Deep-water hypoxic meio-benthic Protozoa and Metazoa taxa of the Istanbul Strait’s (Bosporus) outlet area of the Black Sea

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Abstract
The purpose of these investigations was to understand the response of different meio-benthos taxa on the oxygen depletion in the habitat in the deep-water areas of the Black Sea. The results of first study were published in TrJFAS (Sergeeva et al. 2013) and were devoted to vertical distribution of the deep-sea meio-benthic communities. This article includes a historical overview of research dedicated to meio-benthos and represents first detailed quantitative analysis of taxonomic composition and vertical distribution of main taxa of meio-benthos in the Istanbul Strait’s (Bosporus) outlet area of the Black Sea along the transition from oxic to anoxic conditions, where the sinking water is in contact with the bottom. Nine stations were carried out in the Istanbul Strait’s outlet area of the Black Sea during 9th–21st November 2009 at the R/V ‘Arar’ cruise from the Istanbul University. The abundance and vertical distribution of main taxa of Protozoa (Ciliophora, Gromida and Foraminifera) and Metazoa (Nematoda, Polychaeta and Harpacticoida) on the Black Sea shelf and the upper slope area (75–300 m depth water) were studied. Meiobenthos was present at all investigated depths and included 21 taxa. Gromiids, hard-shell foraminifera and polychaetes were found at depths between 75–250 m, Ciliophora, soft-shelled foraminifera and nematodes were found at depths between 75–300 m. Our data suggest that some benthic eukaryotes (protozoa and metazoa) can tolerate anoxic and sulfidic conditions of the Black Sea.

Key words: Ciliophora, Gromida, Foraminifera, Nematoda, Polychaeta, Harpacticoida, abundance trends, depth gradient, sediment layers habitat versatility.

Introduction
This work continues a series of studies on deep-water meio-benthos in the Istanbul Strait’s (Bosporus) outlet area of the Black Sea, conducted within the framework of the EU 7th FP project HYPOX (In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies) EC Grant 226213. The aim of that study was ambiguous. Firstly, to understand the response of the benthic fauna on oxygen depletion and secondly, to analyze the taxonomic composition and distribution of the benthic fauna inhabiting the depth zone where the oxic/anoxic interface zone meets the sea floor.

Previous Studies
Pioneer studies of benthic fauna in the Bosporus outlet area were done in 1890, where new mollusks species were discovered, previously not described for the Black Sea (Ostroumov 1893, 1894). In subsequent studies the research interests were focused only on the macrobenthic component of bottom fauna (Zernov 1913;
Yakubova 1948). Size category of bottom fauna, called meiobenthos has not been studied until the twentieth century. Meiobenthos embraces a set of microscopic benthic body of 0.1–1 mm size (Mare 1942). Some authors considered 2 mm, as the upper dimensional criteria of meiobenthos (Chislenko, 1961a, 1961b). The size composition of meiobenthos includes the permanent meiofauna (eumeiobenthos) and the temporary meiofauna (pseudomeiobenthos), represented by the juvenile stages of macrobenthos (Chislenko 1961a).

At 1959 for the first time meiobenthic fauna was collected at Bosphorus outlet area of the Black Sea. At six stations in the western part of the Bosphorus area Băcescu & Márgineanu (1959) indentified and described 20 species of meiobenthos that were not only new for the Black Sea, but also new for biological literature. The presence of nineteen species of benthic foraminifera, three species of harpacticoids, three species of ostracods has been documented (Băcescu & Márgineanu 1959; Băcescu 1960). Several ostracods species specific only to the Bosphorus outlet area of the Black Sea were described in the late fifties and early sixties (Caraion 1959; Marinov 1962; Shornikov 1966).

In the sixties another research was focused on benthic foraminifera in the Bosphorus area (depth 80–100 m). Three main foraminiferan complexes were defined based on the dominant foraminiferan species. The first complex, where species *Streblos beccarii* dominated was represented by six species, in the second set (represented by 10 species) species of genera Ammobaculites are abundant and the third complex consisted of a mixed thirty two species group (Didkowsky 1969). Subsequently at Bosphorus outlet area seventy nine species of benthic foraminifers have been discovered, comprising thirty nine genera and six orders. Twenty seven new species were unique for the Bosphorus area of the Black Sea (Yanko & Vorobyova 1991).

Additional studies dealing with benthic fauna in the Bosphorus outlet area were performed by the Department of Benthos of IBSS, during 1958, 1960 during RV ‘Academic Kovalovsky’ cruises at the Bosphorus area. By sampling a total of ten benthic stations at water depths of 70–113 m three ecological communities were distinguished, namely *Modiolula phaseolina*, located to the north-east of the Bosphorus outlet area, and the ecological communities *Sternaspis scutata* and *Amphiura stepanovi – Terebrellides stroemi* located to the north-west of the Strait. In the *Modiolula phaseolina* community four higher taxa and six species of meiobenthos were found. In the *Amphiura stepanovi-Terebrellides stroemi* community also four higher taxa and ten species of meiobenthos were found. In the *Sternaspis scutata* community seven species of meiobenthos were found. In general, the meiobenthos included the following taxa: Nematoda, Kinorhyncha, Polychaeta, Ostracoda, Harpacticoida, Acari. Nematodes as usual were the most numerous taxa (Kiseleva 1969). The taxonomic analysis of sediment samples revealed 51 species of nematodes belong to the thirty seven genera. Further on some species from Bosphorus region were described as new to science, among them there are *Sabatieria praebosporica* Sergeeva 1973, *S. asperum* Sergeeva 1973, *Filencholaimus ponticus* Sergeeva 1974, *Parironus ponticus* Sergeeva 1973, *Halichoanolaimus lukjanovae* Sergeeva 1973, *Mesacanthion heterospiculum* Sergeeva1974, *Crenopharinx brevicaudatus* (Sch. Stekh.), *Paramesacanthion truncus* Vitiello, *Viscosia minudonta*. Four species were found only on the shelf of the Bosphorus area and the two of them later were met in other parts of the Black Sea (Sergeeva 1973a, b, 1974, 1977).

In 1991 U. Luth (2004) presented results of investigations of meiofauna and macrofauna on transect in the region Inebolu in the depth interval from 50 m to 250 m. Special interest was to set taxonomic composition and distribution patterns of deep-water benthic communities inhabiting the layer where the oxic/anoxic interface meets the sea floor. On the Inebolu transect the steep decline in number of taxonomic groups occurred between 130 m and 150 m depth, already in the suboxic zone. Mobile forms with high oxygen demands such as crustaceans or fish were restricted to this zone.

Pioneer studies of diversity and abundance of deep-water Tardigrada at the oxic/anoxic interface in the Bosphorus outlet area of the Black Sea were done by Kharkevych & Sergeeva (2013), where new tardigrades species were discovered, previously not described for the Black Sea.

Brennan et al. (2013) presented first time data about meiobenthos composition on three stations in the oxic/suboxic/anoxic interface of the Black Sea off Sinop. The highest total abundance of meiobenthos was found in the oxic sediment core and the lowest in the anoxic core. The total number of individuals in the oxic zone was approximately 200 times higher than the number of individuals found in the anoxic zone. The taxa composition of meiobenthos on three sites ranged between 5 and 9 major groups. Meiofauna from the anoxic sample includes representatives of only Nematoda, Acari, Harpacticoida and hard-shelled Foraminifera. Nematoda dominated all three zones, followed by Harpacticoida in the oxic and suboxic zones.

Meiofauna from the anoxic sample includes representatives of only Nematoda, Acari, Harpacticoida and hard shelled Foraminifera. The third prevalent group was Polychaeta in the oxic zone and Hydrozoa in
the suboxic zone. Kinorhyncha were recruited only from the oxic and suboxic zones. Turbellaria, Ostracoda and Echinodermata were detected only in the oxic sample (Brennan et al. 2013).

There are significant variations of conditions in the Bosphorus area caused by the fluctuation of the lower flow of the Bosphorus. This is reflected in the distribution of benthos, as shown, for example, in the shift of the peak position in the settlement of the polychaetes Vigtorniella zaikai and Protodrilus sp. (Sergeeva & Zaika 2013; Zaika & Sergeeva 2012)

There is the first information about the marine filamentous fungi of the deep soft sediments at the transition zone from oxic to anoxic conditions (117.4–295.7 m water depths) in the Bosphorus outlet area of the Black Sea. The morphologic difference of filamentous mycobiota indicates to species diversity of fungi in the extreme benthal conditions. Large accumulations of mycelium in the bottom sediments in Black sea deep-water zone is the evidence of fungi habitation in the hydrogen sulfide zone (Sergeeva & Kopytina, 2014).

Systematic study of fauna from the deeper parts of the Black Sea began since start the EU projects HERMES (2006–2009) and HYPOX (2009–20012). Two oceanographic expeditions were conducted to survey fauna at the deep-water part in the outlet area of the Istanbul Strait’s (Bosphorus) during cruises of the RV ‘Arar’ (November 2009) and the RV ‘Maria S. Merian’ 15/1 (April–May 2010). During ‘Arar’ cruise meiothons abundance and distribution on the Black Sea shelf and the upper slope area off the Bosphorus Strait outlet area were studied. This study represents the first detailed quantitative analysis of the structure and distribution of meiothons communities in the transition zone from oxic to anoxic conditions. Meiobenthos was present at all investigated depths and included 21 taxa. (Sergeeva et al. 2013). Our present study is devoted to the further description of taxonomic diversity of meiothons studied in this cruise.

**Material and Methods**

A twelve-day cruise was carried out to the Istanbul Strait’s outlet area (Bosphorus) of the Black Sea with the RV ‘Arar’ from the Istanbul University during 9th–21st November 2009. In this study we sampled and studied the complete taxa of meiothons covering the size range of 63 μm to 1.0 mm in the Istanbul Strait outlet area of the Black Sea from water depths of 75 m to 300 m, where less saline surface waters of the Black Sea interact with the saline Mediterranean waters, creating a special ecological system and rapid transitions from oxic, hypoxic and anoxic water conditions.

The main objectives were, to investigate the distribution patterns of different taxonomic groups of meiothons along different water depths between 75 m and 300 m (i), to determine the maximal sediment depth of meiothons occurrence (ii), to study the quantitative relationships between different taxa and their settlement levels within the sediment (iii).

Geophysical subbottom profiling and sediment coring along depth transects from 70 m to 300 m were conducted. Nine benthic stations were chosen along this transect from the oxic to the anoxic zone (Table 1).

<table>
<thead>
<tr>
<th>Station</th>
<th>Water depth (m)</th>
<th>Latitude, N</th>
<th>Longitude, E</th>
</tr>
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<tr>
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<td>75</td>
<td>41°20,3’</td>
<td>29°06,03’</td>
</tr>
<tr>
<td>3</td>
<td>82</td>
<td>41°24,02’</td>
<td>29°03,21’</td>
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<tr>
<td>4</td>
<td>88</td>
<td>41°23,29’</td>
<td>29°12,24’</td>
</tr>
<tr>
<td>5</td>
<td>103</td>
<td>41°26,86’</td>
<td>29°12,95’</td>
</tr>
<tr>
<td>6</td>
<td>122</td>
<td>41°28,68’</td>
<td>29°14,81’</td>
</tr>
<tr>
<td>7</td>
<td>160</td>
<td>41°28,99’</td>
<td>29°15,14’</td>
</tr>
<tr>
<td>8</td>
<td>190</td>
<td>41°29,36’</td>
<td>29°15,53’</td>
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<tr>
<td>9</td>
<td>250</td>
<td>41°29,93’</td>
<td>29°16,12’</td>
</tr>
<tr>
<td>10</td>
<td>300</td>
<td>41°30,14’</td>
<td>29°16,34’</td>
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</table>
Samples for biological studies were collected using a multiple corer and a gravity corer, devices that obtain virtually undisturbed sediment samples. At each station, the sediment cores were sectioned into the following horizontal layers: 0–1, 1–2, 2–3, 3–5, 5–7 and 7–9 cm. All sediment sections were preserved in 75% alcohol, which is known to preserve morphological structures without distortion. We avoided prior fixation in formalin in order to not damage calcareous taxa. The sediments were washed through sieves with a mesh size of 1 mm and 63 μm, and stained with Rose Bengal solution before being sorted in water under a microscope for “live” (= stained) organisms. We extracted only those specimens that were stained intensely with Rose Bengal and showed no signs of morphological damage. In this study, we identified ‘live’ protists and other meiofaunal organisms based on Rose Bengal staining. The fraction that retained in the sieves was stained with Rose Bengal solution, a dye traditionally used to separate living and dead / decaying organisms (Grego et al. 2013) and sorted in water under a binocular microscope for ‘live’ (stained) organisms, which were identified to higher taxa (Bernhard 2000; Bernhard et al. 2006; Danovaro et al. 2010). We extracted only those specimens that were stained intensely with Rose Bengal and showed no signs of morphological damage. All isolated macro- and meio-benthos were counted and identified to higher taxa level. All protozoa and metazoa fauna, larger than 63 μm were categorized as meio-benthos. All of the organisms isolated were counted and identified to higher taxa. Protists were indentified as gromiids based on test characteristics, test shape and the presence of an oral capsule (Roth et al. 2010). However, because gromiids can be confused with allogromiid foraminiferans, confirmation of these identification must be await molecular analyses and an examination of the test-wall ultra structure (Sergeeva et al. 2012).

Oxygen measurements were conducted at three stations (88, 103, and 122 m water depth) as at the remaining stations pebbles and shells, densely covering the sediment surface, impeded the penetration of the fragile microsensors (Fig. 1).

![Figure 1](image.png)

**Figure 1.** Oxygen concentrations in the sediment and the overlying water at Stations 4–6 (by Sergeeva et al 2013).

**Results and Discussion**

Benthic fauna analyses suggest that the oxic/anoxic transition zone supports a high abundance and rich protozoan and metazoan life. Altogether, these results confirm our early conclusion about a possible adaptation of some forms of benthos to hypoxia/anoxia and the hydrogen sulfide environment (Sergeeva et al. 2012). Our data suggest that some of the organisms (gromiids, allogromiids, ciliophora, hydrozoa, nematodes, and polychaetes) have indeed adapted to live under hypoxic/anoxic and sulfidic conditions in the Black Sea. This fauna is indigenous, rather than having been transported from adjacent oxygenated areas.
1. Protozoa

Protozoa have been defined as single-cell protists with animal-like behavior. Protozoa is the significant components of the micro- and meiofauna. Protozoa refers to a unicellular heterotrophic protist. As components of the micro- and meiofauna, protozoa are an important food source for micro-invertebrates. Thus, the ecological role of protozoa in the transfer of bacterial and algal production to successive trophic levels is important. As predators, they prey upon unicellular or filamentous algae, bacteria, and marine filamentous fungi. Protozoa are both herbivores and consumers in the decomposer link of the food chain.

Protozoans from the Istanbul Strait’s (Bosphorus) outlet area of the Black Sea comprised Gromida, Ciliophora and Foraminifera, notably hard-shelled and soft-shelled single-chambered (monothalamous) taxa (Fig. 2). Gromids and large allogromids (soft-shelled) foraminifera may have been disregarded because of their resemblance to faecal pellets (Nyholm & Gertz 1973). For many years these organisms were difficult for non-specialists to be classified taxonomically or even recognized as protists (Gooday et al. 2000). These taxa are also problematic because they are characterized by a small volume of protoplasm, contained within a large test volume. Representatives of gromids and soft-shelled foraminifers in Bulgarian coastal zone are noticed for the first time A. Valkanov (1970) and V. Golemansky (1974, 1999, 1999a). Then these protozoans along the shelf and continental slope of the Black Sea with oxygen deficiency were found (Sergeeva 2003; Sergeeva & Gulin 2007). Gromida was the permanent component of the meiobenthos on all studied depths. The relative share of Gromida amounts 0–30%. Ciliophora make out main share at the depths 103, 250, 300 m. The relative share of Ciliophora amounts 15–90 %. The relative share of Foraminifera amounts 3–88 %. Foraminifera make out main share on the depths 82, 160, 190 m (Fig. 2).

![Figure 2. Proportion of main protozoan taxa inhabiting along the depth gradient at the Bosphorus outlet area of the Black Sea](image_url)

**1.1. Gromida**

The genus *Gromia* Claparède & Lachman 1859 was referred to large bottom protozoans (the size of some of them make more than 1 cm), living in small and large depths. On the basis of the General morphology *Gromia* was considered to be one of the classes of Foraminifera, with similar life cycle. *Gromia* differ by absence of the anastomosis on the pseudopodia and meiosis gametes at other stages of the cycle. There is a hypothesis that the morphological resemblance between Gromia and Foraminifera may be due to a common ancestor. But molecular phylogeny showed that Foraminifera and *Gromia* are separate branches of Rizaria (Burki et al. 2002; Piña-Ochoa 2010; Rothe et al. 2011). Like soft-shelled foraminifera, representatives of the genus *Gromia* have been mentioned only in the works on the Black Sea. (Golemansky 1999a, 2007)
These protozoans were found at different depths in the Black sea, down to the depths of permanent hypoxia. Usually they registered in the top inch of the bottom sediment. Preliminary studies showed the presence of at least five, maybe new to science.

We presume that these organisms are gromiids because they have a clear, transparent test wall, a well-developed oral capsule, and are filled with stercomata. In our collections in the Bosporus outlet area the discovered gromiids had spherical and ellipsoidal forms of size from a few μm to more than 1.5 mm. These organisms were found in the range 75–250 m water depths. The abundance maximum was at 75 m (Fig. 3). Gromida vertical distribution marked some characteristics. The peaks in abundance of Gromida occurred at the depth 75, 88, 122, 250 m. At the point of maximum observable abundance (75, 88, 250 m) most of individuals settled upper layer of the bottom sediment, only at 122 m depth deeper layer (7–9 cm) was inhabited by Gromia. That is (Fig. 4) notable that the middle layer (3–5 cm) of the investigated bottom sediment was uninhabited by Gromia.

![Figure 3](image-url)

**Figure 3.** Trends in the abundance of gromiids (indiv.*m⁻²) along depth gradient at the Bosporus outlet area of the Black Sea.

![Figure 4](image-url)

**Figure 4.** Proportion of gromiids inhabiting different sediment layers along the depth gradient.

1.2. **Ciliophora**

Three species of commensal ciliates *Cothurnia maritima* Ehrenberg 1838 on oligochaete *Tubificoides* sp.; *Paracineta livadiana* (Mereschkowsky 1881) and *Corynophrya lyngbyi* (Ehrenberg 1834) on harpacticoid
copepods Amphiascella subdebilis (Willey 1935), Haloschizopera pontarchis Por 1959, Cletodes tenuipes Scott 1896 and Enhydrosoma longifurcatum (Sars 1909) were found in the Bosporus region of the Black Sea deep-water (200 and 248 m depths) under hypoxic/anoxic conditions (Sergeeva & Dovgal 2014).

Vertical distribution of the free-living benthic Ciliophora in the Bosporus area at the depths from 120 to 300 m was characterized by two peaks of abundance at 103 and 250 m water depth (Fig. 5).

In the Bosporus area Ciliophora was registered in all layers of the bottom sediment. The most inhibited are the upper layers (0–2 cm) of sediment (Fig. 6). Ciliates abundance peaks can be connected with food accumulations. Different forms were present, including moving and attached forms, totally more than 30 species (morphotypes).

Figure 5. Trends in the abundance \( \left( 10^3 \text{indiv.m}^{-2} \right) \) of Ciliophora along depth gradient at the Bosporus outlet area of the Black Sea.

It is known that the top peak of ciliates abundance usually was located in the region of the hydrogen sulfide border. The most number of benthic ciliates morphotypes was registered at the 250 m depth, in the region of lower peak of abundance.

Figure 6. Proportion of the Ciliophora inhabiting different sediment layers along the depth gradient at the Bosporus outlet area of the Black Sea.

Earlier the bathymetric distribution of the benthic ciliates at depths from 120 to 2075 m near the Dnieper Canyon and the Sorokin Trough (eastern part of the Black Sea) was described from samples of near bottom
water, sediment surface detritus, and the upper layer (0–1 cm) of sediment. Hydrogen sulfide was registered beginning from 160–170 m. The ciliates found in mentioned samples were the representatives of genera Chilodonella Strand 1928, Trachelocerca Ehrenberg 1834, Tracheloraphis Dragesco 1960 and Loxophyllum Dujardin 1841. At the same time more than 30 morphological species were recognized among mentioned materials (Sergeeva & Zaika 2008). The peaks of ciliate abundances were registered at depths of 120, 160–190, and 240 m in the same region (Sergeeva et al. 2008). Average abundance peak coincides with the depths of hydrogen sulfide appearance. Besides, according to the data available, at the same depths there are pelagic peaks of intensity of bacterial chemosynthesis and bacteria production. Therefore ciliates abundance peaks can be connected with food accumulations. The most number of ciliates morphotypes (8) was at the 240 m depth, in the region of the lower peak of abundance.

1.3. Foraminifera

Foraminifers consist of calcareous (hard-shelled) and soft-shelled forms. Distribution of foraminifera in the depths was uneven. The maximum abundance of hard-shelled foraminifera corresponds to the 82 m peak (Fig. 7).

![Figure 7. Distribution of the Foraminifera (hard-shelled and soft-shelled) abundance (N) along depth gradient at the Bosporus outlet area of the Black Sea.](image)

Specimens were found in all layers (0–5 cm) of the bottom sediment at the point of maximum observable abundance (Fig. 8). The most numerous were specimens of Hyperammina sp., which has a fragile sandy shell. Hyperammina sp was the dominant among the other foraminifera. The largest of its individuals can be included in the category of macrobenthos. Other most numerous species were Ammonia compacta (Hofker) and Eggerella scabra (William). Hard-shelled foraminifera in contrast to the soft-walled were more numerous at lower depths (75–160 m). Soft-shelled foraminiferas were observed in conditions of acute hypoxia / anoxia (250–300 m). At a depth of 88 m peak of the soft-shelled foraminifera was marked. Most specimens were found in the top layer (0–2 cm) or in the overlying surface detritus (Figs. 8, 9). Soft-shelled forms were found at all studied depths. At these depths we can identify representatives of the soft-shelled forms Goodayia rostellatum Sergeeva & Anikeeva, 2008 and Tinogulmia sp. (Gooday 1990; Sergeeva et al. 2005) as the most tolerant to oxygen deficiency (Sergeeva & Mazlumyan 2013).
Figure 8. Proportion of hard-shelled foraminifera inhabiting different sediment layers along the depth gradient.

Figure 9. Proportion of soft-shelled foraminifera inhabiting different sediment layers along the depth gradient.

2. **Metazoa**

The Metazoa present between 75 and 300 m included the following taxa: Coelenterata (Hydrozoa), Turbellaria, Nematoda, Oligochaeta, Polychaeta, Nemertini, Kinorhyncha, Bivalvia, Gastropoda, Ophiuroidea, Harpacticoida, Ostracoda, Amphipoda, Cumacea, Tanaidacea, Acari, Tardigrada and Tunicata. Among Metazoa Free-living Nematoda, Polychaeta and Harpacticoida are key components of the deep-water meiobenthic communities (Fig. 10). Nematoda was dominating component of the communities at all studied depths. The relative share of Nematoda amounts 60–98 %. Harpacticoida make out its main share at the 82 m. The relative share of Harpacticoida amounts 8–40 %. The relative share of Polychaeta amounts 0–1.3 %.
2.1. Free-living Nematoda

Nematoda was dominating taxon among meiobenthos along the depth transect. In the distribution of Nematoda some peaks were marked, occurring at the depth 75, 88–103, 162 and 250 m. Maximal abundance value of Nematoda reaches up 1,514 th. ind.*m$^{-2}$ at the depth of 75 m. The share of the Nematoda in its maximum point corresponded to 82 % of all meiobenthos abundance at that depth.

At the depth of 88–103 m abundance, becomes practically even with 700.0–650.0 th. ind.*m$^{-2}$. At the depths of 250 m Nematoda peak of abundance with 400.0 th.ind.*m$^{-2}$. was observed (Fig. 11).

Nematodes inhabited mostly the top layer (0–2 cm) of bottom sediment. The share of the habitation in that layer amounts 60-96 % along the depth transect (Fig. 12).
2.2. Polychaeta

The distribution of Polychaeta abundance in the depth range 75–250 m is very uneven. In the distribution of Polychaeta marked peaks occurred at the depth 88, 162 and 250 m. Maximal abundance value of Polychaeta reached up to 9360 indiv.*m\(^{-2}\) at the depth of 88 m, the second largest peak of polychaetes inhabitation (7280 indiv.*m\(^{-2}\)) occurred at the depth 250 m (Fig. 13). At the depth 162 m polychaetes almost entirely were represented by young individuals of species *Vigtorniella zaikai* Kiseleva and Protodrilus sp. Usually, these species inhabited suboxic layer and upper border of the hydrogen sulfide (Zaika et al. 1999, Zaika & Sergeeva 2008). At the depth 250 m of polychaetes only species *V. zaika* was found, whereas in other parts of the Black Sea this species had its maximum of abundance at a shallower depth (150–170 m) (Zaika & Sergeeva 2012). The planktonic larvae of *V. zaikai* dwell in layer with certain physical and chemical characteristics. They occurred in all studied samples of near bottom water, sediment surface detritus and in the upper layer (0–3 cm) of sediment (Fig. 14).
2.3. Harpacticoida

In the near-Bosporus area on the 82 m water depth there was new record of the species. Among harpacticoides from this region, there were several eurybathic species, known for the Black Sea, widespread on sandy and silty-sandy soils in the depth range of 10–150 m off the coast of the Caucasus, the Crimea and the coast of Bulgaria and Romania (Kolesnikova 2003, 2010). An the Bosporus outlet area at the 82 m water depth new species Sarsameira parva (Boeck) and Tachidiella minuta (Sars) were found in the Black Sea (Kolesnikova & Sergeeva 2011).

The abundance of Harpacticoida rapidly decreased from >200 000 ind *m$^{-2}$ at a depth of 75 m to 520 ind *m$^{-2}$ at a depth of 190 m, however again slightly increased at 250 m (Fig. 15).

In the Bosporus area Harpacticoida were registered from 0–1 to 4–5 cm layers in the column of the bottom sediment. The upper layers (0–2 cm) of sediments are the most habitable at all depths up to 300 m (Fig. 16).
Conclusion

Under hypoxia, many aerobic organisms have difficulties in their life, so it leads to changes of the structure of benthic communities and reduced biological diversity and in the extreme conditions it leads to the disappearance of a number of aerobic benthic forms. At Bosporus outlet area the vertical distribution of some macrobenthic fauna (Annelida) was noted up to 300 m water depth. Although in columns of multiple cores (160-300 m) representatives of the macrobenthos taxa: Annelida, Bivalvia and Gastropoda were marked (Sergeeva et al. 2011). Our data suggest that the oxic/anoxic transition zone supports diversity and density of some meiofauna Metazoan taxa (Nematoda and Harpacticoida) and Protozoan taxa (Cromida, Ciliophora and Foraminifera), the most abundant representatives of the eumeiobenthos in samples from deeper, anoxic/sulfidic areas.

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References


Figure 16. Proportion of the harpacticoids inhabiting different sediment layers along the depth gradient.


