Vestnik zoologii, **50**(5): 387–394, 2016
DOI 10.1515/vzoo-2016-0045

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UDC 595.371(262.5:1-16)

AMPHIPOD (CRUSTACEA, AMPHIPODA) COMMUNITIES IN THE NORTH-WESTERN PART OF THE BLACK SEA

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Amphipod (Crustacea, Amphipoda) Communities in the North-Western Part of the Black Sea. Kudrenko, S. A. — The data about the community composition, number and biomass of amphipods in three gulfs of the North-Western Black Sea are presented. The amphipod communities of the gulfs of Yahorlyk, Karkinit, and Tendra were studied and the species composition was compared with the previously published data. For each particular gulf, the list of amphipod species was composed. The quantitative parameters of the amphipod communities in the studied localities in different years were described.
Key words: Crustacea, Amphipoda, Gammaridae, abundance, biomass, community.

Introduction

Amphipods are utilizers of primary and partly secondary production in ecosystems. Also they transform sediment composition by enriching it with organic matter. These crustaceans are dietary items for many of coastal fishes and aquatic birds (Mordvinova, 2002; Kudrenko and Kvach, 2005). Also, amphipods are used as intermediate and paratenic hosts by a number of parasite species infecting various fishes and aquatic birds (Holmes and Bethel, 1972; MacNeil et al., 2003). In Ukraine, amphipods are traditionally used as forage for poultries and ornamental fish.

The North-Western part of the Black Sea (NWBS) is a specific region with many gulfs, lagoons and estuaries localized manly in its Ukrainian sector. The bays of the NWBS are highly important as habitats for hydrobionts, also playing important role in both coastal and marine off-shore ecosystems. Comparing to adjacent parts of the Black Sea, the bays have higher species diversity. There are six specific subregions distinguished in the Ukrainian sector of the NWBS based on their ecological characteristics (Garkavaya et al., 2006). Three gulfs, i. e. Gulf of Tendra, Gulf of Yahorlyk and Gulf of Karkinit, are assigned to one of the subregions.

In the period of 1966–2003, 48 species of amphipods have been registered in the NWBS according to the published data (Sinegub, 2006). Those are mainly eurybionts widespread in the Black and Mediterranean seas, as well as in the Northern Atlantic. Some of them are tube-dwellers (e. g. *Crassicorophium bonellii* (Milne-Edwards, 1830), *Ampithoe ramondi* Audouin, 1826), but some others are free-living (e. g. *Echinogammarus olivii* (Milne Edwards, 1830), *Pontogammarus maeoticus* (Sovinskij, 1894)). Most of them inhabit macrophytes, but some are specific for particular type of the bottom: *Ampelisca diadema* (Costa, 1853) for silty bottoms, *Bathyporeia guilliamsoniana* (Bate, 1857) for sandy bottoms (Greze, 1977, 1985).

Most amphipods from the region have high ecological plasticity and inhabit also adjacent sea regions. The permanent monitoring of these aquatic ecosystems is necessary because of high validity of biological invasions (Panov et al., 2009). The studies on the amphipod communities can help to evaluate current environmental condition of the water body.

The first detailed list of the Black Sea amphipods was presented by Greze (1977). The list comprises 110 marine, brackish, and freshwater species. Among them, 57 % had Mediterranean origin, 36 % had Ponto-Caspian origin, and 7 % were related to the other groups (Greze, 1977, 1985). The nowadays data confirmed the occurrence of only 88 species of amphipods (Sezgin, Katağan, 2007; Grintsov and Sezgin, 2011).

The data about the taxonomic composition of amphipod fauna in the gulfs of Tendra and Yahorlyk are present in the papers, published in 1970s (Pupkov, 1972; Grigoryev and Pupkov, 1977). Alekseev (1992) reported about 17 amphipod species in these water bodies, but without any quantitative characteristics. Pinchuk et al. (1992) reported on 21 amphipod species in the Gulf of Tendra. The lists of amphipod species inhabiting littoral of the Gulf of Karkinit were published in 1990s (Pinchuk, 1990; Povchun, 1992), the nowadays data are absent. The aim of the present study was to determine the current species composition of amphipods in the

gulfs of Karkinit, Tendra and Yahorlyk and to establish the patterns of spatial and temporal distribution and quantitative characteristics of amphipod communities.

Material and methods

The amphipods were sampled in the gulfs of Karkinit, Tendra and Yahorlyk during the cruise of scientific vessel "Sprut" in summer months of 2005, 2007, 2008 and 2011 (fig. 1). The zoobenthos was sampled using benthic grab (0.1 m^2 sampling area) and a total of 121 samples were collected (table 1).

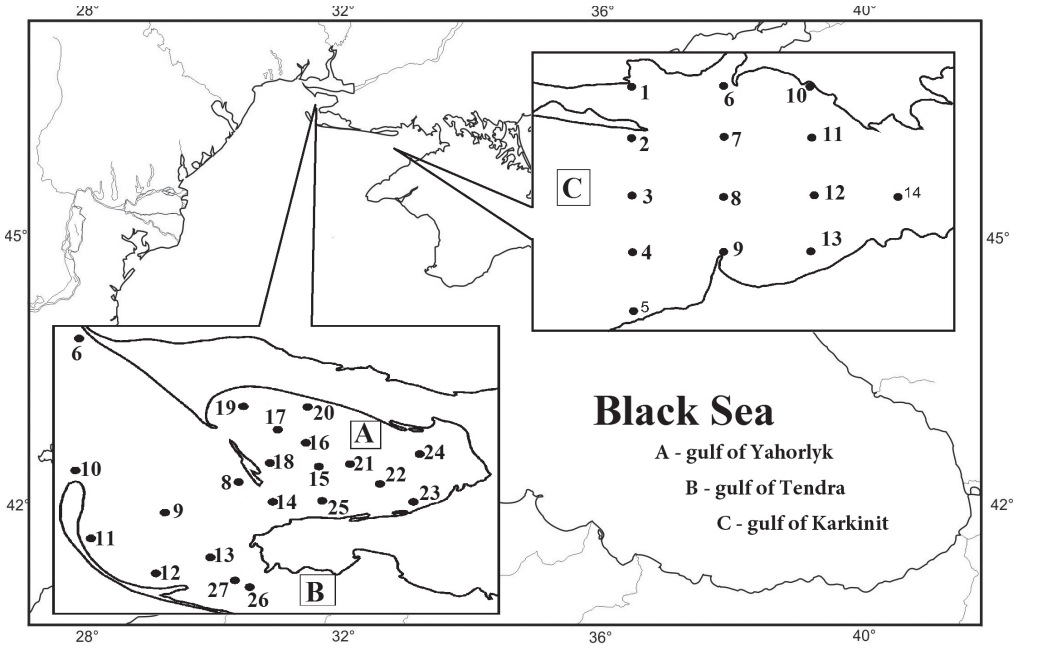

Fig. 1. The schematic map of the sampling area.

Table 1. The sampling sites in the studied gulfs in the NWBS and their depth

Gulf of Karkinit				Gulf of Tendra				Gulf of Yahorlyk			
2008		2011		2005		2007		2005		2007	
No	Depth	No	Depth	No	Depth	No	Depth	No	Depth	No	Depth
1	6.7	1	8.2			7	5.0			14A	3.8
2	8.7	2	10.5			8	8.0	14	3.6	14	4.7
3	9.7	3	9	9	6.4	9	11.5	15	5	15	5
4	14.3	4	9.5	10	15.0	10	15.0	16	5	16	5
5	14.9	5	10.6	11	7.4	11	7.0	17	4.8	17	5
6	2.9	6	9.8	12	12.5	12	7.0	18	3	18	3.5
7	9.9	7	9.1	13	8.0	13	4.5	18-1	3.7	19	3.0
8	10.7	8	5.8	20	5	26	1.0	Dok	5.0	20	0.6
9	9	9	9.6	21	6.2	27	0.5	19	3.2	21	6.0
10		10	5.6					Kut	20.0	22	2.5
11	4.2	11	9.4							23	0.9
12	9.3									24	1.5
13	6.6									25	4.5
14	6.7										

The sampled benthos was filtered through sediment analysis sieves set of decreasing mesh size (from 1 mm to 12 mm), then preserved in 4 % formalin. The preserved samples were transported to the laboratory of the Institute of marine biology where they were analyzed. The amphipods were collected from the samples under dissection stereo-microscope. Each specimen was identified to species level, sorted by species and weighted. The amphipod communities were compared using Bray-Curtis similarity index (BC). The number, N (ind./m^2), biomass (g/m^2) were calculated for each particular species and for total community in each water body. The frequency, P (%), was calculated as: $P = n \times 100\ \% / N$, where n is a number of samples with particular species (or taxa), N is a total number of samples.

Results

In total, 19 amphipod species were found in the studied water bodies (table 2). The amphipods were most frequent in the Gulf of Yahorlyk, P = 95.24 %. In two other gulfs the frequency was also rather high: 90 % in the Gulf of Karkinit and 68.75 % in the Gulf of Tendra. Seven species were common for all three gulfs (table 2): *Apherusa bispinosa* (Bate, 1857), *A. diadema*, *A. ramondi*, *C. bonellii*, *Dexamine spinosa* (Montagu, 1813), *Melita palmata* (Montagu, 1804), *Microdeutopus gryllotalpa* Costa, 1853. Four species, *A. diadema*, *D. spinosa*, *M. palmata* and *M. gryllotalpa*, were most frequent and numerous (fig. 2).

The results of comparative analysis of amphipod communities (BC) showed the high similarity between all three localities: 81.48 % between gulf of Tendra and Yahorlyk, 66.67 % between gulfs of Karkinit and Tendra, and 61.54 % between gulfs of Karkinit and Yahorlyk.

Gulf of Karkinit. The amphipod community is composed by 13 species (table 2). The frequency varied from 1.43 % (accidental findings of *Ericthonius difformis* Milne Edwards, 1830, *Perioculodes longimanus* (Bate & Westwood, 1868), *Synchelidium maculatum* Stebbing, 1906) to 51.43 % (*D. spinosa*; table 2). The mean number of amphipod amounted 14.12 ± 4.15 ind./m^2 (fig. 2). The mean biomass amounted 0.03 ± 0.012 g/m^2. Three species, *A. diadema*, *M. palmata* and *D. spinosa*, were most numerous. *P. longimanus* and *S. macu-*

Table 2. The frequency (P, %) of amphipods in the studied gulfs in the NWBS

Species	Gulf of Karkinit	Gulf of Tendra	Gulf of Yahorlyk
Apheruza bispinosa (Bate, 1857)	18.57	12.50	4.76
Ampelisca diadema (Costa, 1853)	25.71	56.25	80.95
Ampithoe ramondi Audouin, 1826	12.86	18.75	14.29
Bathyporeia guilliamsoniana (Bate, 1857)	–	6.25	–
Cardiophilus baeri G. O. Sars, 1896	–	6.25	9.52
Crassicorophium bonellii (Milne-Edwards, 1830)	5.71	12.50	4.76
Corophium voliutator (Pallas, 1766)	–	18.75	19.05
Dexamine spinosa (Montagu, 1813)	51.43	37.50	28.57
Ericthonius difformis Milne-Edwards,1830	1.43	–	4.76
Gammarus subtypicus Stock, 1966	2.86	–	–
Gammaru insensibilis Stock, 1966	14.29	18.75	–
Melita palmata (Montagu, 1804)	35.71	12.50	19.05
Microdeutopus gryllotalpa Costa, 1853	51.43	50.00	76.19
Microprotopus longimanus Chevreux, 1887	–	6.25	4.76
Nototropis guttatus Costa, 1853	–	12.50	4.76
Perioculodes longimanus (Bate & Westwood, 1868)	1.43	–	–
Synchelidium maculatum Stebbing, 1906	1.43	–	–
Phtisica marina Slabber, 1769	2.86	6.25	–
Caprella acanthifera Leach, 1814	–	–	4.76
Species number	13	14	13

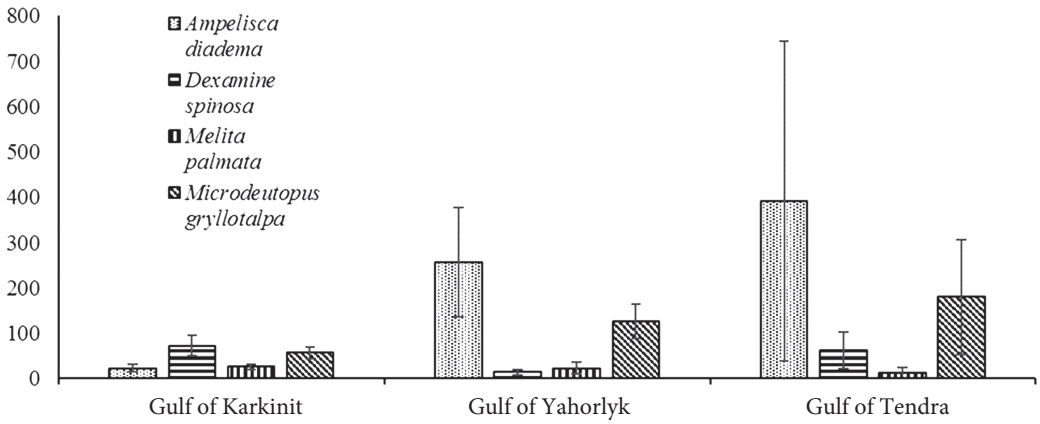

Fig. 2. The number of most frequent species of amphipods in three gulfs of the NWBS.

latum were sporadic. Other three species, *Gammarus insensibilis* Stock, 1966, *Gammarus subtypicus* Stock, 1966 and *A. diadema*, were most abundant, forming the main part of total amphipod biomass (table 3).

The parameters of amphipod populations in the Gulf of Karkinit varied during all period of study. In 2008, *A. diadema*, *M. palmata*, and *M. gryllotalpa* were most frequent (table 2); *A. diadema*, *M. palmata* and *A. ramondi* were most numerous, and *A. diadema*, *G. subtypicus* and *M. palmata* had maximal biomass. In September 2008, the amphipods occurred on 92.31% of sampling stations. In this period, their number was 144.62 ± 37.60 per m^2; biomass 0.272 ± 0.094 g per m^2 (table 3).

In 2011, eight species of amphipods were registered in this water body. Their number reached 318.18 ± 68.79 per m^2 and biomass 0.958 ± 0.370 g per m^2. Three species, *D. spinosa*, *M. palmata* and *A. diadema*, were most frequent (table 2). The most numerous species were *D. spinosa*, *G. insensibilis* and *M. gryllotalpa*, but the maximal biomass was formed by *G. insensibilis*, *D. spinosa* and *M. gryllotalpa* (table 3).

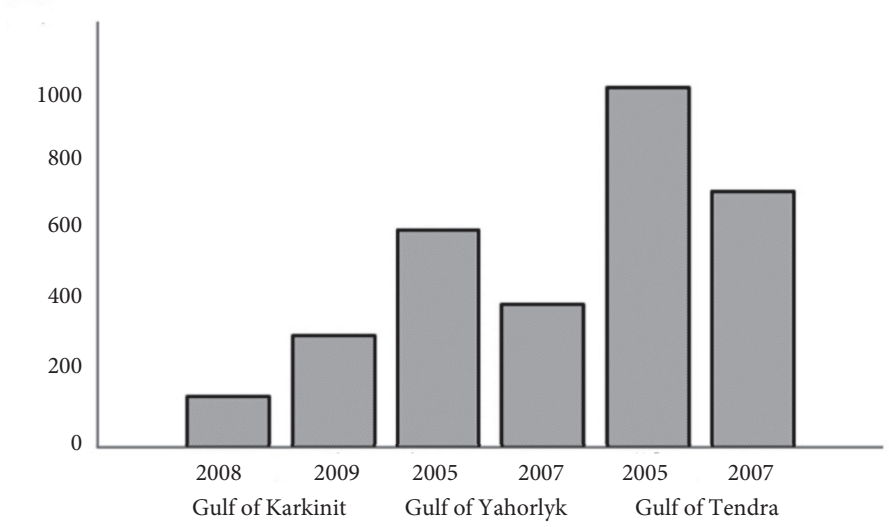

Fig. 3. The distribution of amphipods by three gulfs of the NWBS.

Table 3. The number of amphipods in the studied gulfs in the NWBS in different years

Species	Gulf of Karkinit		Gulf of Tendra		Gulf of Yahorlyk	
	2008	2011	2005	2007	2005	2007
Apheruza bispinosa (Bate, 1857)	0.38 ± 0.38	16.48 ± 5.69	5.63 ± 5.63	–	7.14 ± 7.14	1.11 ± 1.11
Ampelisca diadema (Costa, 1853)	53.85 ± 21.60	3.98 ± 2.43	480.00 ± 299.89	118.46 ± 50.90	25.00 ± 17.01	676.67 ± 625.91
Ampithoe ramondi Audouin, 1826	16.92 ± 10.88	3.98 ± 2.14	1.88 ± 1.88	26.92 ± 23.79	82.14 ± 78.86	3.33 ± 3.33
Bathyporeia guilliamsoniana (Bate, 1857)	–	–	–	–	2.14 ± 2.14	–
Cardiophilus baeri G.O. Sars, 1896	–	–	5.63 ± 5.63	64.62 ± 64.62	–	3.33 ± 3.33
Crassicorophium bonellii (Milne-Edwards, 1830)	0.77±0.77	4.55 ± 2.73	3.75 ± 3.75	–	57.14 ± 55.49	–
Corophium voliutator (Pallas, 1766)	–	–	7.50 ± 4.01	0.77 ± 0.77	24.29 ± 16.01	4.44 ± 4.44
Dexamine spinosa (Montagu, 1813)	9.62 ± 4.24	109.09±35.26	15.00 ± 15.00	13.08 ± 6.44	140.71 ± 87.47	1.11 ± 1.11
Ericthonius difformis Milne-Edwards, 1830	1.54 ± 1.54	–	–	0.77 ± 0.77	–	–
Gammarus subtypicus Stock, 1966	3.85 ± 2.89	–	–	–	–	–
Gammarus insensibilis Stock, 1966	–	78.98 ± 47.92	–	–	267.86 ± 195.03	–
Melita palmata (Montagu, 1804)	31.15 ± 12.92	22.16 ± 7.76	3.75 ± 3.75	34.62 ± 21.20	1.43 ± 1.43	20.00 ± 20.00
Microdeutopus gryllotalpa Costa, 1853	18.85 ± 8.45	78.98 ± 20.38	93.75 ± 47.33	146.15 ± 52.70	392.86 ± 280.57	14.44 ± 12.15
Microprotopus longimanus Chevreux, 1887	–	–	–	0.77 ± 0.77	1.43 ± 1.43	–
Nototropis guttatus Costa, 1853	–	–	–	0.77 ± 0.77	7.14 ± 5.65	–
Perioculodes longimanus (Bate & Westwood, 1868)	0.77 ± 0.77	–	–	–	–	–
Synchelidium maculatum Stebbing, 1906	0.38 ± 0.38	–	–	–	–	–
Phtisica marina Slabber, 1769	6.54 ± 4.54	–	–	–	8.57 ± 8.57	–
Caprella acanthifera Leach, 1814	–	–	–	0.77±0.77	–	–
Total	144.62 ± 37.60	318.18 ± 68.79	616.87 ± 363.51	407.69±118.73	1017.86 ± 468.13	724.44 ± 629.51

Gulf of Tendra. Fourteen species of amphipods were registered in the Gulf of Tendra during the period of the study. Among them, 13 species were found in summer 2005. *M. gryllotalpa* was most frequent (P = 85.7 %) and numerous (392.8 per m^2) in the gulf. Eight species were found in autumn 2007, the phytophilic species were absent (tables 2, 3). The mean number of amphipods reached 60.92 ± 29.07 per m^2, with biomass 0.23 ± 0.14 g per m^2. Three species, *A. diadema*, *M. gryllotalpa* and *G. insensibilis*, had maximal number: 391.56 ± 3.15 per m^2, 180.00 ± 127.16 per m^2 and 117.19 ± 88.51 per m^2, correspondingly. The maximal biomass was registered for *A. bispinosa*, *G. insensibilis* and *M. gryllotalpa*.

Thirteen amphipod species occurred in the Gulf of Tendra in 2005. The number of amphipods in this gulf was maximal (1017.86 ± 468.13 per m^2) for the whole period of the study (fig. 4). The biomass of amphipods in this gulf was higher than in the other studied water bodies: 1.66 ± 1.06 g per m^2 (table 3). *M. gryllotalpa* and *G. insensibilis* were the most numerous and composed main biomass of the amphipod community (table 3). *M. gryllotalpa*, *D. spinosa* and *A. diadema* were most frequent (table 3).

Eight species of amphipods were registered in the Gulf of Tendra in 2007. *A. diadema* and *M. gryllotalpa* were the most frequent (table 2). The total number of amphipods reached 724.44 ± 629.51 per m^2 with the maximum biomass observed for the whole period of the study. *A. diadema* and *M. palmata* were characterized by maximal number and biomass in this gulf (table 3).

Gulf of Yahorlyk. Similarly to the previously described gulfs, the most abundant species in the Gulf of Yahorlyk were *A. diadema*, *D. spinosa* and *M. gryllotalpa* (table 2). The most numerous were *A. diadema* (256.2 ± 120.4 per m^2), *Cardiophilus baeri* G. O. Sars, 1896 (42.1 ± 39.9 per m^2) and *M. gryllotalpa* (126.2 ± 36.9 per m^2). The main biomass was formed by two species: *A. diadema* — 0.5 ± 0.2 g per m^2 and *M. gryllotalpa* — 0.1 ± 0.04 g per m^2.

In June 2005, the amphipods were found in all samples. Nine species with the mean number 616.9 ± 363.5 per m^2 and biomass 1.0 ± 0.6 g per m^2 occurred in this month. The most frequent were *A. diadema*, *C. voliutator* and *M. gryllotalpa*. *A. diadema* and *M. gryllotalpa* were the most numerous and had maximal biomass (table 2).

In September 2007, the amphipods were found in 92.3 % of samples, with the total of 11 species occurring in the Gulf of Yahorlyk. The number and biomass were lesser than in 2005 (407.7 ± 118.7 per m^2 and 0.6 ± 0.2 g per m^2, correspondingly). *A. diadema* and *M. gryllotalpa* were the most frequent (84.6 % each). These species were also the most numerous and composed main biomass in the gulf.

Discussion

The studies localities are characterized by shallow waters with sandy bottoms covered with many macrophyts and epifauna (also infauna). These water bodies are usually used as feeding places by many fish species, such as rays, sturgeons, gobiids, flatfishes, etc., also as a settlement of migrating birds and a habitat for many species of hydrobionts (Greze, 1985).

The amphipod species recorded from 2005 till 2011 can be divided by their geographical origin to the following categories:

– Mediterranean-Atlantic: *A. bispinosa*, *A. diadema*, *B. guilliamsoniana*, *Caprella acanthifera* Leach, 1814, *Corophium volutator* (Pallas, 1766), *C. bonelli*, *D. spinosa*, *M. gryllotalpa*, *M. palmata*, *Nototropis guttatus* Costa, 1853, *Phtisica marina* Slabber, 1769, *P. longimanus*, *S. maculatum*.

– Mediterranean-Lusitanian: *G. insensibilis*, *G. subtypicus*.

– Ponto-Caspian relicts: *C. baeri*.

– Circum-Boreal: *E. difformis*.

– Pontic endemics: *Microprotopus longimanus* Chevreux, 1887.

The majority of species collected in 2005, 2007, 2008 and 2011 related to Mediterranean-Atlantic zoogeographic group (Greze, 1977, 1985). This group is characterized by the

polyhalinity. It is possible that the stable taxonomic composition of the amphipod community during the study period was caused by the stable environmental conditions in the water body. The Mediterranean species were dominating in the communities in the studied water bodies; the amphipods from other zoogeographic groups were not numerous. The Mediterranean species composed the main biomass of amphipods in studied gulfs, making the main contribution to the species diversity.

The Gulf of Yahorlyk is intensively overgrown with macrophyts, inhabited by rich and divers hydrobiont complexes. The specificity of this water body is the unstable temperature regime, water level and salinity. The depth is up to 6 m in the central part of the gulf and 2–4 m in its main part. In summer, the homothermia is typical for the gulf, but in autumn, the water temperature in demersal zone is about 1–2 °C lower than the temperature near surface. The salinity of the Gulf of Yahorlyk ranges 13.9–18.2 ‰. The oxygen is reduced even in summer, especially during the waters stratification in windless periods (Grigoriev, Pupkov, 1977).

Comparing the current data from the Gulf of Yahorlyk with the data of Alekseev (1992), we found the decrease of species number from 17 species in 1979–1982 to 13 in 2005–2007. We did not find five species, *Cryptorchestia cavimana* (Heller, 1865), *E. olivii*, *G. subtypicus*, and *Orchestia montagui* Audouin, 1826, which are common inhabitants of the supralittoral, therefore cannot be sampled by grab.

The Gulf of Tendra is limited by the islands Dovhyi and Kruhlyi in north, Yahorytskyi Kut peninsula in south, and Tendra split in west. The length of the gulf is 65 km, its coastal line is 113 km. Its depth is from 1–2 m in east to 10–13 m in west. The bottoms are sandy or silty; main part of the gulf is related to the Black Sea Biosphere natural reserve (Zaitsev, 2008).

Twenty-one amphipod species were recorded in the Gulf of Tendra in 1970–1980 (Pinchuk, 1989; Pinchuk et al., 1992), but only 14 species were in 2005 and 2007 (table 1). The species which inhabit the supralittoral and beach zone, such as *Deshayesorchestia deshayesii* (Audouin, 1826), *E. olivii*, *Gammarus aequicauda* (Martynov, 1931), *O. montagui*, and *P. maeoticus*, were not found. *P. longimanus* was not numerous and prefers sandy bottoms (Greze, 1985). *A. ramondi*, *Cumadusa crassicornis* (Costa, 1853) and *E. difformis* prefer the growths of *Cystoseira* spp. in the shallow zone (Greze, 1985), which was poorly covered by our sampling. The phytophilic species, *C. voliutator* and *P. marina* (Greze, 1985), were found on silty bottoms in 2005 and 2007. The finding of *Microdeutopus damnoniensis* (Bate, 1856) (Greze, 1985), a species preferring silty bottom on at least 15 m depth, is questionable because of shallow character in the gulf (Pinchuk, 1989). It is plausible, that common in the gulf *M. gryllotalpa* was misidentified as *M. damnoniensis* (Pinchuk, 1989; Pinchuk et al., 1992).

The Gulf of Karkinit is a big water body, located between the continent and northwestern Crimean peninsula. Its length is more than 118 km. The Bakal split and Bakal bank divide the water body to two parts: western part (80 km wide and up to 36 m deep) with sandy coasts, and eastern part (up to 10 m deep) with clay coasts. The salinity of this gulf is about 17–18 ‰ (Zaitsev, 2008).

The published data about the amphipod fauna of the Gulf of Karkinit are very poor. According to Pinchuk (1990), *D. deshayesii*, *E. olivii*, *Orchestia gammarellus* (Pallas, 1766), *O. montagui*, and *P. maeoticus* were registered in its coastal zone. According to Povchun (1992), who presented the data about total zoobenthos, six amphipods species inhabited the gulf: *A. bispinosa*, *A. diadema*, *D. spinosa*, *Megamphopus cornutus* Norman, 1869, and *P. marina*. Also some taxa were not identified to the species level. *M. cornutus* was mentioned in the published data as rare species; it was absent in our samples. This Mediterranean-Atlantic species preferred the silty-sandy bottoms with shells (Greze, 1977, 1985).

Unfortunately, because in the beginning of 20th century the amphipods were sampled in different biotops, we can not provide the comparative analysis of the amphipod communities. *D. deshayesii*, *E. olivii*, *O. gammarellus*, *O. montagui*, and *P. maeoticus* inhabit only at the water boundary and on beaches, therefore they were absent in the present results.

Conclusions

A total of 19 amphipod species are reported from three gulfs of the NWBS (gulfs of Karkinit, Tendra and Yahorlyk) in 2005, 2007, 2008 and 2011. Six species were found as common for these three gulfs: *A. bispinosa*, *A. diadema*, *A. ramondi*, *D. spinosa*, *M. palmata*, *M. gryllotalpa*. *G. subtypicus*, *P. longimanus*, *S. maculatum* were found only in the Gulf of Karkinit, *C. acanthifera* — only in the Gulf of Yahorlyk, *B. guilliamsoniana* — only in the Gulf of Tendra. Four species, *A. diadema*, *D. spinosa*, *M. palmata*, and *M. gryllotalpa*, occurred as most stable component of the amphipod communities of the studied water bodies. They were most numerous, compounding main amphipod biomass. The maximal number of amphipods was registered in the Gulf of Tendra in 2005.

I acknowledge all the scientific stuff of the Institute of marine biology of NAS of Ukraine (IMB NASU), Odessa, Ukraine, who participated in the sampling cruise of "Sprut" vessel, especially A. Bondarenko, A. Rybalko and I. Sinegub. Also I thank Dr. Ludmila Vorobyeva (IMB NASU) and Dr. Yuriy Kvach (Institute of Vertebrate Biology, AS CR, Brno, Czech Republic) for their help in the manuscript preparation.

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Received 10 June 2016
Accepted 5 December 2016