Zoobenthic communities of the near-shore zone of the Baltic Sea (Nida–Juodkrantė water area)

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While studying regularities of the distribution of bioceonoses of the sea ground fauna, the abundance of animals and the amount of biomass, a direct connection can be noticed with the granulometric composition of bottom sediments and the depth. Coarser sediments of the bottom make optimum conditions for the development of zoobenthos. With the sediments getting finer and the depth decreasing, the biomass of some zoobenthic organisms also decreases (e. g., *Macoma baltica*), but the abundance of polychaetes (*Pygospio elegans*) notably increases.

In the Nida–Juodkrantė water area where the bottom is vcovered with fine and intermediate sand, the dominant are the *Pygospio elegans–Macoma baltica–Mesidotea entomon* biocoenoses which are very important as a food resource for benthophagous fish, especially cod.

This work offers an analysis of background data on macrozoobenthic communities at different depths of the Nida–Juodkrantė water area (the economic zone of the Republic of Lithuania).

Key words: macrozoobenthos, biocoenosis, oil products, oil drilling platform

INTRODUCTION

Zoobenthic communities are very important for the functioning of the near-shore zone ecosystem of the Baltic Sea. First of all, they serve as a nutrition basis for fish and the abundance of the latter greatly depends on their quality. Secondly, zoobenthic communities serve as a natural filter and participate in the process of biological purification, determining its course and intensity and the participation of other bottom fauna in the destruction and accumulation of organic matter. The most negative impact on the ecosystems of the Baltic Sea is that of oil products. Large quantities of oil products which are spilled into the waters of the Baltic Sea have a negative impact on animal communities. The oil products stick to plants and gills of fish and other marine animals who die due to the inability to breathe. Oil particles deposit on the bottom of the sea and stay there for a long time (Bubinas, Vaitonis, 2003). When a sea ecosystem is polluted with oil products, more sensitive groups of zoobenthos get extinct and the structure of zoobenthic communities dramatically changes. It should be noted that in case of an accident a large amount of oil products would flow into the North Sea together with surface waters. However, a large amount of oil products would stay in the southern part of the Baltic Sea. While decomposing, oil products form benzapyrene. Decomposition of this chemical causes formation of carcinogenic substances. This is well illustrated by studies which have shown that the concentration of benzapyrene is much higher in the southern part of the Baltic Sea than anywhere else (Žaromskis, 1996).

Cases of oil spillage have dramatically increased in the near-shore zone of Lithuania in the latter 25 years. The most disastrous oil spillages occurred in November 1981 after the crash of the tanker "Globe Asimi" (Ministry of Environment, 1984) and in November 2001 at the Būtingė Terminal (Bubinas, Vaitonis, 2003; Zolubas, 2003). The operation of the oil drilling platform D-6 in the open sea is also dangerous for the ecosystems of the Baltic Sea. The oil drilling platform D-6 is about 13.2 nautical miles away from the shores of Lithuania. The operation of the oil drilling platform was started in July 2004 (Ministry of Environment, 1984). Unsafe usage of this oil drilling platform would violate the interests of the Republic of Lithuania. Almost all severe storms occurred when southwesterly, southerly and northwesterly winds were blowing (Dubra, 2003). In more than 56% of cases, the winds blow from the oil drilling platform D-6 towards the economical zone and the shore-zone of the Republic of Lithuania. Thus, there is a great probability that in case of an accident on the oil drilling platform D-6, the water area of Nida–Juodkrantė and the zoobenthos on its bottom may suffer great losses. In order to estimate the possible impact of oil spillages on the ecosystems of this water area, it is necessary to obtain data on the structure of biocoenoses in the coastal area of Lithuania. Oil spillages that may occur in the ecologically dangerous

zones – Klaipėda Sea Port and Būtingė terminals – would not be so dangerous to the above-mentioned water area due to the prevalent currents from the south towards the north (Dubra, 2003).

There are still no thorough studies of zoobenthos of the Nida–Juodkrantė near-shore zone of the Baltic Sea. More detailed studies of zoobenthic organisms in this water area were started only 30 years ago (Лукшенас, 1967; 1969; Ярвекюлг, 1979). Some research data have been recently published by the Centre of Marine Research in Klaipėda (Report, 2003).

The present work is an analysis of background data on macrozoobenthic communities at different depths of the Nida–Juodkrantė water area (the economical zone of the Republic of Lithuania).

MATERIALS AND METHODS

Zoobenthic communities were studied in 62 study sites which were divided into groups according to the depth range: 5–10 m, 11–20 m, 21–30 m, 31–40 m, 41–50 m and 51–65 m (Fig. 1). For instance, samples for quantitative analysis were obtained using the Van-Veen and Petersen grab (scoop area 0.41 m^2). For the qualitative analysis of zoobenthos, we used a special marine drag

which was dragged for 15 min by a drifting ship. In the same way we also carried out analysis of nektobenthos. The scoured out zoobenthos was fixed in 4% formalin solution.

During the laboratory analysis, zoobenthos samples were defined and divided into groups according to species. In addition, their biomass and abundance were determined. Zoobenthos species were defined according to the key of marine fauna (Гаевская, 1948; Гурьянова, 1951).

RESULTS AND DISCUSSION

The data obtained during the study were divided according to the above-mentioned six depth ranges.

Depth of 5–10 m (study sites 1–8) (Fig. 2)
The bottom sediments of the near-shore zone of Nida–Juodkrantė mostly consist of fine sand (depth 5–10 m). The species composition of the zoobenthos, the number of species of benthic organisms and their distribution were very much similar to the structure of zoobenthos of the Klaipėda–Juodkrantė water area (Bubinas et al., 1998). This area is dominated by polychaetes (*Pygospio elegans*, *Nereis diversicolor*), crustaceans (*Pontoporeia*
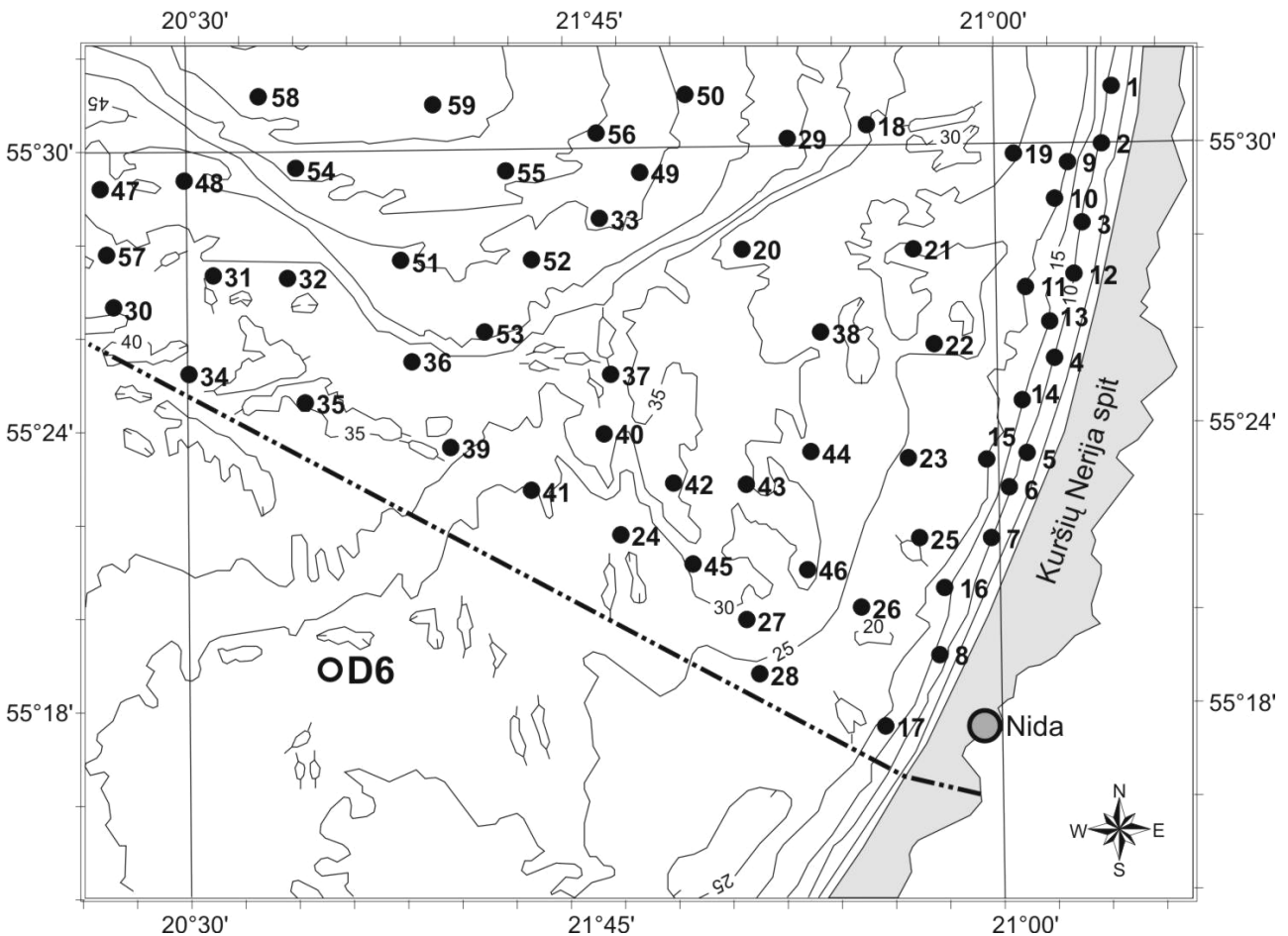

Fig. 1. Distribution of study sites in the near-shore zone of the Baltic Sea (Nida–Juodkrantė water area)
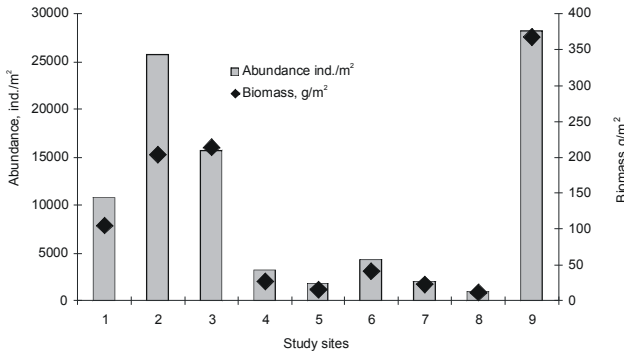
Fig. 2. Total abundance and biomass of zoobenthos at different study sites distributed at a depth of 5–10 m

affinis) and molluscs (*Macoma baltica*). The abundance of benthic organisms was 9000 ind./m^2 and their biomass 82 g/m^2. According to the frequency of occurrence, oligochaetes at this depth range took the second place. Respectively, the total average abundance and biomass of the zoobenthos at this depth range was 10500 ind./m^2 and 112 g/m^2. This study site was not very abundant in species: only 10 species of zoobenthic organisms were reported.

Depth 11–20 m (study sites 9–17, 20) (Fig. 3)
With an increase of depth to 11–20 m, the composition of bottom sediments slightly changed. In addition to sand, small quantities of aleurite could be found. According to the abundance and biomass, like at the depth of 5–10 m, the dominant benthic organisms were polychaetes. However, the abundance of molluscs *Macoma baltica* also greatly increased. Oligochaetes and crustaceans at this depth were less abundant. The number of recorded species of zoobenthic organisms was also rather scarce and equaled 10. Respectively, the total average abundance and biomass of zoobenthos at this depth was 8270 ind./m^2 and 97 g/m^2.
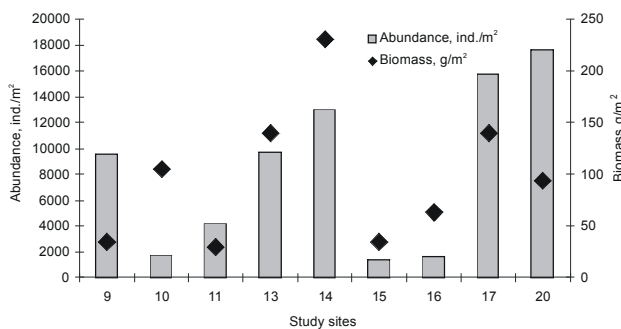

Fig. 3. Total abundance and biomass of zoobenthos at a depth of 11–20 m

Depth 21–30 m (study sites 18–19, 21–28) (Fig. 4)
At a depth of 21–30 m, the bottom sediments mostly consisted of fine to medium sand fractions. The abundance of polychaetes within the range of this depth dramatically decreased. Although their abundance remained the highest at this depth, their biomass was a few times

lower. Small *Pygospio elegans* polychaetes were dominant. The bulk of the biomass consisted of *Macoma baltica* mollusks and single *Mya arenaria* specimens. Oligochaetes were less abundant than in shallower areas. However, they were bigger and, thus, their biomass was much greater than at the depth of 11–20 m. The total average abundance of zoobenthic organisms was lower than in shallower water areas (1770 ind./m^2). However, due to bigger *Macoma baltica* specimens, their biomass was higher (150 g/m^2). Within the range of this depth, 13 species of zoobenthos were found.
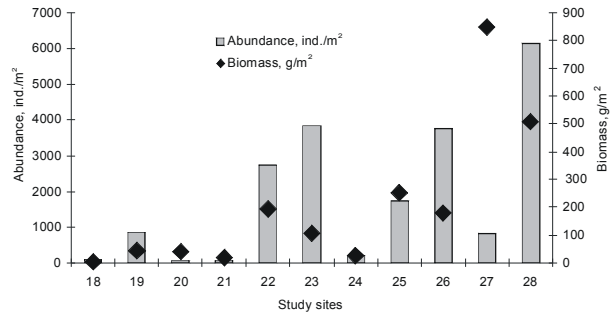

Fig. 4. Total abundance and biomass of zoobenthos at different study sites at a depth of 21–30 m

Depth 31–40 m (study sites 29–35, 37, 39–46, 51–53) (Fig. 5)
The composition of bottom sediments dramatically changed within this range of depth. On the sea bottom at the depth of 34–40 m, in addition to fine and coarse sand, aleurite, gravel, pebbles and boulders were found. At these depths the species diversity of zoobenthos was the greatest: 17 species of zoobenthic organisms were found. However, the overall abundance decreased even more in comparison with the more shallow areas. Among the most abundant zoobenthic organisms were mollusks *Macoma baltica* and *Mytilus edulis*, polychaetes (*Pygospio elegans*, *Nereis diversicolor* and *Harmothoë sarsi*) oligochaetes and crustaceans *Pontoporeia affinis*, *Corophium volutator* and *Mesidotea entomon*. The average abundance and biomass of zoobenthos were 1700 ind./m^2 and 290 g/m^2, respectively.
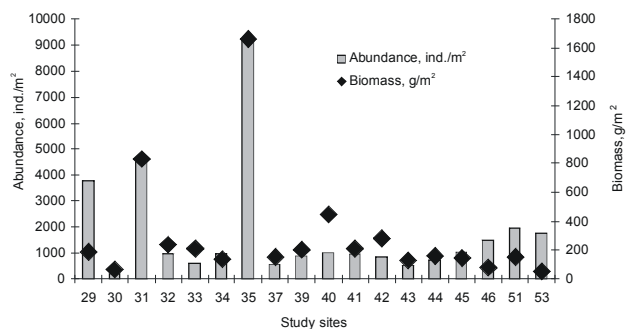

Fig. 5. Total abundance and biomass of zoobenthos at different study sites at a depth of 31–40 m

Depth 41–50 m (study sites 47–53) (Fig. 6)
Within this range of depth, the bottom sediments consisted of fine sand, clay and pebbles. Fifteen species of zoobenthos were defined. Mollusks (*Macoma baltica*, *Mytilus edulis*), polychaetes (*Pygospio elegans*) and crustaceans (*Pontoporeia affinis*) were the most abundant zoobenthic organisms in this water area. The average abundance and biomass of zoobenthos were 1500 ind./m^2 and 400 g/m^2, respectively.
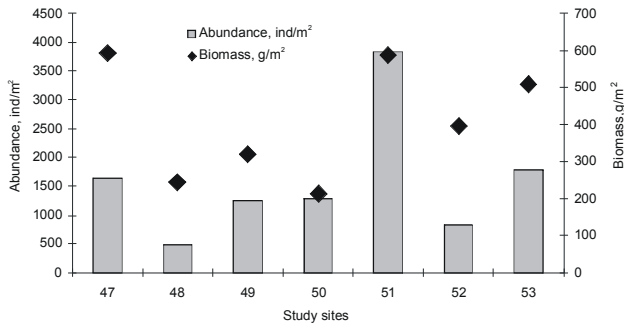

Fig. 6. Total abundance and biomass of zoobenthos at different study sites at a depth of 41–50 m

Depth 51–65 m (study sites 54–61) (Fig. 7)
As compared with the depth range of 41–50 m, the composition of the bottom sediments at a depth of 51–65 m was almost the same. In this study area, 11 species of zoobenthos were registered. The dominant zoobenthic organisms were mollusks (*Macoma baltica*, *Mytilus edulis*), polychaetes (*Pygospio elegans*) and crustaceans (*Mesidotea entomon*). The most abundant zoobenthic organisms were polychaetes, whereas mollusks had the biggest biomass. However, within this range of depth no olygochaetes were found. The average abundance and biomass of zoobenthos were 6140 ind./m^2 and 670 g/m^2, respectively.
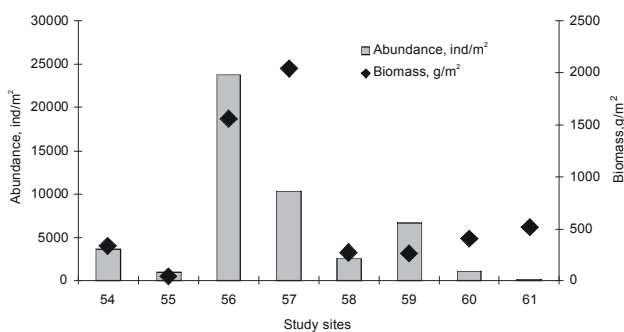

Fig. 7. The total abundance and biomass of zoobenthos at different study sites at depth of 51–65 m

Special attention should be paid to the distribution of mussels (*Mytilus edulis*). According to our data, in a deeper zone of the Nida–Juodkrantė water area (starting from the depth of 31 m) these mussels are ubiquitous if the bottom is hard and covered with boulders. However, their distribution is more fragmental and their abundance is lower than in the Palanga–Būtingė water area (Bubinas et al., 1998, 2000). In this area, this biocoe-

nosis occupies hard bottom biotopes down to the depth of 40 m.

Unlike in the Būtingė–Palanga water area, the biotic community of *Mytilus edulis* is distributed only in deeper zones in the Nida–Juodkrantė water area biotic community, where the bottom is hard or the sediments consist of hard or coarse fractions. At the study sites No 30, 31, 34, 35 and 36, where the depth was 30–40 m and bottom sediments consisted of rough aleurite, pebbles and boulders, the average abundance of *Mytilus edulis* was up to 3000 ind./m^2, whereas their biomass was 500 g/m^2. The productivity indices of *Mytilus edulis* dramatically decreased in the study sites 47, 48 and 58 where fine sand and rough aleurite were dominant in the bottom sediments. Here, at the depth of 40–50 m, the average abundance and biomass of these mollusks hardly reached 400 ind./m^2 and 140 g/m^2, respectively. In the study sites 54, 57 and 59 which are within the depth range of 50–60 m, bottom sediments also consisted of rough aleurite, gravel, pebble and boulders. The average abundance and biomass of *Mytilus edulis* in these study sites were the highest (3500 ind./m^2 and 680 g/m^2, respectively).

Thus, mussels *Mytilus edulis* in the Nida–Juodkrantė water area were found only at a depth of 30–60 m, in the biotope where gravel, pebble, boulders and rough aleurite were prevalent. These mussels were not found in the Klaipėda–Juodkrantė water area where bottom sediments consist of sand of different roughness. Consequently, the distribution of the *Mytilus edulis* biocoenosis, their abundance and biomass depend more on the granulometric structure of bottom sediments than on the depth of the sea (Fig. 8).
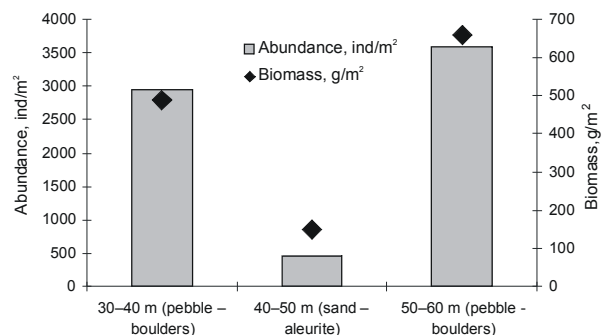

Fig. 8. Total abundance and biomass of *Mytilus edulis* in relation to the depth range according to our data

This biocoenosis is especially important for the nutrition of fish, since in the shore-zone of Lithuania relatively small individuals are dominant in the population of *Mytilus edulis*, which are easily available for benthophagous fish. As a food resource, they are especially important for flounders.

In addition, *Mytilus edulis* filtrate water and thus participate in self-cleaning processes of water, improving living conditions for fish and other hydrobionts.
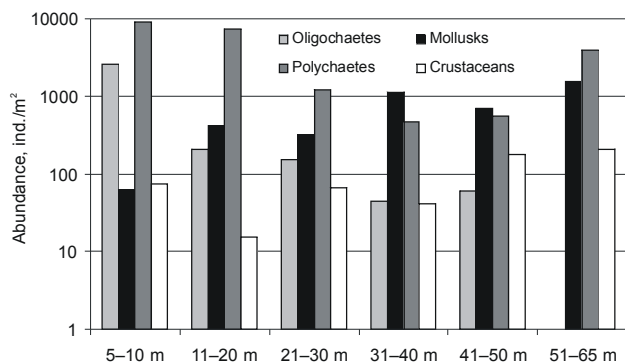
Fig. 9. Abundance of the main zoobenthic groups at different depths in the Nida–Juodkrantė near-shore zone
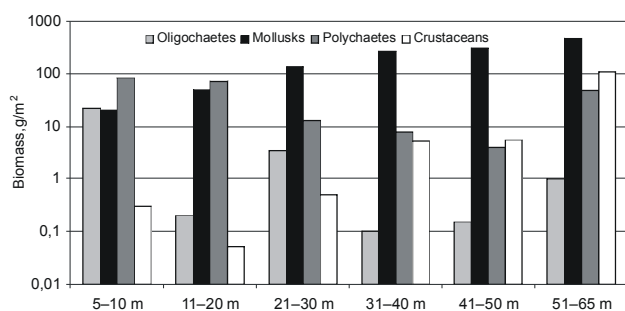

Fig. 10. Biomass of the main zoobenthic groups at different depth in the Nida–Juodkrantė water area

After the spillage of oil at the D-6 drilling platform, and with prevailing southwestern winds, the *Mytilus edulis* biocoenosis can be severely damaged.

Our investigations have shown that the abundance, biomass and ratio of zoobenthos in the biocoenoses mostly depend on the granulometric composition of bottom sediments and on the depth of the sea (Figs. 9, 10).

On the bottom covered with fine and intermediate roughness sand and, partially, with coarse aleurite, the *Macoma baltica – Pygospio elegans* biocoenosis is distributed. It prevails in the Nida–Juodkrantė water area. While studying the peculiarities of the abundance of zoobenthic biocoenoses, their abundance and biomass, we found their direct correlation with the granulometric composition of the bottom and with the depth. Coarser bottom sediments favour the development of zoobenthos. With the sediments getting finer and with the decrease of depth, the biomass of some zoobenthic species also decreases (e.g., *Macoma baltica*). However, the abundance of polychaetes *(Pygospio elegans)* notably increases.

Estimating the Nida–Juodkrantė water area according to the abundance of forage resources for fish, it should be noted that there are quite large quantities of *Mesidotea entomon* crustaceans – one of the main food resources of cod. In addition, this water area is abundant in opossum shrimps, shrimps, amphipods, and polychaetes *Pygospio elegans* and *Nereis diversicolor*, which are important food for benthophagous fish.

CONCLUSIONS

Summarized data of the present study have shown that the zoobenthos in the Nida–Juodkrantė water area consists of four dominant groups of benthic organisms: oligochaetes, polychaetes, mollusks and crustaceans.

The structure and productivity of bottom biocoenoses in the Nida–Juodkrantė shore-zone depend on the granulometric composition of the bottom sediments, geochemical peculiarities, depth and interrelation among different organisms. The sea bottom covered with gravel, boulders and moraine is a suitable substratum for the colonies of *Mytilus edulis*. In the water area studied, this biocoenosis is dominant only in the deep-sea zone of Juodkrantė–Nida. It is important not only as a food resource for benthophagous fish species, but also as a biological purifier. In case of oil spillage at the oil drilling platform D-6, the biocoenosis of *Mytilus edulis* can be severely damaged.

In a larger Nida–Juodkrantė water area, where the bottom is covered with fine and intermediate sand, the dominant are *Pygospio elegans – Macoma baltica – Mesidotea entomon* biocoenoses which are very important as a food resource for benthophagous fish, cod in particular.

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ZOOBENTOSO BENDRIJOS BALTIJOS JŪROS PRIEKRANTĖS ZONOJE (NIDOS–JUODKRANTĖS AKVATORIJA)

S a n t r a u k a

Zoobentoso bendrijos užima svarbią vietą Baltijos jūros priekrantės ekosistemos funkcionavime. Nidos–Juodkrantės dugno biocenozių struktūra ir produktyvumas priklauso nuo grunto granulometrinės sudėties, jūros gylio ir organizmų tarpusavio ryšio. Gargždu, rieduliais ir morena padengtas jūros dugnas – tai substratas *Mytilus edulis* moliuskų kolonijoms. Ši biocenozė paplitusi tik giluminėje tirtos akvatorijos zonoje ir yra svarbi biofiltracijai. Didelį neigiamą poveikį ekosistemai daro patekę į vandenį naftos produktai. Jei įvyktų avarija D-6 naftos gręžinyje ir išsilietų daugiau naftos, *Mytilus edulis* biocenozė būtų pažeista. Tai neišvengiamai turėtų didelę neigiamą įtaką visai ekosistemai.

Didesnėje Nidos–Juodkrantės jūros akvatorijos dalyje, kur dugno nuosėdas sudaro smulkus ir vidutinis smėlis, vyrauja polichetų *Pygospio elegans*, moliuskų *Macoma baltica* ir vėžiagyvių *Mesidotea* (*Saduria*) *entomon* biocenozė, kuri svarbi bentofaginių žuvų mityboje. Čia patekę į vandenį naftos produktai labai pablogintų žuvų pašarų bazę.

Raktažodžiai: makrozoobentosas, biocenozės, naftos produktai, naftos gavybos platformos