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Changes in deep-sea metazoan meiobenthic communities and nematode assemblages along a depth gradient (North-western Sea of Japan, Pacific)

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ABSTRACT

The Sea of Japan is a very young sea which has been newer connected with the deep Pacific. In this connection, a big portion of shallow-water taxa are expected to inhabit the deep part of this sea. Meiofaunal communities were investigated for the first time on 13 stations at depths from 500 to 3700 m within four deep-sea transects in the north-western part of the sea. The densities were very low ranging from 4.80 ± 1.17 ind./10 cm^2 to 177.42 ± 14.3 ind./10 cm^2. There was a significant decrease in the density of meiofauna with depth at all locations. Taxonomic structure of metazoan meiobenthos is plentiful in the whole area and totaled 20 groups. Nematodes were the numerically dominant taxon, constituting 49.6–84.1% of total abundance. At the stations with depth below 3000 m, polychaetes were the dominant taxon and nematodes constituting only 12–36.9% of the total meiofaunal density. On portions of nematodes and polychaetes, deep-sea meiofauna of the Sea of Japan was quite unique in comparison with surrounding deep-sea regions. In total, 92 different nematode species, belonging to 75 genera and 32 families were found. The number of nematode species strongly reduces with depth. Species richness and evenness in nematode assemblages greatly decreased with depth and were very low at depth below than 2000 m. No specific deep-sea nematode fauna was found.

1. Introduction

In the past decades there has been a significant increase in the amount of information on the deep-sea meiofauna distribution. Most of these studies, however, were focused on a few areas of North and Central Atlantic Ocean, Western Mediterranean (Danovaro et al., 1995, 2000, 2009; Gambi and Danovaro, 2006; Soetaert and Heip, 1995; Soetaert et al., 1991; Tietjen, 1984, 1989; Vincx et al., 1994), the Arctic and the Weddell Sea (Vanreusel et al., 2000; and others).

So far only a few meiofauna studies have investigated sediments from deep zones of Pacific Ocean: in eastern Central Pacific (Renaud-Mornant and Gourbault, 1990), in North-East Pacific (Miljutina et al., 2010) and in South Pacific (Bussau, 1993, 1995; Bussau et al., 1995; Danovaro et al., 2002; Gambi et al., 2003).

The ecology of the deep-sea meiobenthos in North and West Pacific has been explored primarily by the Japanese scientists (Shirayama, 1984; Shirayama and Fukushima, 1995; Shirayama and Kojima, 1994). Their studies are mainly devoted to meiobenthic organisms' abundance and size structure examinations. There is, to our knowledge, no published information on the meiofauna of North-West Pacific.

As for the Russian sector of the Sea of Japan, no studies on deep-sea meiofauna were carried out. The Japan Sea, enclosed by the Asian continent and the islands of Japan, is connected with outer seas through four narrow and shallow passages, namely, Tsushima, Tsugaru, Soya and Mamiya Straits. The deep part of the floor of the sea mostly consists of the Japan Basin in the north, the Yamato Basin in the south-east and Tsushima Basin in the south-west, centered around the Yamato Rise situated in the middle of the sea (Minami, 1999). While the connecting straits are shallow, the depth of the sea reaches over 3700 m at some inner parts. The configuration of the Japan Sea is often compared to a washbowl because the maximum and average depths are 3796 and 1350 m respectively. This configuration indicates that the deep water in the Japan Sea is not derived from deep water of the other seas (Senjyu et al., 2005). Because the deep water areas of the Japan Sea are separated from other seas by four straits shallower than about 200 m depth, they are not affected directly by the outer seas. The Sea of Japan is young and was created by rifting some 15–20 million years ago (Middle Miocene). The sediments of the Japan Sea are terrigenous silty clay, with an upper brown unit overlying a lower gray horizon. Upper layers of the sediments are often bioturbated and are dominated by diatoms and radiolarians

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(Gorbarenko and Southon, 2000). The Japan Sea is a highly productive area, but its deep-water biology is not very well studied. It is still unknown whether the isolation from the adjacent deep-sea areas has an effect on its species composition and biodiversity.

The present study deals only with metazoan meiofauna collected during joint Russian–German expedition SoJaBio (Sea of Japan Biodiversity Studies) aimed at exploring the Sea of Japan deep-sea benthos biodiversity. The SoJaBio project covered the following main biological topic: benthos biodiversity patterns in the Sea of Japan in comparison with adjacent basins.

It was especially interesting to compare the structure of meiobenthic communities from deep bottom of the Sea of Japan and from the adjacent Pacific areas. In this paper we present data on the density and composition of the metazoan meiofauna in general, and composition of its most abundant group—free-living marine nematodes, specifically.

The purpose of the investigation was (1) to document the composition, abundance and structure of the metazoan meiofauna in total, and nematofauna; (2) to identify the species composition of free-living nematodes. Because of unique origin of the Sea of Japan, a great number of shallow-water taxa were expected to be found in the deep sea.

2. Materials and methods

2.1. Study area

Samples were collected during the period from 11th August to 5th September 2010 during the SoJaBio expedition in the Sea of Japan (RV "Akademik M.V. Lavrentyev", Russian Academy of Science). Sampling stations are reported in Fig. 1, station locations and depths are given in Table 1. The samples were taken along four transects (A, B, C, D). The transect A includes four stations (A1, A2, A6, A7) (Fig. 1). Water depths ranged between 450 and 3370 m (Table 1). The transect B includes five stations (B1, B4, B5, B6, B7), water depths ranged between 495 and 3666 m. The transect C includes only two stations (Fig. 1) with water depth from 2700 to 3426 m, and transect D was the most southern with two stations D1 and D2, water depths ranged between 2698 and 3358 m (Table 1).

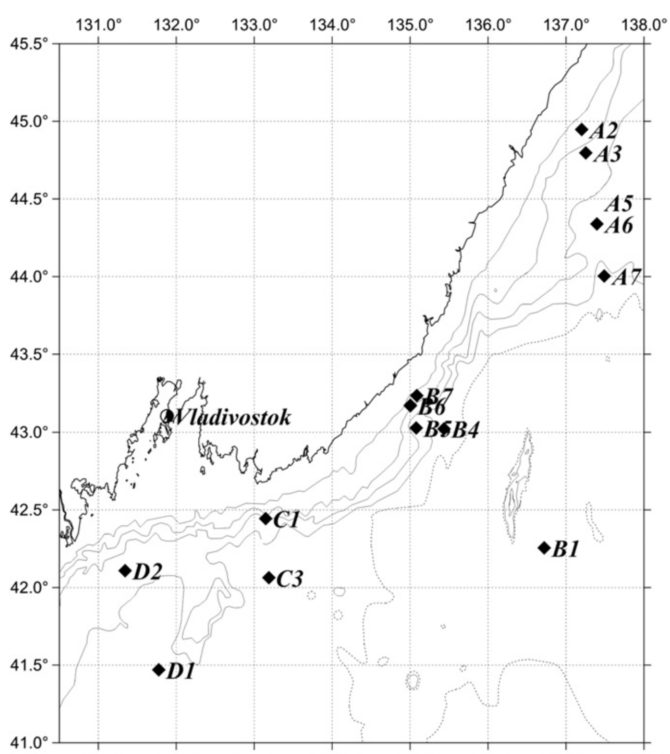

Fig. 1. A schematic map of sampling area and station locations in north-western part of Sea of Japan.

2.2. Sampling method and sample processing

The sediment samples were collected with a multicorer (MUC). The MUC is a gear designed for taking meiofauna and sediment samples (Barnett et al., 1984). The employed MUC is equipped with 8 transparent acrylic glass cylinders, each 62 cm long, so the MUC provides up to 8 parallel, undisturbed samples per station. Each cylinder has an inner diameter of 10 cm, consequently a surface of 78.54 cm^2 and a height of 5 cm resulting in a volume of 392.7 cm^3. As far as possible, for the meiobenthic survey purpose, 3 deployments of the multicorer were carried out at each station, and 5 cores from each deployment were used for meiofaunal studies. One core from each deployment was used for sampling of sediments (i.e. 3 sediment samples from each station in total). In total, 47 MUC deployments on 13 stations and 4 transects took place.

For the meiobenthic studies, the upper 5 cm sediment layer from cores was fixed with approximately 5% buffered formalin. Overlying water was filtered through a 40 μm mesh sieve, and the collected material was also added to the sample. 750 ml plastic jars with leakproof lids were used for sample storage. In total, 164 samples of meiofauna were taken. All samples underwent further processing upon return to the laboratory. Sediment samples were filtered through sieves with 1000 μm and 40 μm mesh sizes. Meiofaunal animals (metazoan only) were identified and counted to higher taxa under a microscope after staining with Rose Bengal. Approximately 100 nematodes were picked up from every meiofauna sample, transferred to glycerin, and mounted on permanent slides for species identification. If less than 100 nematodes were present in the sample, all of them were sorted up. All nematodes were identified to species level according to the most recent data.

2.3. Collecting sediments samples for granulometric analysis and for studying of other environmental parameters in the sampling areas

From each core, the upper 10 cm layer of sediments was collected. Zip-lock plastic bags were used for sample storage in a freezer at -20 °C. Grain size analysis was conducted by combination of two methods. First of all, the sediments were dried in the oven at 105 °C for 24 h and weighed up. The sediment particles >0.5 mm were sieved on a series of standard sieves, meshes of which decrease at regular size intervals. The fractions <0.5 mm were present in form of water suspension and were analyzed using a laser particle size analyzer Analysette 22 (FRITSCH firm). Finally, sediment fractions are normalized to 100% of the initial total amount of the sediment sample. The analyzer of type TOC-V_{CPN} with an attachment for burning of solid samples SSV-5000A of "SHIMADZU" brand was used for the detection of the total organic carbon content (TOC).

The oxygen content was measured in the overlaying water layer. For this purpose, the method of equal concentrations, followed by gas chromatographic analysis on board with Kristall-Lyuks-4000M (Crystal-Lux-4000M) chromatograph, hydrogen generator "HFO-6" and the mixing device LS-110 were used.

2.4. Statistical analysis

The software packages PAST (Hammer et al., 2001) and PRIMERv6 (Clarke and Gorley, 2006) were used for statistical analysis.