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RESEARCH PAPER

Meiofauna of the periphytal of the Odessa coast, Ukraine

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Abstract

A large part of the Odessa coastal zone (up to 3 m depth) is occupied with transects and breakwaters, thus the total area of the surface reaching 16 hectares. Heavy fouling is formed causing impacts on the coastal ecosystem. The meiobenthos is made up of permanent and temporary components. The periphyton lacks gastrotrichs, kinorhynchs, foraminiferans and juvenile gastropods. This is the first study in this periphytal area and a list of species was drawn up of eumeiobenthos (Nematoda – 42 species, Harpacticoida – 13 and Polychaeta – 13 species). The vertical distribution of density of communities and biomass is described for each group, as well as for the meiobenthos on the whole. The periphytal of the meiobentic community differed significantly from that in the adjacent waters.

Keywords: Odessa coast, periphytal, meiofauna

Introduction

In the coastal zones of the sea (Vinogradov 1966, 1967, 1969) or contour biotopes (Zaitsev 1985, 1986, 2006, 2010, 2012; Zaitsev and Polikarpov 2002), an accumulation occurs of organic and mineral substances that contribute to the development of rich life. One of these contour biotopes, the lithocontour forms cliffs and rocky coasts, reefs, banks, underwater mountains and other hard surfaces in the ocean (Zaitsev 1985). In spite of the accessibility to the "coast-sea" zone and its most shallow waters, the lithoconthour has been little studied with relation to macrozoobenthos.

The environmental-biotopic approach in determining the main groupings of organisms in the hydrosphere was proposed by Protasov (1982). The biotope was named periphytal and its communities as periphyton. The specifics of the formation of communities on them are of no less importance than other environmental and biotopical variables in the galosphere (Vernadsky 1968;

Protasov 2011; Protasov and Silaeva 2012). It should be emphasized that it has not been studied yet on different man-made substrates (Reznichenko 1976).

The hydrotechnical surfaces create conditions not only for aquatic organisms and mobile invertebrates, but also contribute for attracting some fish species, which by selecting the most favorable areas, move freely among these structures (Vinogradov, Bogatova and Sinegub 2012). Artificial solid substrates can be used in the coastal waters, as artificial reefs improve the conditions of habitat and aquatic environment and to attract aquatic organisms (Alexandrov 2008). Some authors in connection with technical progress and increase in the number of all types of anthropogenic substrates, besides for pelagic and benthic, recommend a third zone or subcycle of fouling. It should be named mezalu, and in the future, antropal after full development of the World Ocean (Reznichenko 1976). One example of impact on the coastal zone can be seen in a large-scale shoreline protection which began in Odessa Bay in the late 1950's and the early 1960's. Currently, there is a system of concrete traverses and breakwaters which cover the 20 km-long shore, and the latter forming artificial basins. Most of them have poor water exchange with the open sea.

Materials and Methods

The samples were collected in June 2013 from the surface of hydrotecnical construction (travers) in Starik and Delfin basins in Odessa Bay (Figure 1). In each of these artificial basins, samples were taken from concrete surfaces in three vertical sections with depths of 0.5, 1.5 and 2.5 m. Samples were also taken at the bottom under each of the sections of the benthic frame with a 10×10 area of openings trimmed with mesh net № 78 (64 μm). The meiofauna was taken with the thalli of ceramium, cladophora and enteromorpha of macrophytes. Altogether, 25 samples were collected. Each sample was washed in succession through a system of benthic sieves with 5, 1 and 0.1 mm openings for separating into a number of fractions (macro- and meiobenthos). The organisms of meiobenthos concentrated on the sieves with 0.1 mm openings. The washed sample was fixed with 4% formalin and stained with "Bengal rose". Quantitative accounting of meiobenthos was made under a binocular microscope in a Bogorov counting chamber (Hullings and Gray 1971; Vorobyova 1999). Some representatives of eumeiobentos were identified after preparing temporary (for harpacticoids) and permanent (for nematodes) slides with the help of a "Konus 5625 Biorex3" microscope (Filipjev 1918; Platonova 1976).

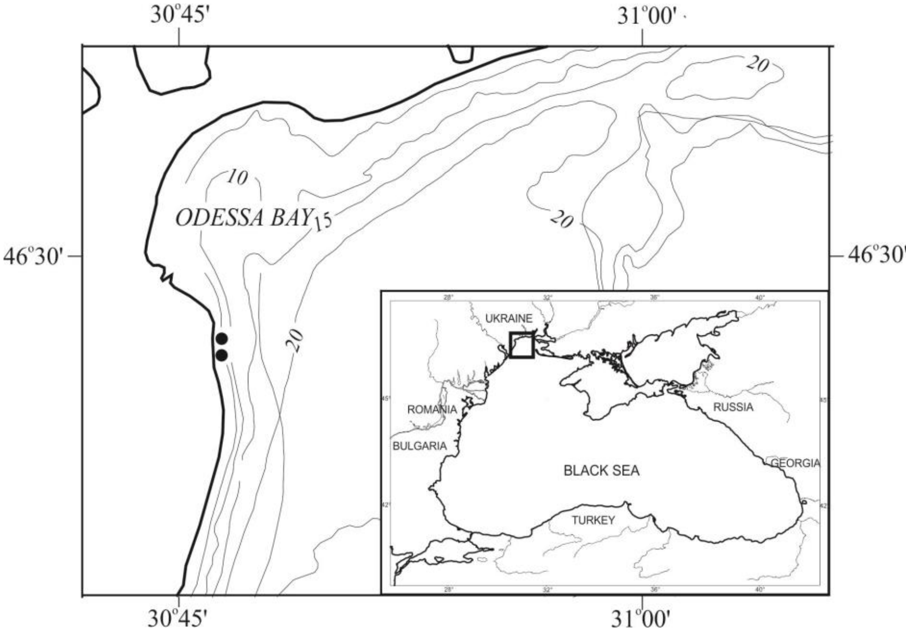

Figure 1. Map of the sampling stations of Odessa Bay

Results and Discussions

Currently in Odessa Bay, there are concrete constructions forming a heavy stretch of fouling and exerting impacts on the coastal ecosystem. There is a rich diversity of macrobenthos developing in the periphytal of the transects and breakwaters. It has much in common with mussels in the biocoenosis of natural substrates in the northwestern Black Sea shelf (Vorobyova and Sinegub 2000). The meiobenthos of the near contact zone and in the near sea bottom is similar (Vinogradov 1969), but the meiofauna of the periphytal is much more poor. Besides foraminiferans, gastrotrichs, kinorhynchs and juvenile gastropods are lacking (Halaman 2009). However, favorable conditions for existence occur for juveniles of amphipods, isopods, cumacea and chironomid larvae.

In June 2013 the meiofauna was represented by the following taxa: Nematoda, Ostracoda, Harpacticoida, Halacaridae, Turbellaria, Polychaeta, Oligochaeta, juvenile Bivalvia, Amphipoda, Cumacea and Chironomidae larvae. The total density of meiobenthos in the transects of Starik was at an average of 346200 ind/m^2 and in the Delphin basin - 517690 ind/m^2. The total density differed significantly 22 years ago, when the density of meiobenthos in both basins was about 20000 ind/m^2 (Vorobyova 1999).

When comparing the distribution, the total density of the meiobenthos was much lower than in the sandy biotope (Figure 2). Its share in total density of meiobenthos in the periphytal was from 32.6 to 49.7% on loose sediment, and it increased by one third. This is due to high nematode density in the sandy biotope, where the density fluctuated from 67.3-80.4% against 26-47% in transects of periphytal. Vertical distribution has shown that the total density of temporary meiofauna in transects is higher than at the bottom. Juvenile gastropods are most abundant at the 0.5 m depth (an average 53300 ind/m^2). Their density drops 2-2.5 times according to increasing depth. The density on sandy bottoms is only 5200 ind/m^2.

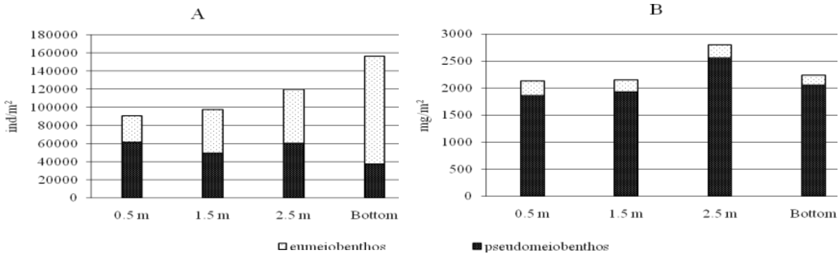

Figure 2. Distribution of total density (ind/m^2) (A) and biomass (mg/m^2) (B) of eumeio- and pseudomeiobenthos in the periphytal and on the bottom

The total density of pseudomeiobenthos at the two lowest depths is compensated by the increase of density of juvenile polychaetes. Their maximum density is characteristic for benthos and its nearest bottom.

As a result when studying the species composition of nematodes, 42 species, 5 orders, 18 families and 29 genera were discovered (Table 1). The nematode species was determined according to Platonova (1968), Filipjev (1918-1921), Gerlach and Riemann (1973) as well as NeMys: World Database; Darwin Nematode Electronic Key.

Order Enoplida dominated in the number of species (17 species) with the following: *Viscosia minor, V. glabra, Anoplostoma viviparum* and *Oncholaimus campylocercoides*. Chromadorida showed 12 species with 45% dominating and high density of communities of *Paracanthonchus caecus, Chromadora nudicapitata* and *Neochromadora poecilosomoides*. Monhysterida is represented by 7 species, however, its frequency and density is less than the above mentioned taxa. *Monhystera rotundicapitata* composite only 36%. Of three representatives encountered from Araeolaimida, *Axonolaimus ponticus* dominated with low frequency. Analysis of quantitative and qualitative indicators on artificial substrates, in points located at different distances from the surface water, has shown their uneven distribution. For example, on the Starik beach at a depth of 0.5 m there were eight species of nematodes. The average density was 8667±349.1 ind/m^2.

Table 1. Species composition of free-living nematodes in the periphytal and on the bottom

Species	Travers (depths)			Bottom
	0.5 m	1.5 m	2.5 m	3 m
Araeolaimida				
Axonolaimadae				
Axonolaimus ponticus Fil., 1918	+	+	+	–
Odontophora sp.	–	+	–	–
Diplopeltidae				
Araeolaimus ponticus Fil., 1922	+	–	–	–
Comesomatidae				
Sabatieria pulchra (G. Schneider, 1906)	+	–	–	+
Monhysterida				
Xyalidae				
Theristus maeoticus Fil., 1922	–	–	–	+
T. oxycerca (De Man, 1888)	+	–	–	–
T littoralis Fil., 1922	+	–	–	–
T. sabulicola (Fil., 1918)	+	–	–	–
T. euxinus (Fil., 1918)	+	–	–	+
Monhysteridae				
Monhystera rotundicapitata Fil., 1922	+	+	+	+
Monhystera sp.	+	–	–	–
Desmodorida				
Microlaimidae				
Microlaimus kaurii Wieser, 1954	+	–	–	+
Desmodoridae				
Metachromadora macroutera Fil., 1918	–	–	–	+
Metachromadora sp.	+	–	–	+
Microlaimidae				
Microlaimus kaurii Wieser, 1954	+	–	–	+
Chromadorida				
Cyatholaimidae				
Paracanthonchus caecus (Bastian, 1865)	+	+	+	+
Paracanthonchus sp.	–	+	+	–
Chromadoridae				
Chromadora nudicapitata Bastian, 1865	+	+	+	+
Neochromadora poecilosomoides (Fil., 1918)	+	+	–	+
Chromadorina obtusa Fil., 1918	+	–	+	–
Chromadorina sp.	+	–	–	–
Chromadorita demaniana Fil., 1922	+	–	–	–
Chromadorella mytilicola Fil., 1918	+	+	–	–
Chromadora nudicapitata(Bastian,1865)	+	–	–	–
Spilophorella sp.	+	–	–	–
Enoplida				
Etmolaimidae				
Ethmolaimus multipapillatus (Paramonov, 1926)	–	–	–	+
Enchelediidae				
Eurystomina assimilis (De Man, 1876)	+	–	–	–
Polygastrophora hexabulba (Fil., 1918)	+	+	–	–
Tripiloididae				
Bathylaimus assimilis De Man 1922	–	–	–	+
Thoracostomopsidae				
Mesacanthion conicum (Fil., 1918)	–	–	–	+
Enoploides sp.	+	–	–	+
Enoplidae				
Enoplus sp.	+	–	–	–
Oncholaimidae				

Table 1. Continued

Species	Travers (depths)			Bottom
	0.5 m	1.5 m	2.5 m	3 m
Metoncholaimus demani (Zuz Strassen, 1894)	–	–	–	+
Oncholaimus dujardinii De Man, 1876	+	–	+	+
O. campylocercoides Coninck et Stekhoven, 1933	+	+	–	+
O. brevicaudatus Fil., 1918	+	–	–	–
Oncholaimus sp.	–	–	+	–
Mononcholaimus sp.	+	–	–	–
Viscosia minor Fil., 1918	+	+	+	+
V. glabra (Bastian, 1865)	+	–	+	+
Viscosia sp.	–	–	–	+
Anoplostomatidae				
Anoplostoma viviparum (Bastian, 1865)	+	+	+	–
Oxystominidae				
Halalaimus sp.	+	–	+	–

Dominating were *V. glabra* (3680 ind/m^2 and *A. viviparum* 2367 ind/m^2. At a depth of 1.5 m there were seven species of nematodes. The average density of nematode species made up 43000±14622 ind/m^2 with *C. nudicapitata* dominating 13084 ind/m^2. At a depth of 2.5 m there was a lowering of the nematode species diversity (three species). In the sandy bottom with a mixture of shells, a maximum species diversity of nematodes was noted (14 species). Their average density was 71300±2324.6 ind/m^2. *Theristus maeiticus* (16054 ind/m^2), *Metachromadora macroutera* (16054 ind/m^2) and *O. campylocercoides* (14270 ind/m^2) prevailed (Figure 3).

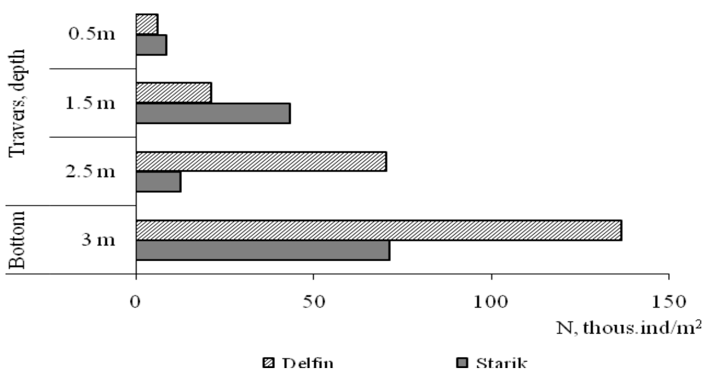

Figure 3. verage density (ind.·m^{-2}) of nematodes in the periphytal and on the bottom

At the Delfin Beach a similar division of quantitative indices of nematodes was noted on concrete surfaces with an increase from surface to bottom. At a depth of 0.5 m, maximum diversity of nematodes (13 species) occurred. However, their quantitative indices were not high (an average 6000 ±3002.0 ind/m^2). *O. brevicaudatus* (1778 ind/m^2) and *A. ponticus* (1114 ind/m^2) dominated. At a depth of 1.5 m from the water surface, the average density of nematodes was 21333±8202.6 ind/m^2.

P. caecus (6926 ind/m^2) and *O. campylosercoides* (4614 ind/m^2) were dominated. Nearer to the bottom (at a 2.5 depth) 12 species were discovered. The average density 70667 ±11242.3 ind/m^2 rose almost 3 times. Species of Enoplida, *A. viviparum* (18016 ind/m^2) and *V. minor* (12474 ind/m^2) were in mass development. Subdominant in density were the following species: *A. ponticus* (5544 ind/m^2) *M. rotundicapitata* (4154 ind/m^2), *C. nudicapitata* (4154 ind/m^2). A maximum of nematodes in sandy shell bottom was noted (136667±24732.8 ind/m^2) with the dominance of *V. glabra* (36446 ind/m^2), *V. minor* (18222 ind/m^2).

Also this was noted in the dominance of the Chromadorida order *Metachromadora* sp. (27333 ind/m^2), Monhysterida order: *T. sabulicola* (18222 ind/m^2) and Areolaimida order: *S. pulchra* (9111 ind/m^2).

Thus in the fouling of the transect community of free living nematodes has been rich. However, the share of total density of meiofauna was only 17-27%. The mean quantitative density of the nematode community varied from 6000±3202.0 ind/m^2 to 70667±11242.3 ind/m^2, the highest in the 2.5m depth. Their number rose in the periphytal.

The study of periphytal in artificial basins showed 17 harpacticoid species, with 10 species in Starik and 12 in Delfin and five species in both basins (Table 2).

In the 1990s, 23 harpacticoid species occurred (Garlitskaya 2010). In comparison with open waters of the Odessa coast they were small in number varying from 2000 ind/m^2 to 40000 ind/m^2. At a 1.5 m depth the number in both basins was 11700 and 10600 ind/m^2. At the 2.5 m depth, the average density for Starik was 3300 ind/m^2. At Delfin it was 3 times higher (918660 ind/m^2). The share of harpacticoids in total density in meiobenthos was 14.4 %. For Starik it was five times lower.

Ostracods are not numerous in the periphytal. They dominated in the two upper depths with 2060 ind/m^2 to 8000 ind/m^2. They do not occur in the bottom deposits of transects. At the same time in the fouling of natural rocky substrates they form significant accumulations. In depths from 3 to 5.2 m the density of communities varied from 13000 to 70000 ind/m^2. They were also numerous in the silty shelly sediment at 10-11 m depth.

For Odessa Bay in the late 1950s, 17 species of halacarids were recorded (Vorobyova and Yaroshenko 1979, 1982) in the near coastal zone of hydrotecnical sourfaces (travers) and breakwaters of shore line protection. Currently eight species were discovered (Gelmboldt 2001). In 2013 in the periphytal and in sandy substrate, six species of halacarids: *Rhombognatides pascens*, *Rh. denticulatus*, *Copidognathus ponteuxinus pectiniger*, *C. magnipalpus ponticus*, *C. magnipalpus pectiniger*, *Aquauopsis brevipalpus* were recorded.

Table 2. List of species of Harpacticoida (Crustacea, Copepoda) in the periphytal and on the bottom

Taxon	Starik				Delfin			
	0.5 m	1.5 m	2.5 m	Bot-tom	0.5 m	1.5 m	2.5 m	Bot-tom
Ameira parvula (Claus,1866)	–	+	+	+	+	+	+	–
Amonardia similis (Claus,1866)	–	–	–	–	–	–	+	–
Amphiascopsis cinctus (Claus,1866)	–	+	–	–	–	–	+	–
Canuella perplexa (T. et A. Scott, 1983)	–	–	–	+	–	–	–	–
Ectinosoma melaniceps (Boeck, 1865)	–	–	+	–	–	+	+	–
Harpacticus littoralis (Sars, 1910)	–	–	–	+	–	–	–	–
H. flexus (Brady et Robert,1873)	+	–	+	+	+	–	–	+
H. nicaeensis (Claus,1866)	+	–	+	–	–	–	–	–
H. ponticus Marcus, 1967	–	–	–	–	–	–	+	–
Heterolaophonte minuta (Boeck, 1872)	–	–	–	+	–	–	–	–
Laophonte elongata (Boeck, 1873)	–	–	–	–	–	–	+	–
L. setosa (Boeck, 1865)	–	–	–	–	–	–	+	–
Nitokra hibernica (Brady, 1880)	–	+	+	–	–	–	–	–
Normanella mucronata (Sars, 1909)	–	–	–	–	–	–	+	–
N. serrata Por, 1959	–	+	–	–	–	+	+	–
Paradactilopodia sp.	–	–	–	–	–	–	+	–
Tisbe furcata (Baird, 1837)	–	–	–	–	–	–	+	–

*General species in the periphytal of the two artificial basins

Only some of them (*Normanella serrata*, *N. mucronata*) were found in biotopes of mollusk silts.

The density of Halacarida was distributed vertically in the peryphytal equally (with a mean from 3800 to 7000 ind/m^2). At the Starik bottom they were lacking, while in the bottom layer, only single individuals occurred. It should be noted that in both basins, the share of total number of halacarids was much higher in the upper depth. It made up a third of the eumeiofauna, up to 12-15% from the total number of meiobenthos. It is exactly in the upper depths that on the algal substrate, the phytophagous, and carnivorous Halacarida dominate. In the biocenosis of mollusks they feed on detritus.

Altogether in the Starik and Delfin beaches, meiobenthos in the periphytal of shore line protection sources and at the bottom sandy biotope, 13 species of polychaetes have been registered. Three of them *Salvatoria clavata* (Claparède, 1863), *Protodrilus flavocapitatus* (Uljanin, 1877) and *Fabricia sabella* (Ehrenberg, 1836) belong to eumeiobenthos, and the rest are juvenile macrobenthos and pseudomeiobenthos. Some juveniles of the Nereidae family could not be identified to species. The total number of meiobenthic polychaetes in certain samples was between 4 650 and 24 300 ind/m^2. Analysis of changes in mean number showed that the upper depth of the periphytal of shore line protection was a maximum in the sandy biotope. At the 0.5 m depth the number of meiobenthic polychaetes was 6783 ± 649 ind/m^2, at 1.5 м it was 9933 ± 1350 ind/m^2, at 2.5 m – 12358 ± 2966 ind/m^2 and 14658 ± 2797 ind/m^2 at the bottom. Most of the taxa of meiobenthic polychaetes were registered in the two biotopes with 72.7%.

In the periphytal of hydrotecnical surfaces (transect), eleven species of polychaetes in the meiobenthos were registered. Most often, representatives of eumeiobenthos such as: *S. clavata* and *F. sabella* and also juvenile *Polydora cornuta* Bosc, 1802, *Alitta succinea* (Leuckart, 1847), *Platynereis dumerilii* (Audouin et M.-Edwards, 1834) and Nereidae were encountered. In the sandy biotope there were nine species of bristle worms. High numbers of eumeiobenthic *S. clavata*, *P. flavocapitatus, F. sabella* and juvenile, *Scolelepis (Parascolelepis) tridentata* (Southern, 1914), *Spio filicornis* (Müller, 1776), *P. cornuta*, *Capitella capitata capitata* Fabricius, 1780 and juvenile Nereidae (Table 3) occurred in the eumeiobenthos.

Table 3. Occurrence (P, %) of meiobenthic polychaetes in the periphytal and on the bottom

Species	Periphytal of hydrotecnical surfaces	Sandy biotope
Harmothoe reticulata (Claparède, 1870)	33	–
Salvatoria clavata (Claparède, 1863)	100	100
Nereis zonata Malmgren, 1867	11	–
Alitta succinea (Leuckart, 1847)	61	17
Hediste diversicolor (O. F. Müller, 1776)	6	17
Platynereis dumerilii (Audouin et M.-Edwards, 1834)	56	–
Perinereis cultrifera (Grube, 1840)	6	–
Nereidae	100	100
Protodrilus flavocapitatus (Uljanin, 1877)	–	67
Scolelepis (Parascolelepis) tridentata (Southern, 1914)	–	100
Spio filicornis (Müller, 1776)	28	100
Polydora cornuta Bosc, 1802	100	100
Capitella capitata capitata Fabricius, 1780	22	100
Fabricia sabella (Ehrenberg, 1836)	72	50

The number of species in the biotopes differed. In the periphytal of shore line protection structures, representatives of true eumeiobenthos such as *S. clavata* and juvenile *P. cornuta* prevailed. Their share in total number of meiobenthic polychaetes at different depths varied from 37 to 47 % and from 37 to 57 %, respectively. The number of *S. clavata* at depth from 0.5 m to 2.5 m varied from 3208 ± 607 ind/m^2 to 4233 ± 346 ind/m^2. *P. cornuta* occurred mostly at depth of 1.5 and 2.5 m with 5467 ± 999 and 7042 ± 2430 ind/m^2 respectively.

The number of given species in the sandy biotope was significantly lower, although they were encountered in periphytal making up 100%. Only one juvenile species of *S. filicornis* dominated (10058 ± 1865 ind/m^2), making up 69% of the total polychaete density of meiobenthos in the biotope. Juveniles of this species in the fouling of hydrotechnical substrates rarely occurred (Figure 4). *S. clavata* occurred 100% in both of the biotopes. In spite of the high occurrence, the density of *F. sabella* in both of the sandy beaches was low. *P. flavocapitatus* was noted only in the sandy biotope which is a natural habitat of this species.

Bivalvia was represented by mytilus and mitellyasters. Their total density reaches a mean 36300 ind/m^2 for the surface of the transect of the Delfin basin, and 29500 ind/m^2 for Starik. Meanwhile at the bottom, it is 4000 ind/m^2, and 3300 ind/m^2 for the two basins. The highest density of juvenile mollusks was found close to the surface with a mean of 36200 ind/m^2. With increasing depths, the density of mollusks decreased almost one and a half times. It was similar in the distribution of indicators of mollusk biomass and their share in the total density of meiobenthos. For example, in the near surface layer of Delfin, it was a mean 1066.6 mg/m^2 (48% of the total biomass of the whole meiobenthos) and at the lower depths, almost half (555.3 mg/m^2). Its share in meiobenthic biomass was a mean 24%.

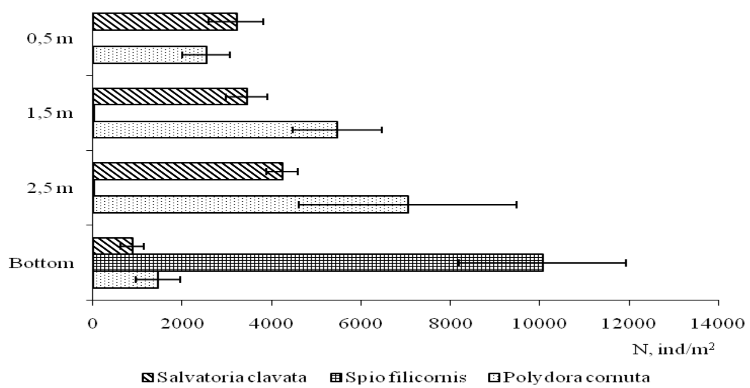

Figure 4. Density of dominant species of the meiobenthic polychaetes at different levels of the periphytal and on the bottom

Conclusions

The meiobenthos of the periphytal of artificial substrates was represented by eight groups while foraminifera, gastrotricha, kinorhyncha, oligochaeta and juvenile bivalves were absent in the coast of Odessa Bay. The total density of meiobenthos was almost three times lower than that of the benthos in the Odessa coast registered at the same time. The 93.3% of loose sediments was formed by eumeiobenthos, while in the periphytal a permanent component made up 49.7%. The main difference and importance of meiobenthos in the periphyton is the formation of a large biomass 142666.7 mg/m^2 and in comparison in loose sediments (2190.2 mg/m^2).

These high indicators are due to polychates which belong to meiobenthos and to juvenile bivalves. Of importance is the sedimentation and survival of Bivalvia larvae on a huge surface area of shoreline protection. In the future they will supply larvae in Odessa Bay and in the close sea area. Significant difference is observed in the density of settlements of groups of eumeuiobenthos and their temporary component (pseudomeiobenthos) on loose sediments. The larvae of bivalves are more active and they choose sedimentation in the periphytal zone (located in one half a meter from the sea surface). Here there are two-three times more than at 1.5-2.5 m depths. In the near surface layer of basins, indicators of density are formed due to harpacticoida, ostracoda, halacarida, juvenile bivalves. Lower towards the bottom layer the total densities of nematodes and juvenile polychaetes increase. The predominance in the biomass of meiobenthos, including harpacticoids, juvenile polychaetes and bivalves makes them important for feeding both juvenile and adult fish.

References

Alexandrov, B.G. (2008) Hydrobiological Basics for Managing the State of the Black Sea Ecosystems. Naukova dumka, Kiev. 340 pp. (in Russian).

Darwin Nematode Electronic Key Plym. Mar. Lab. (http://web.pml.ac.uk/ nematode/WebHelp/Nemkey.htm)

De Ley, P., Blaxter, M.L. (2004) A new system for Nematoda: combining morphological characters with molecular trees, and translating clades into ranks and taxa. *Nematology Monographs & Perspectives* 2: 633-653.

Filipjev, I.N. (1918-1921) Free-living nematodes of the Sevastopol area. Trudy osob. zool. lab. Sevastop. *Biol. Stan.* (1/2) 4: 1-614. (in Russian).

Galtsova, V.V. (1976) Free-living nematodes as a component of meiobenthos in Chupa Bay of the White Sea. Nematodes and their role in meiobenthos. L.: Nauka, pp.169-175. (in Russian).

Garlitskaya, L.A. (2010) Ecology of Harpacticoida (Cumacea, Copepoda) of the northwestern of Black Sea. Ph.d. Dissertation. Institute of Biology of the Southern Sea, Sevastopol, 20 pp. (in Russian).

Gelmboldt, M.V. (2001) Species composition and density of marine mites (Halacaridae: Acari) of the Odessa Bay. *Hydrobiological Journal* 37 (1): 22-26 (in Russian).

Gerlach, S., Riemann, F. (1973) The Bremerhaven Checklist of Aquatic Nematodes. Veröff. Inst. Meeresforsch. Bremenhaven, Bremen. 4 (1, 2): 736.

Halaman, V.V. (2009) Fouling terminology and determination in general biology 70(6): 495-503.

Hullings, N.C., Gray, J.S. (1971) A manual for the study of meiofauna. *Smit. Contr. Zool.*78: 1-84.

NeMys: World Database of Free-Living Marine Nematodes. (http://nemys.ugent.be). (Accessed 2015-02-18).

Platonova, T.A. (1968) Class of roundworms – Nematoda. Determinant of the fauna of the Black and Azov Seas. Kiev: Naukova dumka 1: 111-183 (in Russian).

Platonova, T.A. (1976) Lower ENOPLIDA (free-living marine nematodes) seas of the USSR. In: Nematodes and Their Role in Meiobenthos. The fauna of the seas Vol. XVII (XXV). L.: Nauka. pp. 3-164 (in Russian).

Protasov, A.A. (1982) Periphyton: Terminology and the basic definitions. *Hydrobiological Journal* 18 (1): 3-9 (in Russian).

Protasov, A.A. (2011) Life in the hydrosphere. Proceedings in General Hydrobiology, Kiev: Akademperiodika, 704 pp. (in Russian).

Protasov, A.A., Silaeva, A.A. (2012) Contour grouping of hydrobionts in technical systems. TES and AES Institute of Hydrobiology National Academy of Sciences of Ukraine. Kiev, 274 pp. (in Russian).

Reznichenko, O.G. (1976) Mezalus as Anthropogenic Biotope of the Galosphera. Proceedings of the III Congress of Hydrobiological Society. Riga, Zinatne. 1: 172-174 (in Russian).

Vernadsky, V.L. (1968).The Biosphere. Moscow: Mysl, pp.374 (in Russian).

Vinogradov, K.A. (1966) On the Question of Studying Contact Zones of the Sea. Proceedings of the VI zoogeographic conference. Odessa, Ukraine. pp. 43-45 (in Russian).

Vinogradov, K.A. (1967) Contact zones of the Southern Seas and some aspects of their ecological and geographical study. *Voprosy biookeanografii*. Kiev: Naukova dumka, pp.154-161 (in Russian).

Vinogradov, K.A. (1969) Contact zones of the Southern Seas // Biological Oceanography problems of the southern seas. Kiev: Naukova dumka, pp.45-48 (in Russian).

Vinogradov, A.K., Bogatova, Yu.I., Sinegub, I.A. (2012) Ecosystems of marine port areas in the Black Sea – Azov basin. – Odessa: Astroprint, 512 pp. (in Russian).

Vorobyova, L.V. (1999) Meiobenthos of the Ukrainian shelf of the Black and Azov Seas. Kiev: Naukova dumka, 300 pp. (in Russian).

Vorobyova, L.V., Sinegub, I.A. (2000) The structure and quantitative indicators of zoobenthos of fouling of shore protection in Odessa. In: Global Watch System of the Black Sea: the fundamental aspects. Sevastopol, pp.132-138 (in Russian).

Vorobyova, L.V., Yaroshenko, N.A. (1979) Marine mites (Halacaridae) of the northwestern part of the Black Sea. *Hydrobiological J.* 15(6): 29-33 (in Russian).

Vorobyova, L.V., Yaroshenko, N.A. (1982) Qualitative compound of Halacaridae in the Odessa Bay and the Black Sea limans. *Hydrobiological J.* 17(3): 40-43 (in Russian).

Zaitsev, Yu.P. (1985) Conturobionts in monitoring the ocean. Complex global monitoring of the World Oceans: *Trudy Intern. Symp*. L.: Gidrometizdat, 2: 76-83 (in Russian).

Zaitsev, Yu.P. (1986) Contributionts in Ocean Monitoring. Environmental Monitoring and Assessment. *D. Riedel Publ. Comp*. 7: 31-38.

Zaitsev, Yu.P. (2006) Littoral concentration of life in the Black Sea area and coastal management requirements. J. *Black Sea/Mediterranean Environment* (12): 113-128.

Zaitsev, Yu.P. (2010) Marginal effect of marine ecosystems. Scientific Proceedings of the Ternopol National Pedagogic Univ. Ser. Biol. Vinnitca, Ukraine. 4(27): 90-92 (in Ukranian).

Zaitsev, Yu.P. (2012) A key role of sand beaches in the marine environment. *J. Black Sea/Mediterranean Environment* 18(2): 114-127.

Zaitsev, Yu.P., Polikarpov, G.G. (2002) Ecological processes in critical zones of the Black Sea: Results synthesis of two research directions, middle of the XX th beginning of the XXth centuries. *Marine Ecological Journal* 1(1): 33-51 (in Russian).

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