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FREE-LIVING MARINE NEMATODES OF THE COASTAL ZONE AREA NEAR THE SNAKE ISLAND OF THE UKRAINIAN SHELF OF THE BLACK SEA

The species diversity, quantitative parameters and spatial distribution of the free-living marine nematodes in the meiobenthic community of the coastal zone area near the Snake Island, Black Sea, Ukraine shelf, have been studied for the first time. In total of 47 species from 5 orders, 14 families and 31 genera were registered. The representatives of orders Monhysterida and Enoplida were most abundant. The results of the comparative analysis of nematode assemblage in dependence of the substrate type are described. The percentage of nematodes in total meiobenthos in piers fouling consisted of 16% only, but on silt bottoms it reached 60.8%. The species diversity also increases on silt bottoms. Four nematode species are registered in piers fouling, but 36 on silts. The omnivores-carnivores consisted of 50% of the nematode assemblage in piers fouling. On silts, the percentage of non-selective deposit feeders reached 47%, but epistrate feeders decreased up to 14%.

Key words: free-living marine nematodes, meiobenthos, Black Sea, Ukrainian shelf, Snake Island

The Snake Island is a landform located in contact zone of the sea and riverine waters in from of the Danube River mouth. The most powerful ecotone in the Black Sea, the zone of co-existence of two ecosystems (limnetic and marine) is formed here. The salinity of the sea water in the dwelling levels near the Snake Island is significantly higher than in the other parts of the North-Western Black Sea. So, in 2005 the salinity of the coastal waters of the island was 18.2–18.7‰.

The studies, provided in the mid-80s, showed that the zoobenthos species diversity in the island coastal zone is much richer than in the other areas of the North-Western Black Sea. The biota of this region is the source gene pool for communities inhabiting the entire North-Western Black Sea shelf. This North-Western Black Sea is affected by regular hypoxia, which results in the mass death of bottom dwellers invest areas [4]. Therefore, the populations of the island coastal inhabitant play a role in biological restoration of the other Black Sea regions [4].

The North-Western Black Sea is under the conditions of regular dwelling hypoxia. The important feature of the island coastal waters is the fact that they did not fully experience the environmental shocks that occurred in the 1970-1980s in the rest of the north-western shelf [2]. First of all, it applies to the phenomena of seasonal benthic hypoxia, which is consequence of anthropogenic eutrophication of the sea, and the mass death of benthic invertebrates and fish [1, 5]. The macrofauna of the island coastal waters is the source of marine invertebrates' larvae (mainly mussels) for the adjacent waters. The coastal area of the island is comparable by the biodiversity of benthic macrofauna with such Black Sea areas as the Gulf of Yahorlyk and the Karadag region.

In total of 25 fish species, mostly lithophilous, belonging to 16 families, are registered in the coastal shelf of the island, at the depths of 1–17 m [13]. Three of them are listed in the Black Sea Red Data Book. The feeding value of meiobenthos for fries and juveniles of commercially important demersal fishes is highest in the island near-shores [19]. Meiobenthos plays a role of feed for juvenile of many fishes, such as gobiides, blenniides, anchovies, grey mullets, etc. The development of larvae and juveniles of fishes, as well as some macrozoobenthos species, depends on the meiobenthic organisms as feed. Unfortunately, the data on this community in the island costal waters are extremely poor.

The free-living nematodes are one of the prevailed meiobenthic taxa in the North-Western Black Sea by frequency and density. The quantitative characteristics and species composition of the nematodes are described for the mentioned water area [6]. The nematodes from the Black Sea bathyal and methane concentration zones are already studied [2]. Also, the meiobenthic nematodes from the western Black Sea shelf are described [23]. The current condition of free-living nematode populations in the Gulf of Odessa, Gulf of Zhebriany (under the strong influence of the Danube flow), and the other North-Western Black Sea parts, are analysed as well [2].

This is attributed to low salinity and low temperature regime. The nematode species diversity in some areas has decreased even more due to heavy anthropogenic impact of the ecosystem in recent years [7–10].

The information about quantitative characteristics of nematodes in the meiobenthos of coastal zone of the Snake Island is poor [2, 4]. The data on taxonomic diversity of the nematode fauna; its trophic structure, spatial distribution, effect of some environmental factors (for example, the substrate type) are still absent. Therefore, the aim of the presented work was the comprehensive study of the nematode assemblage on the coastal off-shores of the Snake Island.

Material and Methods

The benthos was sampled in summer of 1983, 1998, and 2005 in the coastal zone area near the Snake Island. The depth of the studied localities varied from 0.1 to 37 m. The mixed bottom substrate at the depth of 8–15 m consisted of sand and shells. At the depth from 17 till 37 m, silt-shell and silt bottoms prevailed.

The sampling of piers fouling was done using the small frame (size: 10 x 10 cm), benthos' sampling was done by dragger. In total of 33 meiobenthic samples were collected. The samples were preceded due to the standard protocol [3,14,18]. Each of the samples was washed through sieves – 1 mm, 0.250 mm, 0.100 mm and 90 μm mesh size. All of the samples were stained with Congo Red, preserved in 4% formaldehyde and stored in plastic bags. Qualitative composition was made using zoom in Bogorovs' camera. The species identification of the nematodes was provided using light microscope «Konus 5605 Biorex3». For the species identification the old published keys [11, 12], as well as modern databases, such as «NeMys» [16], and Darwin Nematode Electronic Key [20] were used. Shannon-Weaver Index was used for species diversity [21]. For description of the trophic structure of nematode community the Wieser [24] classification was used.

The density (D, mg×m^{-2}) and biomass (B, mg×m^{-2}) of nematodes were calculated for data analysis. The frequency (P, %) was calculated percentage of nematodes in total meiobenthos: $P=\frac{a\times 100}{A}$, where A – total number of samples, a – number of samples with particular species.

Results and discussion

Totally, 47 nematode species from 5 orders, 14 families and 31 genera occurred in the coastal zone area near the Snake Island (Table 1). The representatives of orders Monhysterida (20 species) and Enoplida (15 species) were most numerous.

Among the representatives of Monhysterida, two species prevailed by frequency and density: *Axonolaimus setosus* (P=57.3%, D varied from 0 to 333,312 ind.×m^{-2}, average 34,236 ind.×m^{-2}) and *Terschellingia pontica* (P=48.4%, D varied from 0 to 148,250 ind.×m^{-2}, average 24,709 ind.×m^{-2}). All other representatives of this order were registered with low frequency (10–25.0%) and minimal density (70–5,320 ind.×m^{-2}).

Most of species from the order Enoplida were found in just few localities and their density was low, varying from 420 to 3,520 ind.×m^{-2}.

Table 1

Species composition and average density (ind.×m^{-2}) of free-living marine nematodes in the coastal zone area near the Snake Island

Taxa	Piers fouling (0–8 m)	Sand-shells (8–15 m)	Silt-shells and silt bottoms (17–37 m)
1	2	3	4
Enoplus littoralis Filipjev, 1918	1676	0	0
E. maeioticus Filipjev, 1916	63	46	0
Enoplus sp.	0	199	35
Oxyonchus dubius (Filipjev, 1918)	0	0	42
Enoploides brevis Filipjev, 1918	0	643	493
Mesacanthion conicum (Filipjev, 1918)	0	0	488
M. heterospiculum Sergeeva, 1974	0	0	1248
Anticoma acuminata (Eberth, 1863)	0	442	499
Viscosia minor Filipjev, 1918	0	162	274
Metoncholaimus demani (Zuz Strassen, 1894)	0	169	0
Oncholaimus campylocercoides De Coninck end Stekhoven, 1933	0	150	0
Onholaimus sp.	0	84	0
Oxystomina elongata (Butschli, 1874)	0	0	1763
Halalaimus wodjanizkii Sergeeva, 1972	0	0	864
Bathylaimus cobbi Filipjev, 1922	0	46	113
Chromadora nudicapitata (Bastian, 1865)	0	49	687
Chromadorella mytilicola (Filipjev, 1918)	0	42	0
Prochromadorella mediterranea (Micoletzky, 1922)	0	125	563
Chromadorita gracilis (Filipjev, 1922)	0	10	0
Neochromadora poecilosomoides (Filipjev, 1918)	0	357	2592
Paracanthonchus caecus (Bastian, 1865)	104	917	3854
Cobbionema acrocerca Filipjev, 1922	0	0	132
Microlaimus kaurii Wieser, 1954	0	31	0
Monhystera collaris Filipjev, 1922	0	50	544
M. conica Filipjev 1922	0	0	1577
M. rotundicapitata Filipjev, 1922	0	0	1133
Daptonema longicaudatum (Filipjev, 1922)	0	580	220
Daptonema oxycerca (de Man, 1888)	0	130	71
Theristus setosus Butschli, 1874	0	46	0
T. latissimus Filipjev, 1922	0	324	729
Theristus sp.	0	31	116
Sphaerolaimus gracilis De Man, 1976	0	0	621
S. macrocirculus Filipjev ,1918	0	0	563
S. ostreae Filipjev, 1918	0	84	2445
Metalinhomoeus zosterae Filipjev, 1918	0	0	744
Linhomoeus hirsutus Bastian, 1865	188	0	0
Terschellingia pontica Filipjev ,1918	0	983	24709
T. longicaudata De Man, 1907	0	95	2266
Terschellingia sp.	0	448	0
Axonolaimus ponticus Filipjev, 1918	0	146	593
A. setosus Filipjev, 1918	0	309	34236
Odontophora angustilaimus (Filipjev, 1918)	0	0	389
Parodontophora quadristicha (Stekhoven, 1950)	0	0	5396
Sabatieria abyssalis (Filipjev, 1918)	0	0	11997
S. pulchra (G. Schneider 1906)	0	646	23868
S. quadripapillata Filipjev,1922	0	0	3344
Araeolaimus gen. sp.	0	0	864

Oxystomina elongata (average 1,762 ind.×m^{-2}) and *Mesacanthion heterospiculum* (average 1,247 ind.×m^{-2}) prevailed by density.

Two species of Chromadorida were registered with prevalence by frequency (53.2%) and high density: *Paracanthonchus caecus* had from 560 till 31,098 ind.×m^{-2} (average 3,854 ind.×m^{-2}) and *Neochromadora poecilosomoides* had from 560 till 20,753 ind.×m^{-2} (average 2,594 ind.×m^{-2}). Also, two species from order Araeolaimida, *Sabatieria pulchra* and *S. abyssalis*, had high frequency (up to 60%). The quantitative parameters of their population on most of localities varied from 5,000 to 82,350 ind.×m^{-2}, with average 23,868 and 11,997 ind.×m^{-2}, correspondingly.

Most of nematodes occurred near the Snake Island have marine origin (79%), but the rest are inhabitants of sea and brackish waters with wide range.

The density of nematodes on sample stations varied from 0 to 666,524 ind.×m^{-2}, biomass from 0 to 168.09 mg×m^{-2}. Average parameters were: D=49,396±22,937 ind.×m^{-2}, B= 11.08±5.49 mg×m^{-2}.

The Shannon-Weaver Index had high parameters (2.4) on two sampling stations, located on sandy-shell and silt bottoms. Most of the stations are characterized by low parameters of this index (1.1–1.7). The species diversity of nematodes in pier fouling (till 8 m depth) varied from 0 to 0.7, average 0.1. Four from 16 sampling stations on piers have no nematodes in the samples, but the rest have 1–2 species only. In total, four nematode species are registered on pier fouling: *Enoplus littoralis*, *E. maeoticus*, *P. caecus* and *Linhomoeus hirsutus*.

The percentage of nematodes in the total meiobenthos in piers fouling made up only 16%. The maximal density of nematodes in this substrate was 8,000 ind.×m^{-2}. Its average density 2,031±592.6 ind.×m^{-2}, but biomass 0.49±0.14 mg×m^{-2}.

On the sand-silt bottom at 8–15 m depth, the Shannon-Weaver Index for nematodes increases, getting in average 1.9. The nematode fauna is represented by 29 species from 5 orders. The orders Monhysterida (41%) and Enoplida (35%) were most frequent. The core of the assemblage was composed by *T. pontica* (average 983 ind.×m^{-2}), *P. caecus* (average 917 ind.×m^{-2}), *S. pulchra* (average 646 ind.×m^{-2}), *Enoploides brevis* (average 643 ind.×m^{-2}), and *Daptonema longicaudatum* (average 580 ind.×m^{-2}).

On the sand-shell bottoms, the percentage of nematodes in total meiobenthos was 28.7% with density varied from 2,500 to 12,000 ind.×m^{-2}. Its average density was 7,344±1,690 ind.×m^{-2}, but average biomass 1.69±0.37 mg×m^{-2}.

36 nematode species were registered on silt bottoms at the depth 17–37 m. The biodiversity index parameters varied from 1.1 to 2.3 with average 1.9. Except the high proportion of representatives of orders Monhysterida (47%) and Enoplida (28%), the percentage of ones of order Araeolaimida (11%) increases as well. Four species reached maximal number in this biotope: *A. setosus* (34,236 ind.×m^{-2}), *T. pontica* (24,709 ind.×m^{-2}), *S. pulchra* (238,675 ind.×m^{-2}), *S. abyssalis* (11,997 ind.×m^{-2}). Secondary by density were: *Paradontophora quadristicha* (5,395 ind.×m^{-2}), *P. caecus* (3,854 ind.×m^{-2}), *N. poecilosomoides* (2,591 ind.×m^{-2}), *Sphaerolaimus ostreae* (2,444 ind.×m^{-2}).

The percentage of nematodes in total meiobenthos on silt bottom was 60.8%. Their density on this substrate varied between 5,366–666,524 ind.×m^{-2}, average density – 130,071±57,446.7 ind.×m^{-2}, average biomass – 29.11±13.9 mg×m^{-2}.

The most important role in the nematode assemblage on all types of bottom was played by non-selective deposit feeders (38%) and omnivores-carnivores (31%). Selective deposit feeders consisted of 13% and prevailed mainly on sand-shell and silt bottoms. They were not observed in piers fouling. And conversely, the frequency of epistrate feeders was increasing in this biotope (25%).

Discussion

We described the nematode fauna in the coastal zone area near the Snake Island of the Black Sea, consisting of 47 species, for the first time. In the assemblage, the core group, presented by *A. setosus*, *T. pontica*, *P. caecus*, *N. poecilosomoides*, *S. pulchra* and *S. abyssalis*, also secondary one, i.e. *P. caecus*, *N. poecilosomoides*, *S. ostreae*, have high tendency to form the community, joined by the other, less dense species.

The nematode assemblage of the Snake Island coastal waters has general tendency for decreasing, comparing to adjacent parts of the Black Sea. Its percentage in the total meiobenthos was only 34%. The nematodes prevailed in the meiobenthos in all high-trophic areas of the Black Sea, consisting of 87-100% of total meiobenthos [2, 8].

The study of the nematode community in the coastal zone area near the Snake Island showed that its quantitative and qualitative characteristics are heterogenous. This is depended on the hydrological conditions, also on substrate of the habitat. Therefore, the percentage of nematodes in fouling was 16% only, but reached 60.8% on silt bottoms. The species diversity and quantitative parameters of nematode populations also higher on silts. Same trend occurred analysing the species richness. So, only four species observed in fouling, but 36 in silts. The maximal parameters of nematode density in fouling reached 8,000 ind.×m^{-2} (average 2,031±592.6 ind.×m^{-2}), with average biomass 0.49±0.14 mg×m^{-2}. The density of nematodes on silts was reaching 666,524 ind.×m^{-2} (average 130,071±57,446.7 ind.×m^{-2}), with average biomass (29.11±13.9 mg×m^{-2}).

The study area is characterised by heterogenous substrate. Big rocks are located directly near the water edge. The space between different rocks is filled with sand, small pebbles and shells. The position and area of these sites are affected by continuous changes depending on the direction and duration of storms. All this factors affects the structure of the nematode fauna.

The free-living marine nematodes are mainly inhabitants of soft bottoms [22]. Our study provided on sand-shell and silt bottoms near the Snake Island confirms these data. The piers are under the influence of waves and winds, therefore the conditions of not suitable not only for sessile fauna, but also for small-sized meiobenthic organisms, such nematodes.

Similar tendency is observed in whole the North-Western Black Sea [7, 9]. The analysis of qualitative and quantitative parameters of nematode assemblage on piers at different depth showed their irregular distribution. For example, 8 nematode species with average density 8667 ± 349.1 ind.×m^{-2} were registered at the depth of 0.5 m on a pier wall, located in the central part of the Gulf of Odessa [9]. Two species, *Viscosia glabra* (D=3,680 ind.×m^{-2}) and *Anaplostoma viviparum* (D=2,367 ind.×m^{-2}), prevailed at this depth. More deeper, at 1.5-m depth, on the same pier, the nematode density was 43,000±14,622.9 ind.×m^{-2} with the prevalence of *Chromadora nudicapitata* (D=13,084 ind.×m^{-2}).

The maximal parameters of nematode assemblage observed in sand bottom with shells [9]. Here the average density was 136,667±24,732.8 ind.×m^{-2}, with prevalence of species from the order Enoplida (V. glabra (D=36,446 ind.×m^{-2}) and V. minor (D=18,222 ind.×m^{-2}) and Chromadorida (Metachromadora sp. (D=27,333 ind.×m^{-2}), T. sabulicola (D=18,222 ind.×m^{-2}) and S. pulchra (D=9,111 ind.×m^{-2})). Earlier studies showed that valuable concentration of nematodes was observed at summer on silts (average 377,429±83,690 ind.×m^{-2}), but minimal on shells (average 650±110 ind.×m^{-2}) [7]. The specificity of the distribution of maximal densities and high diversity of nematodes is their concentration on silts, located in open parts of the north-western Black Sea shelf (average density 530,000 ind.×m^{-2}, biomass 1.4 g×m^{-2}). In the sea regions under the strong influence of riverine flow, the nematode fauna is maximally poor (average density 83,000 ind.×m^{-2}, biomass 0.2 g×m^{-2}).

The free-living nematodes, as well as the other meiobenthic organisms, form different and complicated communities [17]. Progressing the communities development, different combinations of species appeared. But finally, only stable relations between nematode species survive the environmental conditions.

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ВІЛЬНОЖИВУЧІ МОРСЬКІ НЕМАТОДИ ПРИБЕРЕЖНОЇ ЗОНИ О. ЗМІЇНИЙ УКРАЇНСЬКОГО ШЕЛЬФУ ЧОРНОГО МОРЯ

Резюме: Видове різноманіття, кількісні показники і просторовий розподіл вільноживучих нематод у складі мейобентосу були вперше вивчені в прибережній зоні о. Зміїний (Чорне море, Український шельф). У районі дослідження зафіксовано 47 видів нематод, що відносяться до 5 рядів, 14 родин і 31 роду. Найбільшого поширення набули представники рядів Monhysterida і Enoplida. Частка нематод у загальній чисельності мейобентосу в обростаннях на траверсі пірсу склала лише 16%, тоді як на мулистих ґрунтах вона досягала 60,8%. Видове різноманіття і кількісні показники нематод також збільшуються на мулистому субстраті. Усього в обростаннях було зафіксовано 4 види нематод, тоді як на мулистих ґрунтах виявлено 36 видів. Максимальне значення щільності нематод в обростаннях досягало 8000 екз. · м-2 (середня щільність – 2031 ± 592,6 екз. · м-2, середня біомаса – 0,49 ± 0,14 мг · м-2). На мулах значення щільності нематод досягали 666 524 екз. · м-2 (середня щільність – 130 071 ± 57446,7 екз. · м-2, середня біомаса – 29,11 ± 13,9 мг м-2). У обростаннях на траверсі пірсу головну роль відіграють «хижаки» (2В), складаючи 50% всього поселення нематод. На мулистих ґрунтах спостерігається збільшення частки «невибіркових детритофагов» (1В), досягаючи 47% і зменшення частки зіскоблювачів (2А) до 14%.

Ключові слова: вільноживучі морські нематоди, мейобентос, острів Зміїний, Чорне море, Український шельф

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