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Research Article **Araştırma Makalesi**

Meiobenthic Assemblages of the Laspi Bay (Crimea, Black Sea): Taxonomic Diversity and Quantitative Development

Laspi Körfezi (Kırım, Karadeniz) Meiobentik Toplulukları: Taksonomik Çeşitlilik ve Kantitatif Büyüme

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Abstract: It is known that degassing processes are currently observed in the underwater part of the beach zone of Laspi Bay (the southern coast of Crimea). The site of gas emissions (methane) is confined to the coastal part of the bay and located at a distance of 15.0 – 40.0 m from the coastline. Data on the taxonomic richness and quantitative development of meiobenthos in Laspi Bay (2017) are presented for the first time in this study. The meiobenthic assemblages of the studied area were very diverse including representatives of 24 high taxa from Protozoa and Metazoa (phylum, class, order). The most numerous group at almost all stations was the free-living nematodes. The taxonomic richness by station did not reveal any noticeable variability, including 12 to 18 faunal groups, while an unevenness of spatial distribution in the density of meiobenthic settlements was clearly expressed. Minimum values of 63.2×10^3–72.9×10^3 ind./m^2 were noted in the seaward zone, and maximum values of 1368×10^3–2051×10^3 ind./m^2 in the eastern coast where localized methane seepage areas were observed.

Keywords
- Meiofauna
- Protozoa
- Metazoa
- Methane seeps
- Abundance

Özet: Laspi körfezi (Kırım’ın güney kıyıları)’nin sahil bölgesinde deniz tabanından gaz çıkışları olduğu bilinmektedir. Söz konusu gaz (metan) sızıntı alanları, körfezin kıyı kesimi ile sınırlı kalmaktadır ve kıyıdan 15.0-40.0 m mesafede yer almaktadır. Bu çalışmada, Laspi Körfezi meiobentosunun (2017) taksonomik zenginliği ve kantitatif büyümesi hakkında ilk veriler sunulmaktadır. Çalışma bölgesindeki meiobentik topluluklar çok çeşitlilik göstermiş ve Protozoa ve Metazoa’ya ait 24 yüksek takson (filum, sınıf, ordo) kaydedilmiştir. Neredeyse tüm istasyonlarda en bol bulunan organizma grubu serbest-yaşayan nematodlar olmuştur. İstasyonlardaki taksonomik zenginlik dikkate değer bir değişkenlik göstermemiş, her istasyonda 12-18 faunal grup tespit edilmiştir. Ancak meiobentik toplulukların yoğunluğunda düzensiz bir dağılım kaydedilmiştir. Doğu kıyısında, metan gazının çıktığı lokal alanlarda maksimum değerlere (1368×10^3–2051×10^3 birey/m^2) ulaşılırken, denize doğru ilerledikçe minimum değerler (63.2×10^3–72.9×10^3 birey/m^2) gözlenmiştir.

Anahtar kelimeler
- Meiofauna
- Protozoa
- Metazoa
- Metan sızıntı kaynakları
- Bolluk

1. INTRODUCTION

Laspi Bay is an open bay, located in the southwestern part of the Crimean Peninsula (the Black Sea, 44°024’44’’– 44°025’20’’N; 33°042’10’’– 33°042’45’’E); the length of its coastline, limited by the capes Sarych and Aya, is about 4 km. The hydrodynamic regime of its water area is a result of the influence of anticyclonic circulation systems, the inflow of deep waters into the surface layers due to surge phenomena and water exchange with the open sea, which contributes to the dynamic activity and aeration of waters (Atsikhovskaya and Chekmeneva, 2002).

Even during the Greek colonization of the peninsula, it received its name from the main and only village of Laspi that existed by the end of the 18th century (the saddle of the Ilya-Kaya and Machuk mountains). The literal translation of the Greek word “laspi” (“dirt, turbidity”) reflects periodically repeated mudflows, floods, and active landslide activity in the territory of the Laspinskaya basin. The complex landslide slope outlining the Laspi Bay has a highly dissected relief and is indented by numerous erosion troughs, which are the channels of temporary streams. During precipitation, these bring muddy freshwater into the bay, with parameters very different from seawater, which in turn, affects the distribution of hydrological parameters in the coastal zone (Budnikov et al., 2019).

The first studies of the diversity and spatial distribution of benthic communities in Laspi Bay were carried out in 1983 at depths up to 25 m (Petuhov et al., 1990, 1991). As a result, 49 species of macrobenthic fauna were found, and based on the principle of species dominance at these depths, the authors identified two groups of communities as *Venus gallina* and *Gouldia minima-Pitar rudis*. Subsequently, a biodiversity assessment and a study of the status of macrozoobenthos in the zone of loose sediments of Laspi Bay was carried out in 1996, as a result of which 131 species of benthic fauna were identified. Particularly, Mollusca (44 species), Annelida (43), Crustacea (31), and 13 species of other groups were recorded (Revkov and Nikolaenko, 2002). At the studied site, the authors identified three independent biocoenotic complexes confined to the coastal and more open areas of the bay. The most significant differences in the complexes were associated with the development of certain dominant species. The authors concluded that the total number of species in the Laspi Bay, the number of species of macrozoobenthos inhabiting loose sediments of the Crimean coast of the Black Sea agreed with the long-term studies (Kiseleva, 1981).

The results obtained verify the high species richness of the zoobenthos in Laspi Bay, which allowed the authors to designate this area as one of the natural aquatic gene pool reserves of the region providing information about the relatively favorable condition of the bottom ecosystems of the studied area at the Southern coast of Crimea.

Meiobenthos, as an important component of the bottom communities of Laspi Bay, has not been previously studied, and therefore full assessment of the structure of benthic communities couldn’t be possible in this area during the study periods. In recent years, the coastal zone of Laspi has been actively built up, and the water area of the bay is subjected to domestic pollution through a collector that discharges polluted water from a coastal hotel complex into the bay.

Sanitary-biological research in separate parts of the Laspi Bay showed that this coastal water area can be generally characterized as relatively safe at present based on certain parameters. However, several indicators (the content of petroleum hydrocarbons in water, specifically in the bottom layer and the relatively high concentration of heterotrophic bacteria in seawater and bottom sediments) show that this part of the water area, which was previously considered a standard clean zone, is experiencing a significant anthropogenic impact. The obtained results may be related to the active development of the Laspi area observed in recent years. Pollutants enter the aquatic environment of the coastal waters of the Cape Aya reserve through sewage and other waters, and the environmental parameters indicate a low level of oxidation and, accordingly, self-purification (Tikhonova et al., 2020).

2. MATERIAL AND METHODS

2. 1. Study Area

In recent decades, outgassing has been observed in the underwater part of the Laspi Bay beach area. Methane emission zones, occupying a certain bottom area in the bay, were discovered by Shik (2006) in the summer of 2004. Gas seeps were visually noted at a distance of 15.0–40.0 meters from the coastline. The composition of gas fluid bubbles is represented by methane, ethane, propane, and hydrogen sulphide, which indicates the deep origin of the bubbles (Lysenko & Shik, 2015).

Scientists who monitored gas releases in the summer period from 2004 to 2013 (Lysenko & Shik, 2014) found a change in the location and number of specific points of gas bubble escapes while noting that the degassing area itself remained approximately within the same boundaries. Its total area was about 500 square meters. During the studies conducted in different years about these gas releases in the Laspi Bay, 10 to 20 points of jet gas seeps were recorded. On average, a flow of 30 to 80 gas bubbles per minute was observed from the seeps, ranging in size from 5.0 to 15.0 mm (possibly smaller bubbles also existed). The authors observed periodicity in their emissions. Based on the chemical analysis of data, methane was the main component of seeps and it was concluded that there were no fundamental differences in the composition of hydrocarbons between the gasses released in Laspi Bay and the fluids of deep-sea seeps of the Black Sea (Lysenko, 2014; Lysenko & Shik, 2015). More than 20 individual points of bubble gas emissions were also hydroacoustically and visually recorded by other researchers in the bay (Malakhova et al., 2015).

Jet gas seeps can affect the hydrochemical composition of water, as well as the temperature distribution in the overlying water column due to bubbling properties. Using an algorithm based on the analyses of the recorded acoustic signals generated by the bubbles, Ivanova et al. (2021) calculated the gas release rate for three shallow-water seeps in Laspi Bay, derived from audio recordings obtained during the summer of 2019. The rates were 14–16 bubbles/s and gas flows were 21, 46, and 28 L/day, respectively. Budnikov et al. (2019) estimated the daily volume of gas from permanent bubble gas emissions as 69 – 106 L/day released from the bottom of the site at a depth of 2 m in the bay.

However, to date, there has been no systematic observation of the volumes of emissions and the composition of cold gas jets over the entire bottom area and the coast of the bay over a long time. Lysenko and Shik (2013) suggested that the current activity of gas seeps in Laspi Bay was associated with seismic processes in the Foros uplift. Gas jets were indicators of the state of the degassing subsoil. The connection of jet gas emissions with geological bottom structures was previously shown in several studies (Shnyukov et al., 2005; Artemov et al., 2007).

The impact of methane on benthic organisms of the Black Sea has been poorly studied (Sergeeva & Gulin, 2007; Polikarpov et al., 1998; Luth & Luth, 1998) with contradictory data. Inarguably, the fluctuating process of gas release from the bottom into the habitat of the benthic fauna, along with the anthropogenic factors, can influence the formation of the structure and quantitative development of the bottom communities inhabiting Laspi Bay.

It is known that the effect of various methane concentrations on bottom ecosystems is significantly different and much more complex than previously considered (Yanko et al., 2009; Shnyukov & Yanko, 2014). The relationship between the distribution of meiobenthos and hydrocarbon gas concentrations (mostly methane) has been studied in the sediments of the north-western part of the Black Sea (Yanko et al., 2014, 2017a, b). Based on the analysis of abiotic parameters (physical and chemical parameters of the water column, geochemical, lithological, and mineralogical properties of the sediment) and biotic characteristics (quantitative and taxonomic composition of foraminifers, nematodes, and ostracods), the authors proposed the possibility of using meiobenthos as indicators of gaseous hydrocarbons deposited under the seabed.

In this paper, the taxonomic composition and quantitative distribution of meiobenthos in the water area of Laspi Bay are investigated for the first time. Considering the above, it was of interest to study the taxonomic structure of the meiobenthos and its spatial distribution in this area where methane degassing points were described. It should be borne in mind that we can only give an objective assessment of the recent spatial distribution and development of the meiofauna at this stage without discussing the specific relationship of these indicators with the activity and localization of degassing or the distribution of organic pollution due to the lack of indicator factors. Comprehensive hydrobiological and geological studies are needed to identify the existing relationships between the development of various meiobenthic taxa and the above-mentioned environmental factors.

2. 2. Sampling and processing of samples

In the Laspi Bay, 19 benthic stations were studied in the depth range of 4 – 21 m (Figure 1, Table 1). Bottom sediments were sampled (as two replicates) using push cores (height: 5 cm, mouth area: 18.1 cm^2) at each station by Scuba diving to study the meiobenthos of the area, and a manual bottom grab was used to sample the macrobenthos. Samples of bottom sediments were individually fixed using 75% alcohol immediately after the sampling. In the laboratory of the IBSS RAS, each sample was carefully washed through a sieve set, the upper one with a mesh size of 1 mm, and the lower one of 63 µm. Bengal rose solution (0.1%) was added to the sediment fractions retrieved on sieves to stain the material, and the samples were studied under a binocular microscope using a Bogorov chamber. All organisms recorded in the sample were counted and identified to the higher taxon level. Subsequently, all calculated and recorded individuals were extracted and temporary slides (glycerine + pure water) were prepared for their identification to species or morphospecies/morphotype level. Morphological analysis of the fauna was performed using Olympus CX41 and Nikon E200 stereomicroscopes equipped with a digital camera connected to a PC.

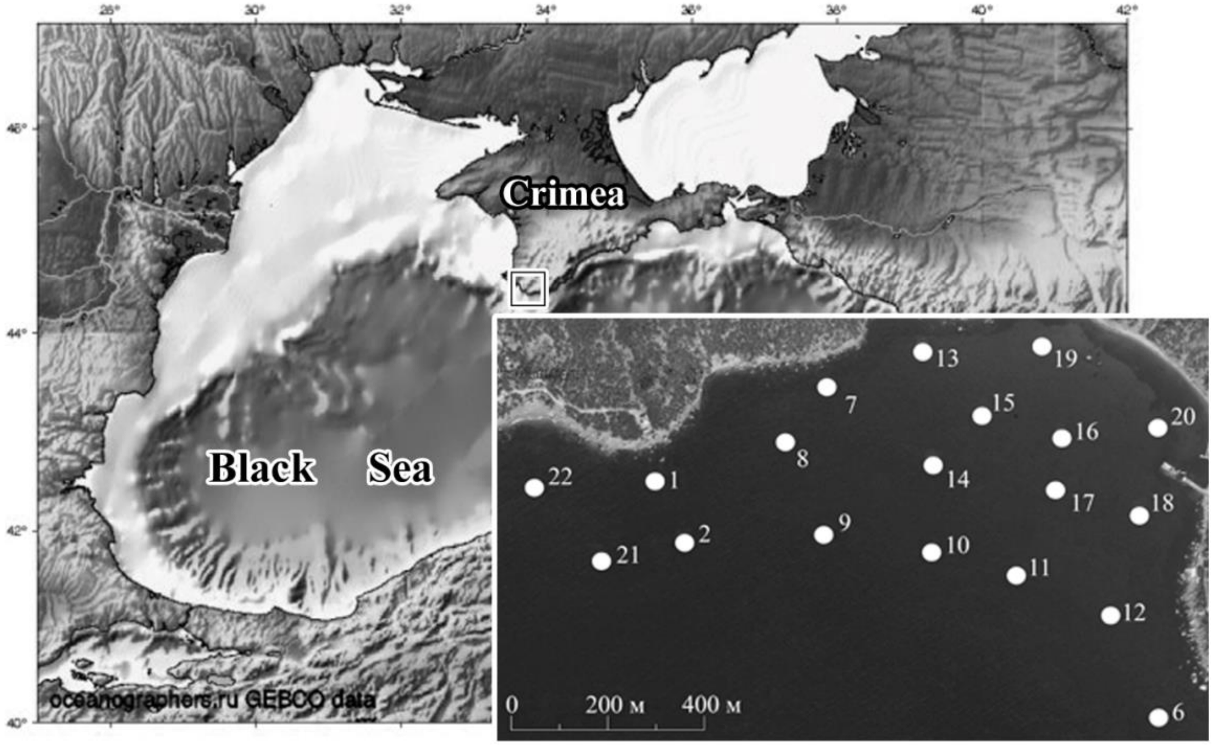

Figure 1. Sampling stations located in the Laspi Bay.

Concurrently, samples from the same stations were taken by the staff of the Marine Hydrophysical Institute of RAS for analysis of the geochemical composition of the bottom sediments (Table 1). Psammitic sediments were mainly characterized by fine-grained and coarse-grained fractions, with an admixture of stone and shell pebbles, as well as silty and pelitic material to varying degrees. According to the authors, the C_{org} (organic carbon) content in the bottom sediments of the bay varied within a range of 0.09 — 0.46%. The absence of Corg accumulation within the investigated depths was primarily due to the granulometric composition of the sediment, the hydrodynamic factor and the morphometric features of the coastal area of the bay (Orekhova & Ovsyany, 2020).

Carbonate structures, which were formed as a result of methane degassing from the sea bottom, were found at a depth of 1.5 – 2 m in the area of stations 13, 15, 19, and 20 (Lysenko & Shik, 2017). These structures with settled polychaetes and mollusks provided us with evidence of this process. The area of jet gas release is confined to the apex of the bay, where it somewhat protrudes to the coast (Station 19).

In addition, gas diffusions into beach sands and gravel stones were observed. Gaseous fluids may exist in the rest of the bay bottom (Budnikov et al., 2019). Undoubtedly, these processes enrich the bottom sediments of the coastal and central zones of the bay with methane bacteria, which are included in the trophic relationships of the benthic fauna. For a clear understanding of these phenomena, special comprehensive studies are required focusing on the benthic zone of Laspi Bay.

Table 1. Data of the stations in the Laspi Bay (2017) (by Orekhova and Ovsyany, 2020)

Station	Coordinates	Depth, m	Humidity, %	Sediment characteristics
1	44°25'05,5"N - 33°41'43"E	14.5	29.4	Dark-grey sand (91)* with alevrite (8) and gravel admixture (1)
2	44°25'01"N - 33°41'45"E	18	23.3	Coarse-grained sand (52) with gravel (47) and alevrite admixture (1)
6	44°24'50"N - 33°42'32"E	13	6.8	Stone gravel (99) with sand admixture (1)
7	44°25'12"N - 33°41'58"E	10	26.1	Dark-grey fine-grained sand (95) with alevrite (5)
8	44°25'08"N - 33°41'55"E	13	31.4	Dark-grey fine-grained sand (87) with alevrite (12) and shell gravel admixture (1)
9	44°25'02,5"N - 33°41'59"E	21	26.3	Dark-grey sand (57) with alevrite (42) and shell gravel admixture (1)
10	44°25'01,5"N - 33°42'10"E	14	27.6	Dark-grey sand (75) with alevrite (28) and shell gravel admixture (3)
11	44°25'00"N - 33°42'17"E	14	27.7	Dark-grey fine-grained sand (75) with alevrite (25)
12	44°24'57"N - 33°42'25"E	15	25.1	Dark-grey fine-grained sand (80) with alevrite (16) and shell gravel admixture (4)
13	44°25'14"N - 33°42'07,5"E	6	21.6	Sand (98) with gravel (1) and alevrite (1) admixture
14	44°25'07"N - 33°42'08"E	12	21.4	Sand (98) with gravel (1) and alevrite (1) admixture
15	44°25'10"N - 33°42'13"E	9	22.9	Dark-grey medium-grained sand (98) with alevrite admixture (2)
16	44°25'08"N - 33°42'20,5"E	8	22.5	Dark-grey fine-grained sand (86) with alevrite (13) and gravel admixture (1)
17	44°25'04"N - 33°42'22"E	10	27.4	Dark-grey fine-grained sand (64) with alevrite (35) and gravel admixture (1)
18	44°25'03,5"N - 33°42'28"E	9	21.2	Dark-grey coarse-grained sand (84) with gravel (15) and alevrite admixture (1)
19	44°25'14,5"N - 33°42'18,5"E	4	25.0	Dark-grey medium-grained sand (99) with alevrite admixture (1)
20	44°25'09"N - 33°42'29,5"E	5,5	23.1	Dark-grey medium-grained sand (92) with gravel (7) and alevrite admixture (1)
21	44°25'01"N - 33°41'37"E	17	19.0	Gravel (66) with sand (33) and alevrite admixture (1)
22	44°25'05"N - 33°41'35"E	11	-	Sand

* Percentage of the fractions is given in parenthesis.

2. 3. Data Analysis

The meiobenthos composition was evaluated using multivariate statistics in the PRIMER 6 package (Cluster, SIMPER analyses) (Clarke, 1993; Clarke & Gorley, 2001). The presence/absence transformation of the number of taxa at the stations was used for the Cluster analysis. The measure of station similarity was based on the Bray-Curtis similarity coefficient. The determination of the leading taxa in the meiobenthos (SIMPER analysis) was carried out based on the assessment of their contribution to the intracomplex similarity based on the untransformed values of their abundance.

3. RESULTS and DISCUSSION

3. 1. Distribution of meiobenthic diversity and abundance

The meiobenthos composition of the studied area was very diverse with representatives of 24 high taxa both from Protozoa and Metazoa (phylum, class, order). The representation of meiobenthos at the high-level taxa showed no noticeable fluctuations, ranging from 12 to 18 faunal groups station by station, while a distinct variability is revealed in the distribution of the density of meiobenthos. The minimum values (63.2×10^3 – 72.9×10^3 ind./m^2) were noted in the seaward zone, and the maximum values (1368×10^3 – 2051×10^3 ind./m^2) were recorded on the eastern coast (Figures 2 and 3).

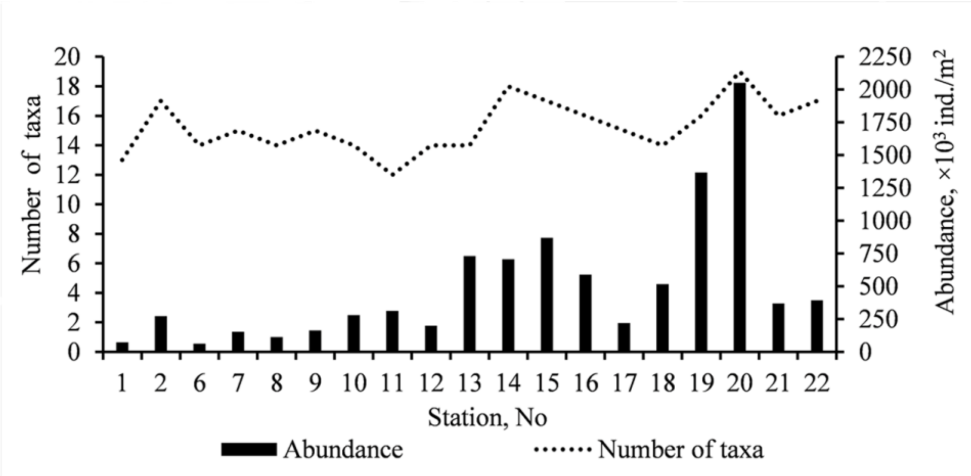

Figure 2. Abundance (10^3 ind./m^2) and diversity of meiobenthos in the Laspi Bay.

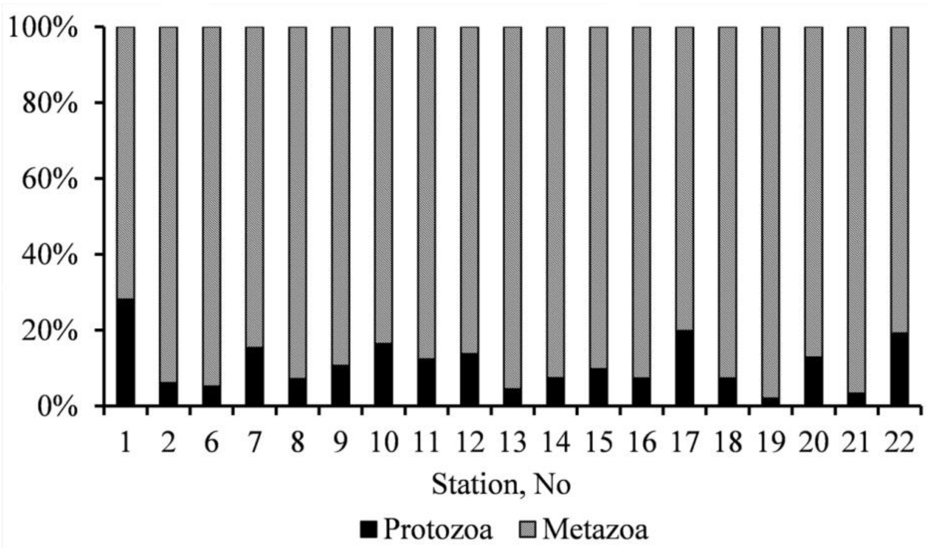

Figure 3. The share of Protozoa and Metazoa (based on densities) in the meiobenthos of the Laspi Bay.

In many publications focusing on the structure of benthic communities, the authors individually considered three size groups of benthos: macro-, meio- and microbenthos. It should be noted that the latter group is practically not taken into account in most of the studies when assessing the structure of benthic communities. Exclusively, multi-chambered hard-shelled foraminifers can be recognized among the protozoans as an exception, which has been included in benthic communities in just several works.

Based on our results on the Black Sea benthic communities, including the fauna of Protozoa and Metazoa, we cannot agree with this approach, since protozoans often exceed the linear dimensions of microbenthos in their size parameters, adopted in the classification of benthic groups (Mare, 1942). Representatives of Ciliophora, Gromiidea, and soft-walled Foraminifera may exceed the accepted sizes of micro- and meiobenthos by an order of magnitude or more in our collections. Moreover, in some cases, these representatives should be considered as part of the macrobenthos, not of meiobenthos and microbenthos based on their size (Sergeeva, 2019; Sergeeva and Anikeeva, 2018, 2020). Benthic protozoa are very numerous; they enter into trophic relationships with both microflora and meio- and macrofauna. They play an important role in the circulation of organic substances in the bottom ecosystems of water bodies, utilizing bacteria, fungi, diatoms, and bottom fauna. At the same time, they serve as a trophic link for higher benthic fauna (Sergeeva, 2019; Sergeeva and Anikeeva, 2018).

Given the information above, we also included the analysis of Protozoa to obtain a structure close to the real character of the meiobenthos of the Laspi Bay (macrobenthos will be evaluated in a different paper by other authors).

Protozoa. The population density of protozoa (Figure 3) in the meiobenthos of Laspi Bay accounted for a significant share (up to 20 – 26%) of the total meiobenthic structure. The share of protozoa in the composition of the meiobenthos was similar among the stations, with some exceptions (stations 13, 19, and 21). It should be considered that unaccounted factors are also available which unquestionably play a role in the density of protists and meiobenthos in general.

Ciliophora (Cl), Gromiidea (Gr), soft-walled (SWF, Monothalamea), and hard-shelled Foraminifera (HSF) were recorded in the studied area. Information about Protozoa of Laspi Bay is presented for the first time in this paper.

The share of individual groups of benthic unicellular organisms in the total number of Protozoa is presented in Figure 4, from which three dominant groups of unicellular organisms can be seen as Ciliophora, Gromiidea and soft-walled Foraminifera. These groups are permanent components in the taxocenoses of Protozoa of the Laspi Bay, while hard-shelled Foraminifera was exclusively recorded at several stations in small numbers. Soft-walled foraminifers (allogromiids) had the greatest quantitative development, however, gromiids, and ciliophorans also accounted for a significant proportion in the total abundance of Protozoa, while at some stations their share exceeded that of allogromiids. Since we cannot explain this situation in detail, specific studies are needed about the protozoans of the bay concerning environmental factors and the development of macrobenthos. It cannot be ruled out that bioturbation and trophic factors play important roles in the density of protozoa along with degassing and anthropogenic impact.

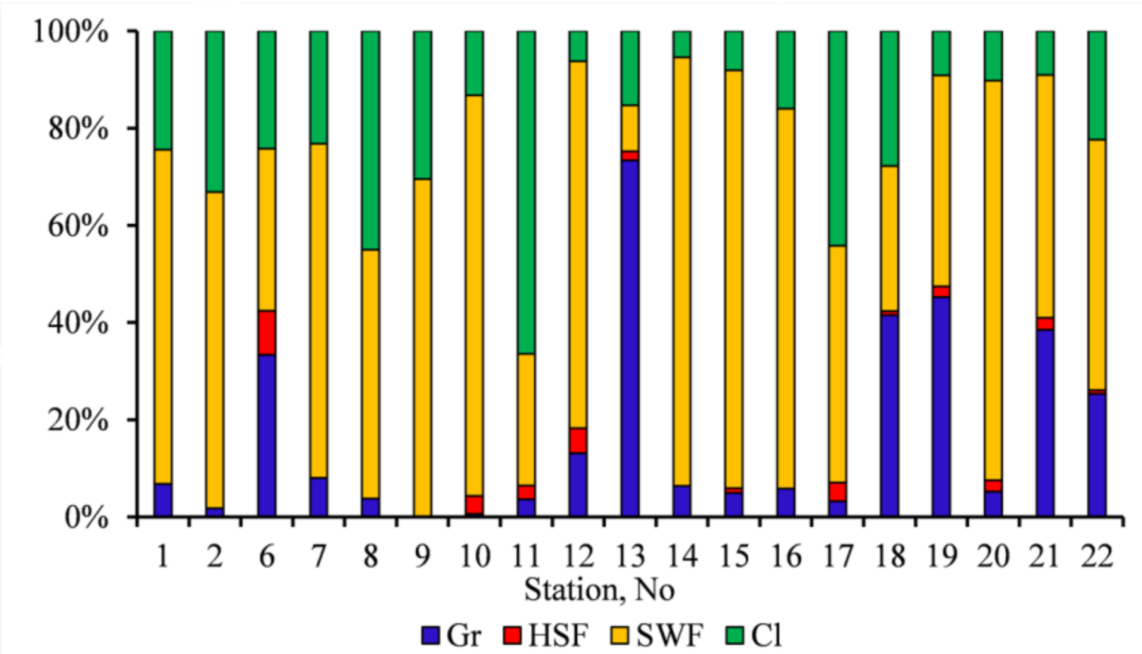

Figure 4. The share of benthic unicellular organisms in Protozoa of the Laspi Bay (Gr: Gromiidea, HSF: Hard-Shelled Foraminifera, SWF: Soft-Walled Foraminifera, Cl: Ciliophora).

Metazoa. 20 high-level taxa were recorded in the meiobenthic communities of the bay: Nematoda, Polychaeta, Oligochaeta, Platyhelminthes (Turbellaria), Nemertea, Kinorhyncha, Rotifera, Gastrotricha, Arthropoda (Harpacticoida, Ostracoda, Cumacea, Amphipoda, Decapoda, Diptera, Arachnida, Tardigrada), Mollusca (Bivalvia, Gastropoda, Polyplacophora) and Cnidaria. It is worth noting that a few representatives of unknown organisms were also found at some of the stations. These organisms, which were not identified to a class or order (incertae sedis) were referred to as "Miscellaneous". Characteristically, the taxonomic richness, including Protozoa, did not significantly vary throughout the studied area (12 – 18 in the rank of type or class) (Figure 2). Protozoa inhabited all the studied stations, and the taxonomic diversity of Metazoa varied within 8 – 14 faunal groups.

The multicellular meiobenthic composition of the Laspi Bay included the permanent meiofauna (eumeiobenthos) and the temporary meiofauna including the early stages of macrobenthos (pseudomeiobenthos). Tardigrada, Rotifera, and Gastrotricha were recorded for the first time in this area in the composition of the meiobenthic fauna. Representatives of two new genera of Gastrotricha— *Diplodasys* Remane, 1927 and *Tetranshyroderma* Remane, 1926— are the first records for the Black Sea (unpublished data). Gastrotrichs were distributed almost over the entire water area of the bay, and their population density varied between 2700 and 10500 ind./m^2. The greatest values were recorded in the central part of the bay (stations 13, 14, and 15). Tardigrades were also distributed over most of the bay with a population ranging from 300 to 43100 ind./m^2, with a maximum value at station 13.

In terms of abundance, the largest proportion of meiobenthos belonged to the free-living nematodes and the harpacticoids (Figure 5, Table 2). Quantitative indicators of the total density of meiobenthos and dominant taxa (nematodes and harpacticoids) decreased with depth (Fig. 6). Maximum numbers of nematodes (863 – 511×10^3 ind./m^2) and harpacticoids (774 – 671×10^3 ind./m^2) were recorded at the minimum depths of 4-5.5 m (stations 19 and 20).

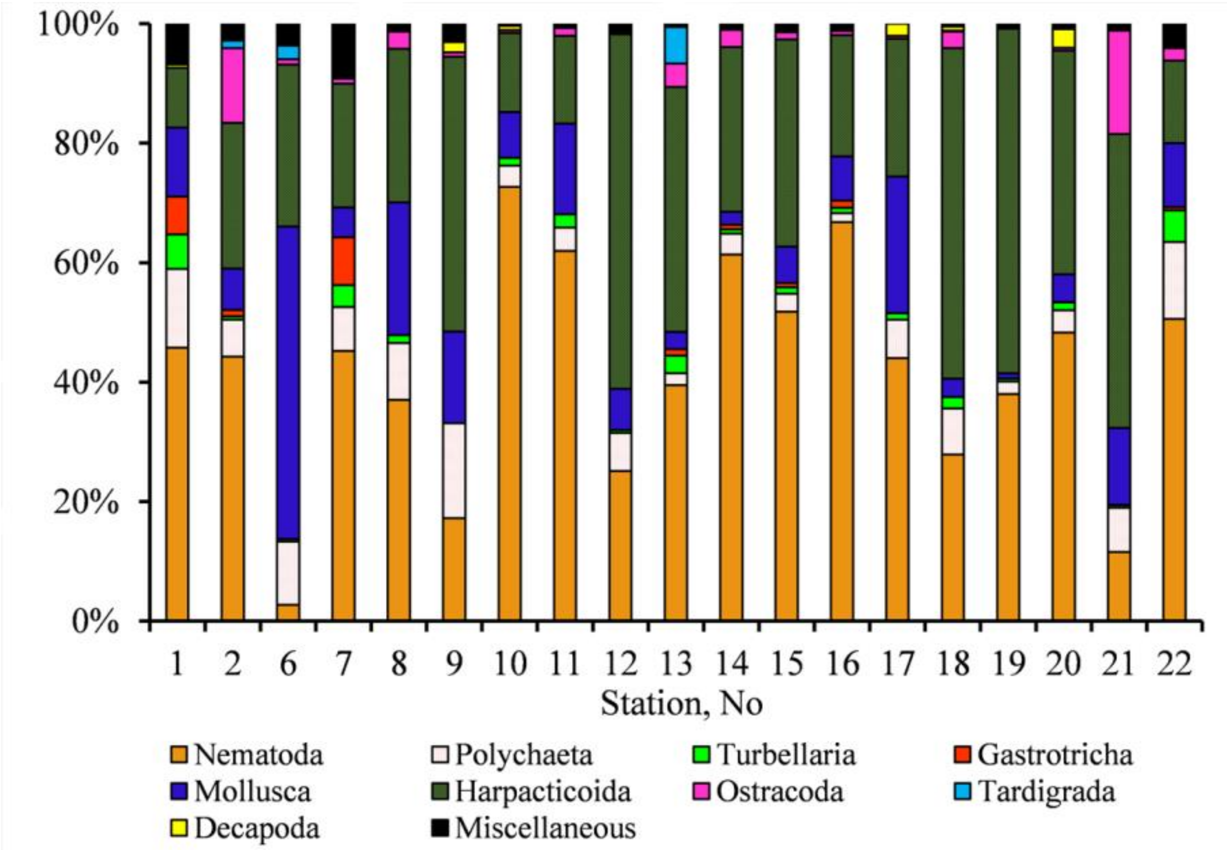

Figure 5. The share of the most characteristic Metazoan groups (based on densities) in the meiobenthos of the Laspi Bay.

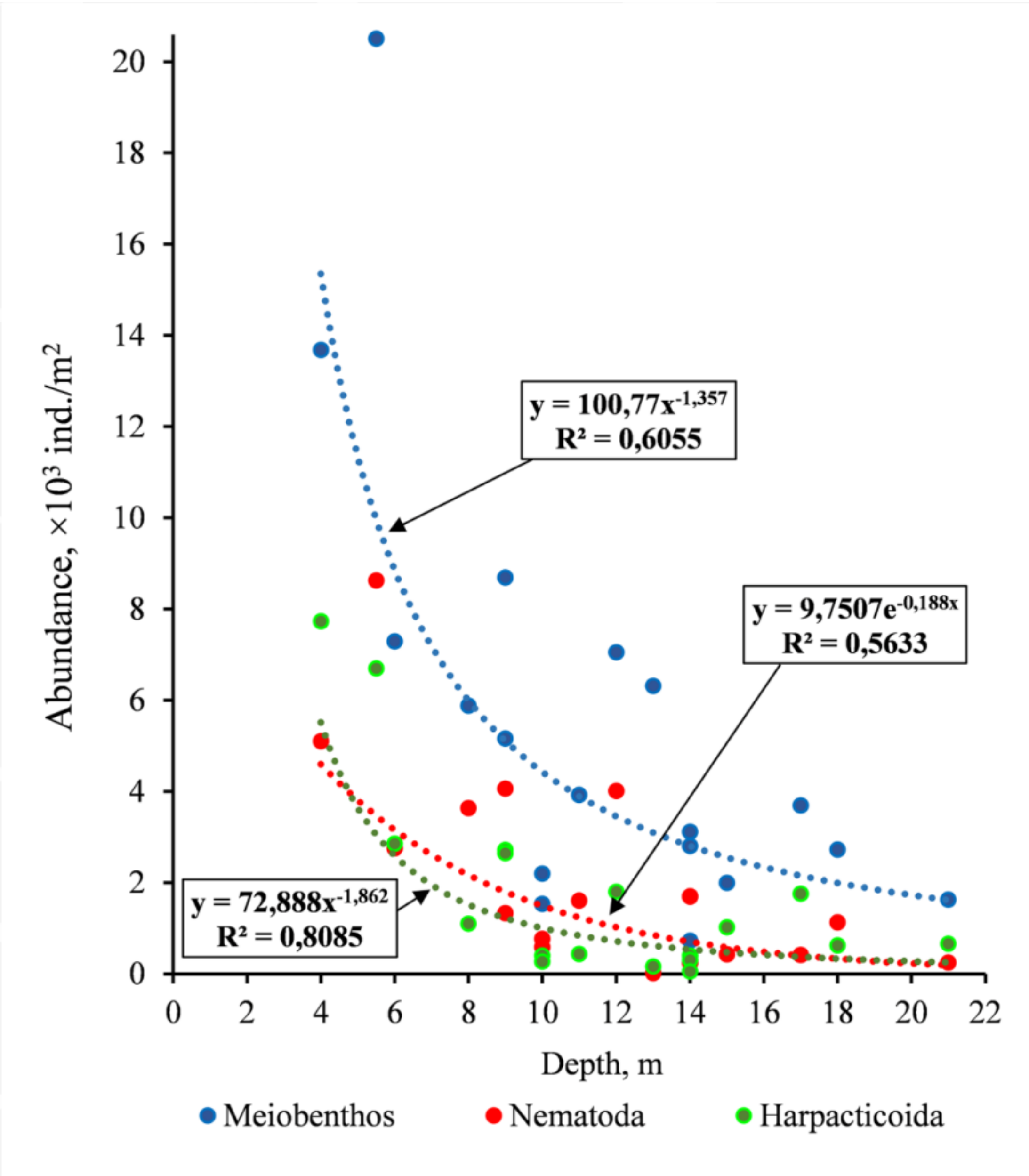

Figure 6. The abundance of meiobenthos and the dominant taxa along the depth gradient.

3. 2. Meiobenthos and the dominant taxa

Nematoda and Harpacticoida were the leading groups (Table 2), whose total contribution to intracomplex similarity, based on absolute abundance values was 67.19%. These two groups were followed by Bivalvia (10.4%), Polychaeta (7.1%), and soft-walled Foraminifera 6.7%). Multivariate analysis of the data using supraspecific taxonomic diagnostics did not allow for the identification of individual faunal complexes of meiobenthos in the Laspi Bay. The faunal similarity of all stations (Bray-Curtis similarity) of the area was relatively high and exceeded 75%.

Table 2. Main meiobenthic taxa based on their contribution to the interstation similarity, calculated using untransformed values of their average abundances (N, ind./m^2)

Taxa	N ± Standard	Minimum	Maximum	$_i$	$_i$ / SE($_i$)	$_i$%	Cum., i%
Nematoda	204092 ± 50673.1	1656	863052	17.47	1.39	38.74	38.74
Harpacticoida	168140 ± 49507.9	5244	773628	12.71	1.43	28.19	66.93
Bivalvia	26635 ± 4244.4	4968	80040	4.68	1.18	10.37	77.31
Polychaeta	024 ± 3507.4	6348	7068	20	.76	10	4.41
Foraminifera (soft-walled)	1013 ± 11101	1104	16384	03	.16	73	1.14
Ciliophora	8293 ± 1823	828	6772	16	.05	56	3.70
Ostracoda	415 ± 3550.5	0.00	1824	66	.61	47	5.17
Platyhelminthes	457 ± 1580.6	276	4288	66	.29	46	6.63
Other	249 ± 713.9	552	0935	48	.90	05	7.69
Gromiidea	5852 ± 1676	0.00	4012	42	.82	92	8.61
Gastropoda	1249 ± 162.7	276	2484	26	.12	58	9.19
Gastrotricha	2322 ± 733.1	0.00	0443	15	.38	34	9.53
Foraminifera (hard-shelled)	843 ± 317.6	0.00	6072	06	.54	13	9.66
Arachnida	422 ± 114.4	0.00	1932	04	.58	09	9.75
Amphipoda	552 ± 177.8	0.00	3036	04	.47	08	9.83
Tardigrada	731 ± 2248.5	0.00	3056	03	.30	06	9.89
Cumacea	291 ± 95.5	0.00	1656	02	.44	05	9.95
Rotifera	887 ± 429.7	0.00	6072	01	.23	02	9.97
Oligochaeta	247 ± 159.2	0.00	3036	01	.27	01	9.98
Nemertea	73 ± 41.4	0.00	552	00	.13	01	9.99
Decapoda	022 ± 2826.7	0.00	3820	00	.12	01	00.00
Diptera	44 ± 23.7	0.00	276	00	.13	00	00.00
Kinorhyncha	88 ± 73.3	0.00	1380	00	.08	00	00.00
Polyplacophora	15 ± 14.5	0.00	276	00	-	00	00.00
Cnidaria	73 ± 72.6	0.00	1380	00	-	00	00.00

Note: N is the average value of the number; i – absolute and i % – relative contributions of taxon “i” to the average Bray–Curtis similarity within the complex; SE - standard error

4. CONCLUSION

The results of the meiobenthos studies in Laspi Bay (2017) are presented for the first time in this paper. Meiobenthos of this water area is very diverse considering Protozoa and Metazoa, with a composition including 24 major taxa (type, class).

In the composition of benthic Protozoa throughout the entire area of the bay, Ciliophora, soft-walled Foraminifera, and Gromiidea presented with high densities, while hard-shelled Foraminifera was found exclusively at some of the stations and only in small quantities.

The diversity of higher taxa did not show significant fluctuations, ranging from 12 to 18 faunal groups in the area. However, a distinct variability was observed in the distribution of meiobenthos density as a whole. Its minimum values were 63.2×10^3 – 72.9×10^3 ind./m^2 in the open zone, and the maximums were 1368×10^3 – 2051×10^3 ind./m^2 in the inner eastern coastal part. The dominant groups were free-living nematodes and harpacticoids, and the role of these groups in the meiobenthic communities showed spatial variations. In general, the indicators of taxonomic richness and quantitative development of meiobenthic communities in the Laspi Bay are comparable to other water areas of the Crimean coastal zones (Sergeeva & Mazlumyan, 2006; Sergeeva et al. 2011; 2012). As various areas of Crimea were taken into consideration, the highest mean abundance value of meiobenthos was lower (596.2×10^3 ind. m^{-2}) in previous studies (Sergeeva, 2003).

Similar trends have been reported from the southern coast of the Black Sea (Sinop Bay, Türkiye) where 25 higher taxa were found with total meiobenthos abundances ranging from 18×10^3 – 935×10^3 ind./m^2 (Ürkmez et al., 2016a). A study on meiobenthos at the southwestern coasts (Igneada, Turkiye) of the Black Sea reported abundance values of 67–757 × 10^3 ind. m^{-2}, much lower than the documented values in the present study Sampling area in Igneada was represented with low human activity with limited anthropogenic impact (Ürkmez et al., 2016b).

It is assumed that the uneven quantitative distribution of meiobenthos may be due to the local (methane) degassing from the bottom of the Laspi Bay and the incoming domestic sewage. Future comprehensive geological, hydrochemical, and hydrobiological studies will allow us to describe the interaction of benthic communities with the above environmental characteristics of the studied bay.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

AUTHOR CONTRIBUTIONS

Conceptualization: NGS; Methodology: NGS; Investigation: NGS; Formal analysis: TNR; Manuscript writing — original draft: NGS, TNR; Manuscript writing —review — editing: DU; Visualization: TNR; Discussion: DU; Translation: DU; Supervision: NGS; Finishing formalization: DU. All authors approved the final draft.

ETHICAL STATEMENTS

Local Ethics Committee Approval was not obtained because experimental animals were not used in this study.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

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