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Meiobenthic polychaetes in the northwestern Black Sea

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Abstract

Polychaetes of the northwestern Black Sea (NWBS) were sampled in January 2005 at 4 sites comprising 32 stations. The 4 sites have different anthropogenic loads, different depths (<10 m, 11-20 m, 21-30 m, >30 m) and different substrates (shelly, silty). The species composition of polychaetes in Black Sea meiobenthic communities has not previously been studied. Twenty polychaete species belonging to 11 families, the Phyllodocidae, Nephtyidae, Polynoidae, Sigalionidae, Nereidae, Syllidae, Hesionidae, Protodrilidae, Spionidae, Capitellidae and Ampharetidae, were recorded. The polychaete density varied with depth and type of substrate from 500 ind. m^{-2} to 66,000 ind. m^{-2}.

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INTRODUCTION

The history of intensive studies of marine meiobenthos is relatively short, dating back to the mid 1960s. As in other areas of the world oceans, studies of Black Sea meiobenthos have traditionally concentrated on its permanent components. To date the best studied groups are those with the highest diversity, density and frequency, which in the Black Sea include nematodes, harpacticoids, foraminifers, ostracods, and halacarids. In contrast, there is a paucity of published data on the temporary meiobenthos components. However, studies of these organisms are necessary and important for restoring macrozoocoenoses, particularly polychaete abundances in areas undergoing heavy anthropogenic impact.

It has been previously reported that three species of polychaetes, all of them members of the temporary meiofauna, contributed to more than 70% of the identified species (Petti et al. 2004). Polychates have been recognised as being significant members of the temporary meiobenthos (McIntyre 1969). The temporary meiofauna has been seen to make up more than 40% of the total meiobenthos abundance in the Black Sea (Kiseleva 1965), and reach high values of total biomass (Vorobyova 1999).

In relation to size and methodological criteria (Mare 1942) some polychaetes may be regarded as permanent components of the meiofauna. In the Black Sea there are species, besides specimens at early stages of ontogenesis maturing into macrozoobenthos later, which in all life stages are attributed to meiobenthos. To date specific studies on the taxonomic composition of Black Sea polychaete meiofauna have not been conducted, although data on total abundances and on quantitative parameters in space and time are available (Vorobyova 1999, Vorobyova et al. 1992, Vorobyova & Kulakova 1998).

The study of meiobenthic polychaetes is very important from both theoretical and practical points of view. According to Nipper & Carr (2003) meiofaunal polychaetes are sensitive to contaminants, easy to culture, and are representative of the interstitial habitat. Three species of interstitial meiofaunal polychaetes new to science have recently been described in the Bay of Bengal, (Westheide 1992), and a previously undescribed species reported in the Yellow Sea, (Zhao Jing et al. 1991). Further research of polychaete meiofauna may add more species to the list of polychaetes in the northwestern Black Sea (NWBS).

The aims of this paper are to present qualitative and quantitative aspects of meiobenthic polychaete distribution in the NWBS, to provide a list of the polychaete species occurring in the areas sampled, to determine abundance and diversity related characteristics of the polychaete taxocoenoses, and to look for patterns of polychaete distribution with relation to the effects of depth and sediment type.

MATERIALS AND METHODS

In our study 32 samples were collected at depths of 6-38 m with a 0.25 m^2 Petersen grab in January 2005. The sample sites were in four areas of the NWBS (Fig. 1, Table 1): stations 2, 4, 5, 7, 10-12, 15, 18 and 19 in the Odessa area, stations 40, 48, 49, 55 and 62 in the Danube area, stations 203, 208, 209-214 and 217 near Zmeiny Island, and stations 27-29, 36, 37, 43, 44 and 54 in the area of Zernov's Phyllophora Field. Sediment cores of 12.5 cm^2 were taken, washed through sieves of 1 mm and 110 μm, and fixed in 4% formaldehyde. Polychaetes were identified to species level according to Kiseleva (2004).

At each station for each species the density, average abundance at different depths (<10 m, 11-20 m, 21-30 m, >30 m) and types of substrates, frequency (P %) and dominance (D %) were determined.

Table 1

Sampling stations (station number, coordinates, water depth (WD), region name).

No.	Latitude	Longitude	WD	Name of areas
2	N46°31'24"	E30°47'36"	9 m	Odessa area
4	N46°33'30"	E31°00'00"	17 m	Odessa area
5	N46°32'36"	E31°25'06"	6 m	Odessa area
7	N46°30'42"	E30°45'18"	10 m	Odessa area
10	N46°25'00"	E31°01'12"	18 m	Odessa area
11	N46°23'30"	E31°00'00"	25 m	Odessa area
12	N46°21'36"	E30°45'18"	18 m	Odessa area
15	N46°20'00"	E31°14'54"	25 m	Odessa area
18	N46°17'48"	E30°41'24"	15 m	Odessa area
19	N46°12'06"	E30°48'42"	27 m	Odessa area
27	N45°55'27"	E30°50'18"	20 m	Phyllophora Field
28	N46°00'00"	E31°15'06"	27 m	Phyllophora Field
29	N46°00'00"	E30°30'00"	15 m	Phyllophora Field
36	N45°49'54"	E31°00'12"	24 m	Phyllophora Field
37	N45°50'00"	E31°29'00"	25 m	Phyllophora Field
43	N45°40'00"	E31°00'00"	27 m	Phyllophora Field
44	N45°43'54"	E31°40'48"	28 m	Phyllophora Field
54	N45°34'54"	E31°33'54"	42 m	Phyllophora Field
40	N45°39'18"	E30°15'12"	18 m	Near Danube area
48	N45°29'18"	E29°52'06"	18 m	Near Danube area
49	N45°31'36"	E29°58'54"	21 m	Near Danube area
55	N45°20'06"	E29°50'00"	20 m	Near Danube area
62	N45°12'12"	E29°49'06"	20 m	Near Danube area
203	N45°20'30"	E30°11'06"	28 m	Zmeiniy Island
208	N45°15'18"	E30°07'06"	28 m	Zmeiniy Island
209	N45°15'54"	E30°11'06"	31 m	Zmeiniy Island
210	N45°16'18"	E30°11'54"	31 m	Zmeiniy Island
211	N45°15'54"	E30°14'06"	33 m	Zmeiniy Island
212	N45°14'18"	E30°12'54"	35 m	Zmeiniy Island
213	N45°15'06"	E30°15'00"	35 m	Zmeiniy Island
214	N45°15'42"	E30°25'42"	38 m	Zmeiniy Island
217	N45°10'06"	E30°11'30"	38 m	Zmeiniy Island

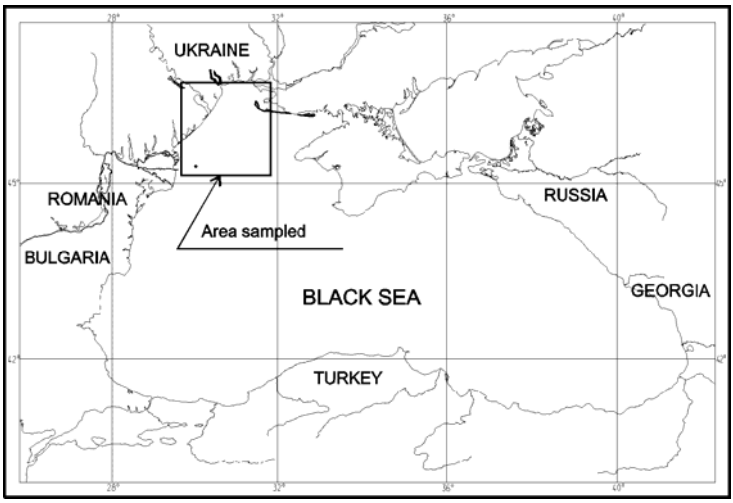

Fig. 1. Map of general area of sampling stations of the R/V Vladimir Parshin, January 2005.

An analysis of polychaete biological diversity at different depths and on different types of substrate was made using Shannon's index, evenness was calculated according to Pielou's formula, the number of species and dominance were calculated according to Simpson (Odum 1986), and the similarity of fauna and abundance of polychaetes according to Czekanowski-Sørensen (Lebedeva & Krivolutzky 2002).

RESULTS AND DISCUSSION

In samples taken in January 2005 in the NWBS 20 species of polychaetes were recorded belonging to the following families: Phyllodocidae, Nephtyidae, Polynoidae, Sigalionidae, Nereidae, Syllidae, Hesionidae, Protodrilidae, Spionidae, Capitellidae and Ampharetidae. A high frequency of five species (*Prionospio cirrifera* Wiren, 1883 (74.2%), *Neanthes succinea* Frey and Leuckart 1847 (32.26%), *Polydora ciliata limicola* Annenkova 1934 (51.6%), *Exogone gemmifera* Pagenstecher, 1862 (58.0%), *Heteromastus filiformis* Claparede 1864 (29.0%)) was observed. The frequency of Spionidae larvae, *Capitella capitata capitata* Fabricius 1780 and *Melinna palmata* Grube 1870 varied from 16.0% to 19.0%.

Meiobenthic larvae and juveniles made up 8.7% of the total polychaete species composition in the winter, with adult individuals accounting for the rest. Analysis of species distribution on the shelf showed that the highest number of

polychaete species was in the area of Zernov's Phyllophora Field (14 species) and near Zmeiny Island (11 species). In the marine part of the Danube 9 species were recorded, and in the Odessa area 8 species (Table 2).

Table 2

Distribution of polychaete species in different areas of the northwestern Black Sea.

Species	Odessa area	Phyllophora Field	Near Danube area	Zmeiniy Island
Eulalia viridis (Linne 1767)			+	+
Nephtys hombergii Savigny 1818 (late nectochaete)			+	
Harmothoe reticulata (Claparede 1879)		+		+
Pholoe sinophthalmica Claparede 1868		+		+
Neanthes succinea (Frey et Leuckart 1847)	+		+	+
Neanthes succinea (late nectochaete)	+			
Syllides longocirrata Oersted 1845	+	+	+	+
Exogone gemmifera Pagenstecher 1862		+		
Sphaerosyllis bulbosa Southern 1914		+		
Microphthalmus sp.		+		
Protodrilus flavocapitatus (Uljanin 1877)		+		+
Aonides paucibranchiata Southern 1914		+		
Spio filicornis (Muller 1776)		+		
Pygospio elegans Claparede 1863	+	+		
Polydora antennata Claparede 1868				+
Polydora ciliata limicola Annenkova, 1934	+	+	+	+
Polydora ciliata limicola (late nectochaete)	+			
Prionospio cirrifera Wiren 1883	+	+	+	+
Spionidae larvae				+
Capitella capitata capitata (Fabricius 1780)	+	+	+	
Heteromastus filiformis (Claparede 1864)	+	+	+	+
Melinna palmata Grube 1870	+		+	

Two species, *Neanthes succinea* and *Polydora ciliata limicola* (both at the late nectochaete stage), were only observed in the Odessa area. One species, *Nephtys hombergii* (late nectochaete), was encountered only in the near Danube area, while *Polydora antennata* and Spionidae larvae were only seen near Zmeiny Island. The largest number of species was observed in Zernov's Phyllophora Field, an area characteristic of polychaete dominance. Here the share of *Syllides longocirrata* in the total polychaete density reached 56.22%, *Prionospio cirrifera* 17.16% and *Protodrilus flavocapitatus* 14.93%.

Of the 14 polychaete species recorded in the Phyllophora Field three species contributed 88.31% to the total abundance. The rest of the species accounted for 0.25-3.23% each, with a mean of 1.04%**.** On the northwestern shelf the density of polychaetes at different stations varied from 500 ind. m^{-2} to 66,000 ind. m^{-2}. The mean density was minimum in the Odessa area, at 10,778 ±5,912 ind. m^{-2}, and maximum in the marine part of the Danube, at 32,500 ±9,068 ind. m^{-2}.

Analysis of the distributions of the polychaetes showed that only 4 species were encountered at depths of 6-38 m, *Heteromastus filiformis*, *Prionospio cirrifera*, *Polydora ciliata limicola* and *Neanthes succinea*, of which the first three occurred most frequently in Odessa area.

A minimum number of species (7) was recorded at a depth of 10 m (Table 3), the density of which varied from 250 ind. m^{-2} to 23 000 ind. m^{-2}, with the dominant *Polydora ciliata limicola* comprising 65.96% of total abundance of polychaetes. The late nectochaete of this species was discovered only at a depth of 10 m. The rest of the species accounted for 0.76 - 9.93% of the total polychaete abundance.

Nine species of polychaete were recorded at depths of 11-20 m, their densities ranging from 50 to 6,500 ind. m^{-2}. *Polydora ciliata limicola* was dominant, with a mean density of 6,500 ind. m^{-2} (37.14% of total abundance). Subdominant were *Syllides longocirrata* (10%) and *Heteromastus filiformis* (18.86%). Only in this depth range was the late nectochaete *Nephtys hombergii* encountered.

The largest number of polychaete species (19) was found at depths of 21-30 m (Table 3). Species of *Sphaerosyllis bulbosa*, *Aonides paucibrachiata*, *Spio filicornis* and *Pygospio elegans* were seen only in this depth range, and were at low abundances (0.23-1.59% of total polychaete density each). *Syllides longocirrata* was dominant (41.04%), with *Protodrilus flavocapitatus*, *Prionospio cirrifera* and *Heteromastus filiformis* being subdominant, with 4.31-24.26% of the total polychaete abundances each.

Thirteen species were recorded from depths greater than 30 m, with abundances at the different sites varying from 10 to 12,834 ind. m^{-2}. Larvae of Spionidae and the species *Prionospio cirrifera* dominated, with 50.95% and 25.43% of total polychaete abundance respectively. More frequently at this

Table 3

Distribution of polychaete species at different depths in the northwestern Black Sea.

Species	Depth (m)			
	<10	11 - 20	21 - 30	>30
Eulalia viridis ▲			+	+
Nephtys hombergii (late nectochaete) ■		+		
Harmothoe reticulata ▲			+	+
Pholoe sinophthalmica ▲			+	+
Neanthes succinea ▲■	+	+	+	+
Neanthes succinea (late nectochaete) ▲■	+			
Syllides longocirrata ▲■		+	+	+
Exogone gemmifera ▲			+	+
Sphaerosyllis bulbosa ▲			+	
Microphthalmus sp. ▲			+	
Protodrilus flavocapitatus ▲		+	+	+
Aonides paucibranchiata ▲			+	
Spio filicornis ▲			+	
Pygospio elegans ▲■	+		+	
Polydora antennata				+
Polydora ciliata limicola ▲■	+	+	+	+
Polydora ciliata limicola (late nectochaete) ■	+			
Prionospio cirrifera ▲■	+	+	+	+
Spionidae larvae▲			+	+
Capitella capitata capitata ▲■	+	+	+	
Heteromastus filiformis ▲■	+	+	+	+
Melinna palmata ■	+	+	+	

Sample sediment type: shelly - ▲ and silty - ■

depth *Syllides longocirrata* (62.5% frequency), *Protodrilus flavocapitatus* (50.0%), *Polydora ciliata limicola* (50.0%), *Prionospio cirrifera* (50.0%), *Heteromastus filiformis* (37.5%), and Spionidae larvae (37.5%) were observed. *Polydora antennata* was observed at depths of 35-38 m in the northwestern region, whilst being absent from shallow water areas.

Polychaete larvae abundances varied with depth; down to 10 m they comprised 9.29% of total numbers, 0.57% at depths of 11-20 m, and at depths exceeding 30 m they accounted for 50.95% of the total abundance (Fig. 2).

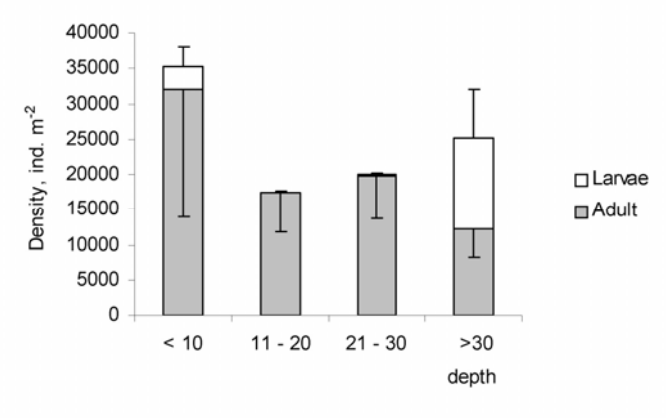

Fig. 2. Distribution of polychaete abundances (ind. m^{-2}) with relation to depth (m).

Comparisons of species similarity of polychaetes at different depths using the Czekanowski-Sørensen index gave results of from 0.69 to 0.45, with highest values observed when comparing adjacent zones (Fig. 3). The similarity index values decreased with increasing distance between samples and increasing depth. Minimal values were observed for depths of less than 10 m and exceeding 30 m.

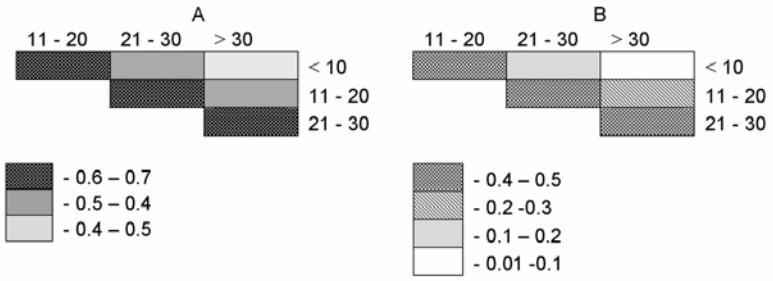

Fig. 3. Matrices of species similarity (A) and abundance similarity (B) of polychaetes in different depth categories (according to Czekanowski-Sørensen Index).

The values of the similarity index, as illustrated in Fig. 3, were low but had a wide range of variation, and the trend for changes in abundance and diversity were analogous. When comparing polychaete abundances a maximum value of 0.46 was calculated, between the 11-20 m and 21-30 m depths and a minimum of 0.09 when comparing depths of less than 10 m and those exceeding 30 m. These results reinforce the evidence of a greater distance separating the zones leading to less similarity.

The Shannon index was used to estimate species diversity, being lowest (1.87) at a depth of 10 m and maximum (2.55) at 21-30 m deep.

Analysis of the relationship between polychaete abundances and substrate types shows that species richness is highest on shelly substrates. Eighteen species were encountered there, of which eight are characteristic for that type of substrate. The density varied greatly, with some species (*Eulalia viridis*, *Neanthes succinea*, *Microphthalmus* sp., *Aonides paucibranchiata*, *Spio filicornis*, *Pygospio elegans*) represented by a single individual. The density of other species varied from 142 ind. m^{-2} to 7,634 ind. m^{-2}, with a mean polychaete density for shelly substrates of 24,069 ±3,788 ind. m^{-2}. *Syllides longocirrata* dominated, with 30.54% of the total number of individuals, and *Prionospio cirrifera* was also highly represented (25.04%). In the shelly substrates larvae contributed 13.8% of individuals (Fig. 4).

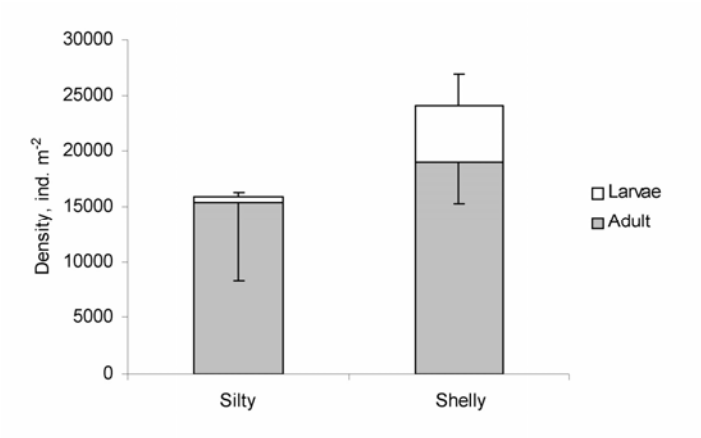

Fig. 4. Distribution of polychaete abundances (ind. m^{-2}) in different types of substrate.

Eight species of polychaete were observed in silty substrates, of which two (*Melinna palmata* and *Nephtys hombergii*) were only recorded in this substrate in the Danube area. The highest frequencies were of *Prionospio cirrifera*

(70.0%), *Heteromastus filiformis* (70.0%), *Polydora ciliata limicola* (50.0%) and *Melinna palmata* (50.0%). Two species prevailed, *Polydora ciliata limicola* at an average of 9,000 ind. m^{-2} made up 55.73% of the total polychaete abundance, and *Heteromastus filiformis,* with an average of 2,840 ind. m^{-2}, made up 17.9%. A small number of polychaete larvae were seen in silty sediments, contributing up to 4.5% of the total number of individuals (Fig. 4). The average polychaete density in samples from the silty substrate was 16,150 ind. m^{-2}.

The dominance/diversity curves show that polychaete diversity is less on silty sediments than on the shelly ones (Fig. 5).

Shannon's index for shelly sediments was 2.85 compared to 2.14 for silty. However, on both substrates a few species were dominant, with the two species *Polydora ciliata limicola* and *Heteromastus filiformis* contributing up to 73.63% of total polychaete abundances. The share of the remaining 7 species is relatively insignificant.

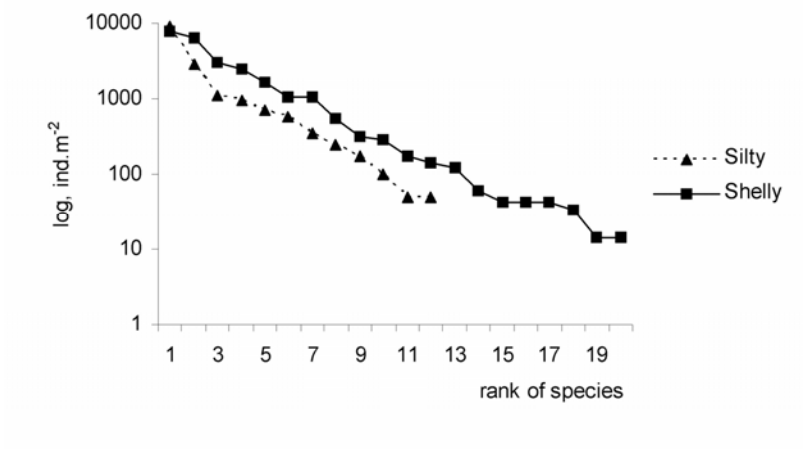

Fig. 5. Dominance curves of polychaete diversity in different types of substrate.

The number of species on shelly sediments was twice as high as that in the silty. Representatives of *Syllides longocirrata*, *Prionospio cirrifera* and Spionidae larvae dominated the shelly, making up 67.68% of the total polychaete abundance. The remaining 15 species contributed relatively insignificantly, their combined numbers comprising the remaining third of all polychaete abundance.

When comparing species composition of polychaetes on silty and shelly sediments, the Czekanowski-Sørensen index was 0.56 and the abundance 0.27, illustrating the low similarity on different substrates and large differences in abundances.

This study is the first published report on the specific ecology of polychaetes in the NWBS. Previously certain common macrozoobenthic species in the Black and Mediterranean seas have been studied (Kiseleva & Slavina 1965, Makkaveeva 1979, Gomoiu 1997, Teaca et al. 2006, Labrune 2007). In a couple of reports (Gomoiu 1997, Teaca et al. 2006) data on the abundance of meiobenthic polychaetes and their frequency in the western Black Sea has been published. The latter cannot be compared to this study as sampling occurred in different areas of the NWBS shelf at a different time of year.

The results presented here show that most meiofaunal polychaetes of the NWBS sampled in the winter are adults. The number of larvae observed was insignificant, which coincides with their spawning time in the Black Sea. Their greatest species diversity and abundance in the pelagic and benthic zones occur in the spring and early autumn periods (Kiseleva 2004). Of the 20 encountered species, true permanent forms (not exceeding 5 mm) recorded in the list of Black Sea interstitial polychaetes (Mastepanova 2004) include *Syllides longocirrata, Exogone gemmifera, Sphaerosyllis bulbosa, Microphthalmus* sp., and *Protodrilus flavocapitatus*. Other polychaetes that would mature to greater lengths in the adult stages were encountered in the samples as they had not reached maximum size and had passed through the 1 mm mesh sieve, while being retained on the 110 μm.

Analyses of the spatial distributions of polychaete species diversity show great regional differences between the areas of the NWBS shelf. Maximum numbers of species were seen in areas (Zernov's Phyllophora Field, Zmeiny Island) with more stable ambient factors (depth, salinity, hydrochemical parameters, etc.). Two other areas (Odessa and Danube) are highly impacted zones due to eutrophication and hypoxia in bottom sediments and as a result of discharges of wastewaters, etc. (Bronfman et al. 1991, Garkavaya & Bogatova 1990, Garkavaya 1998). The most commonly observed species over all four areas are *Syllides longocirrata, Heteromastus filiformis* and *Polydora ciliata limicola.*

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