosa                       |
| 22_19            | 106       | -0.1             | 40                   | 46±19         | 2550±234          | Spiochaetopterus typicus                  |
| 33_19            | 105       | -0.1             | 21                   | 11.3±1.3      | 1235±355          | Lumbrineridae g. sp.                      |
| 34_19            | 127       | 0.8              | 34                   | 18.5±12       | 1250±490          | Nephtys ciliata                           |

Comparison of the polychaete species lists by cluster analysis made it possible to distinguish three faunistic complexes in the study area that differed from each other in species composition and quantitative characteristics (Fig. 2).

The first large group of stations located in the western Novaya Zemlya Trench and further northwards at the depths from 79 to 203 m. Brown silty clays with an admixture of sand, stones and clastic material predominated here. In this complex, 78 species of polychaetes were recorded. According to the relative metabolic rate and biomass, the foraging detritus feeder Spiochaetopterus typicus prevailed here (its share varied as 30—70%). This group of stations has been divided into two complexes that differ in quantitative characteristics.

Complex Ia located in the southern Novaya Zemlya Trench, at the depths of 130—203 m, on silty clays and silty sands with stone material admixture. This complex is characterized by high biomass (125 ± 29 g/m²) and population density (2500 ± 620 ind./m²). The metabolic rate of the dominant species S. typicus is 60%.

Complex Ib combined the stations of the northern part of the Novaya Zemlya slope, the depths of 79—161 m, where mixed silty sands with an admixture of stones prevailed. In this complex, the biomass (42 ± 15 g/m²) and population density (1020 ± 110 ind./m²) are significantly lower than that of the complex Ia. The metabolic rate of the dominant species S. typicus was reduced down to 30%.

The second complex located in shallow waters at the northern tip of the Southern Island of Novaya Zemlya. This zone was characterized by shallow depths (from 60 to 77 m) with active hydrodynamics, where the largest area was occupied by sandy silts with an admixture of stones and shelly ground. The western slope of the Southern Island of Novaya Zemlya is located in the zone of the Polar Front, where vertical circulation phenomena are expressed, providing nutrients to the bottom, where, in turn, the active development of the abundant bottom fauna takes place [5]. In this complex, 54 species of polychaetes have been recorded. Spio arctica, Chone duneri, and Nephtys longosetosa predominated.
in this community by metabolic level, *Lumbrineris fragilis* by biomass. The complex was characterized by low biomass of $30 \pm 8$ g/m$^2$, but by a high population density of $2260 \pm 783$ ind./m$^2$.

![Figure 2. Dendrogram of the polychaete species similarity along the Novay Zemlya Archipelago](image)

The third complex located in the north-eastern part of the Novaya Zemlya Island. This complex has been noted at the depths of 105—127 m, on coarse-grained sands with viscous gray clay and stones. Fifty-two species of polychaetes have been registered here. *Nephtys ciliata* and *Spiochaetopterus typicus* dominated by the metabolic rate and biomass. The complex was characterized by low biomass of $25 \pm 11$ g/m$^2$ and a low population density of $1680 \pm 360$ ind./m$^2$.

[3] **Discussion**

We have found that a change in the quantitative characteristics and structure of polychaete communities was noted in accordance to a change in environmental conditions when moving from northwards along the Novaya Zemlya archipelago.

In the shallow areas along the Southern Island of Novaya Zemlya, low biomass accompanied by at a high population density of polychaetes have been registered on sands with admixture of gravel and pebble. In this area, in the frontal zone, where the warm coastal waters of the Novaya Zemlya Current meet local cold waters, there are favorable conditions for the abundant development of the bottom fauna, so the proportion of predator polychaetes increases. Here, on the underwater slopes washed by the bottom currents more intensively, coarse sandy sediments with a low nutrient content prevail, which leads to a decrease in the polychaete biomass and an increase in small species of filter feeders in the area.

In the Novaya Zemlya Trench and northwards off, i.e. in the area characterized by weakly pronounced hydrodynamics and the highest sedimentation rates, the foraging detritus feeder *Spiochaetopterus typicus* dominates. Here, in the southern part of the Novaya Zemlya Trench, high biomass and population density of polychaetes have been noted on silty clays rich in organic matter. Northwards off the Novaya Zemlya Trench, a decrease in the biomass and the proportion of the
species *S. typicus* occurs in accordance with a decrease in both depth and organic matter content in the bottom sediments.

The northernmost complex of the Novaya Zemlya Island, where the predator polychaete *Nephtys ciliata* and the detritus feeder *S. typicus* dominates, is characterized by low biomass and low population density. Most of the outlet glaciers, located in the northern Novaya Zemlya, calve to the sea and thus influence the ecosystems of the coastal waters [1]. The increase in particulate matter and rock material as a result of the flow of melt glacial water forms here viscous clay sediments that contain almost no detritus, which leads, in turn, to a decrease in the biomass of polychaete communities in these areas.

**Conclusions**
The detritus feeder *Spiochaetopterus typicus* plays the main role in the composition of the polychaete communities along the western coast of Novaya Zemlya. Our data correspond to that obtained earlier [3, 5, 6, 12], namely, we have observed that high quantitative characteristics of polychaete communities were noted due to the dominant species *S. typicus* in the bottom depressions, where the hydrodynamics was weakened and the sedimentation of the suspended matter prevailed over its transport. Despite the increase in the number of snow crab *Chionoecetes opilio*, no significant changes in the composition of the dominant species of polychaetes have been registered along the western coast of Novaya Zemlya. However, low polychaete biomass at shallow stations of the Southern Island of Novaya Zemlya may be due to the increasing impact of the snow crab on the bottom biocenosis in this area. The obtained data substantially supplement the information on the species composition and quantitative characteristics of polychaete communities along the western coast of Novaya Zemlya and allow to follow further changes in the composition of bottom communities.

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