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Meiobenthos of Sevastopol Bay (Black Sea): Current State and Long-Term Changes

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Abstract

The paper presents data (density, taxonomic composition) on the meiobenthos population of Sevastopol Bay (the Black Sea) in 2018 as compared with the results of previous studies. The data were obtained using standard hydrobiological methods. Eleven large taxa were identified as part of the bay's multicellular meiobenthos: Nematoda, Harpacticoida, Ostracoda, Kinorhyncha, Halacaridae categorized as eumeobenthos, and small specimens of Polychaeta, Oligochaeta, Turbellaria, Nemertea, Amphipoda, Cumacea categorized as pseudomeiobenthos. Nematodes dominated, averaging from 37.7 to 88.5 % of the total number of meiobenthos. The meiobenthos density varied from 8 to 248 ind./10 cm^2 while the meiobenthos distribution across the bay was uneven. Artilleriyskaya Bay and an area in the centre of Sevastopol Bay were marked by consistently low values of the meiobenthos density. At other sites, meiobenthos characteristics varied widely. The paper considers in greater detail Yuzhnaya Bay and the top of Sevastopol Bay, where the largest changes in the studied parameters have occurred over the past 25 years. In 2018, the highest indices of taxonomic diversity and the density of meiobenthos organisms were noted here. Uneven distribution of meiobenthos in very extended Sevastopol Bay is associated both with different particle size distribution of bottom sediments and with the influence of numerous various sources of pollution. This unevenness persists for a long time with a significant difference among the values of various years; changes in different parts of the bay occur rather synchronously.

Keywords: meiobenthos, long-term changes, Sevastopol Bay, Black Sea

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Мейобентос Севастопольской бухты (Черное море): современное состояние и многолетние изменения

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Аннотация

Приведены данные о плотности и таксономическом составе мейобентосного населения б. Севастопольской (Черное море) в 2018 г., которые сравнены с результатами предыдущих исследований. Данные получены стандартными гидробиологическими методами. В составе многоклеточного мейобентоса бухты определены 11 крупных таксонов: Nematoda, Harpacticoida, Ostracoda, Kinorhyncha, Halacaridae, которые отнесены к эвмейобентосу, и мелкие экземпляры Polychaeta, Oligochaeta, Turbellaria, Nemertea, Amphipoda, Cumacea псевдомейобентоса. Доминировали нематоды, составляя в среднем от 37.7 до 88.5 % общей численности мейобентоса. Численность мейобентоса изменялась от 8 до 248 экз./10 см^2, при этом наблюдалась неравномерность распределения мейобентоса по бухте. Стабильно низкими показателями численности характеризуются б. Артиллерийская и участок в центре б. Севастопольской. На других участках наблюдали широкую вариабельность характеристик мейобентоса. Более подробно рассмотрены вершина б. Севастопольской и б. Южная, где за 25 лет произошли наибольшие изменения по изучаемым параметрам. В 2018 г. здесь отмечены самые высокие показатели таксономического разнообразия и плотности поселения организмов мейобентоса. Неравномерность распределения мейобентоса в очень протяженной б. Севастопольской связана как с разным гранулометрическим составом донных отложений, так и с влиянием многочисленных разнообразных источников загрязнения. Эта неравномерность сохраняется в течение длительного времени при достоверной разнице между показателями разных лет, изменения в различных частях бухты происходят довольно синхронно.

Ключевые слова: мейобентос, многолетние изменения, Севастопольская бухта, Черное море

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Introduction

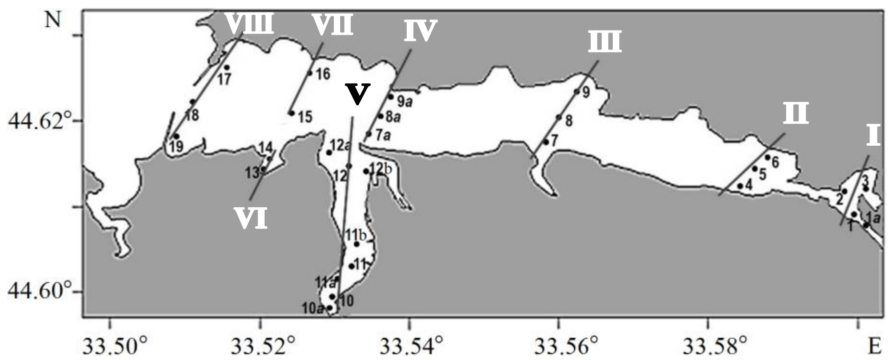
The study of the meiobenthos of the Sevastopol coastal water has a significant history. Thus, the first information concerning nematodes was given in the works of I. N. Filipyev in 1918. Faunistic studies of various taxonomic groups of this benthos aggregation have been carried out during the 20th century [1] and continue nowadays [2, 3]. The focus area of A. O. Kovalevsky IBSS Department of Marine Sanitary Hydrobiology is the study of the dependence of the meiobenthic organisms' distribution on the level of pollution of bottom sediments. Related work has begun more than 30 years ago and is carried out with the frequency of integrated sanitary and biological surveys once every three years. Sevastopol Bay is elongated in the latitudinal direction with its length of 7 km. At the top, the Chyornaya River enters the bay, which is its paleochannel.

Its mouth, narrowed by moles, is opened to the west. The coastline is crenelated and forms many smaller bays, which differ from each other in their depth, types of bottom sediments and water exchange nature. Along the shores and in the water area of the bay, there are various industrial facilities, which, like coastal residential construction, represent the sources of heterogeneous pollution [4]. The pollution nature and level of the bay have repeatedly changed over a quarter of the century, which was caused by socio-economic reasons [5, 6].

In connection with the new data collected during long-term monitoring, the aim of this work is to characterize the current state of Sevastopol Bay meiobenthos as compared with the results of previous studies [7, 8]. The most closed areas with limited water exchange, classified as moderately and heavily polluted, are considered in more detail [9, 10].

Materials and methods

In 2018, meiobenthos of Sevastopol Bay bottom sediments was studied at 27 permanent sampling stations (Fig. 1) during the so-called biological summer season [11] (in July–August), as well as during the surveys of 1994–2006. The material was sampled in three replications with a tube 3.4 cm in diameter, from the bottom lifted on board the vessel using a Petersen grab with sampling area of 0.038 m^2. Samples of bottom sediments were washed through a sieve with a mesh diameter of 1 mm in order to separate macrobenthic organisms. The filtrate was collected with *76PA-50* silk bolting cloth (mesh size – 0.082 μm), the sediments were fixed with 96 % ethanol. Samples were microscoped using



F i g . 1 . Grid of meiobenthos sampling stations during complex sanitary and biological surveys. Roman numerals stand for transects a Bogorov chamber to determine the density of representatives of the meiobenthos main taxonomic groups with recalculation of the density of organisms per 10 cm^2.

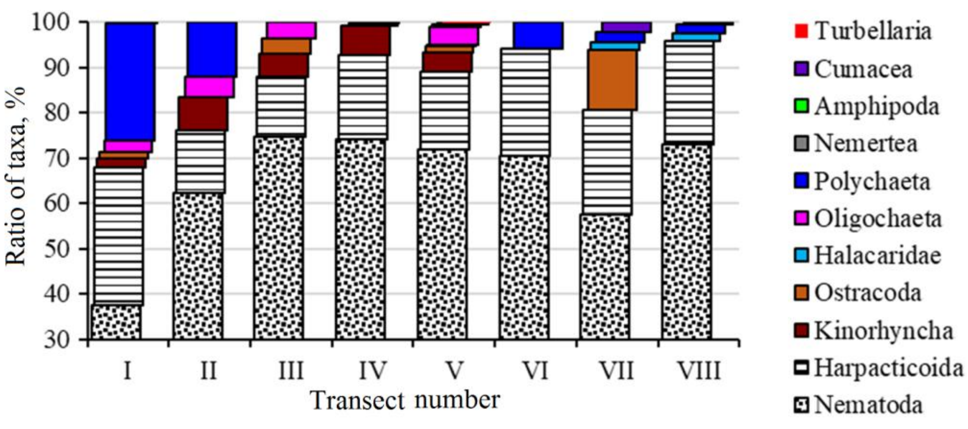
Results and discussion

The samples taken showed the representatives of such taxa as Nematoda, Harpacticoida, Ostracoda, Kinorhyncha, Halacaridae categorized as eumeobenthos, and small specimens of Polychaeta, Oligochaeta, Turbellaria, Nemertea, Amphipoda, Cumacea, categorized as pseudomeiobenthos. A total of 11 large taxa were identified (Fig. 2).

Fig. 2 shows that Nematoda dominated, averaging from 34.9 to 85.7 % of the total number of meiobenthos. Harpacticoida are also presented at all the stations, ranging from 14.6 to 25.1 %. The remaining groups were not found at all the stations, and their proportion made less than 10 %, except for Kinorhyncha at the mouth of the bay (16.6 %) and Polychaeta at the top (25.7 %), as well as at the mouth (15.2 %). The meiobenthos density varied from 8 to 248 ind./10 cm^2 (Fig. 3). The minimum values were noted in transects III and VI (Artilleriyskaya Bay), the maximum ones – in transect V (Yuzhnaya Bay).

The areas of the bay where bottom sediments have been classified as polluted for a long time are considered in detail [7, 8, 10]. These are the areas of the Inkerman boat basin and the adjacent water area (transects I and II), as well as Yuzhnaya Bay (transect V).

The meiobenthos of Sevastopol Bay top at stations 1–6 is represented by eight large taxa dominated by eumeiobenthos, which, in turn, is dominated by Nematoda (from 20.0 to 100.0 %) (Fig. 4). Harpacticoida accounted for up to 41.4% of the total density. At station 3, Ostracoda made a significant contribution to the density. Pseudomeiobenthos is represented by worms with the predominance of Polychaeta, whose contribution to the total density was significant in the estuarine area (the place of the Chyornaya River inflow, station 1). At the very mouth (station 1a), the number of meiobenthos is insignificant. The total



F i g . 2 . Representation and ratio of meiobenthos taxa in Sevastopol Bay in 2018

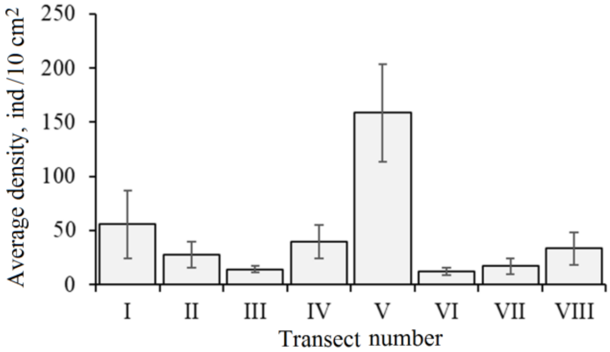


Fig. 3. The average density of meiobenthos of Sevastopol Bay in 2018

abundance varied within 4.4–128.2 ind./10 cm^2 with the maximum values at station 1; the maximum taxonomic diversity was also noted there.

Yuzhnaya Bay meiobenthos (stations 10–12) is represented by nine large taxa with the significant predominance of eumeiobenthos (Fig. 5). It, in turn, was dominated by Nematoda (37.1–83.0 %). Harpacticoida accounted for 3.1 to 58.4 % of the total density. Pseudomeiobenthos is represented mainly by juvenile specimens of worms with the predominance of Oligochaeta. Malacostracans (Cumacea) were recorded at two stations. The total density of meiobenthos varied within 32.3–321.6 ind./10 cm^2 with a tendency to increase towards the exit from the bay.

Due to the small sample size, nonparametric statistical methods were used to compare the data on the density of meiobenthic population and its taxonomic diversity obtained at stations I, II, V in 2018 with similar indices of past surveys.

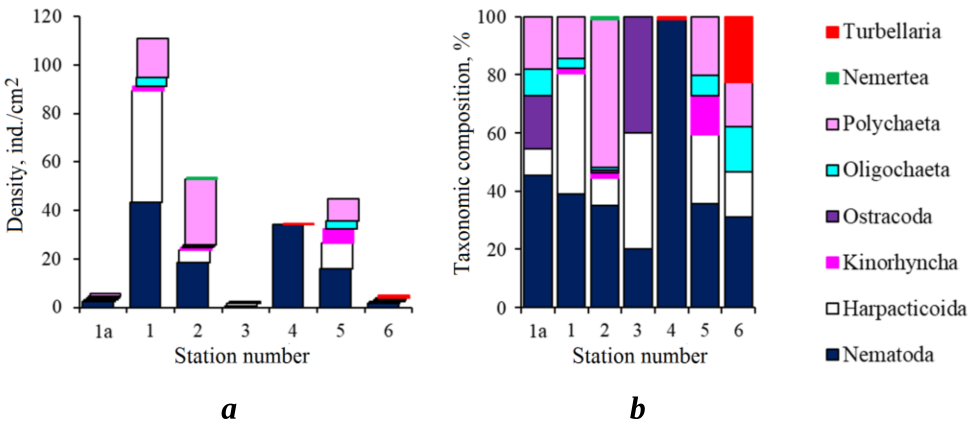
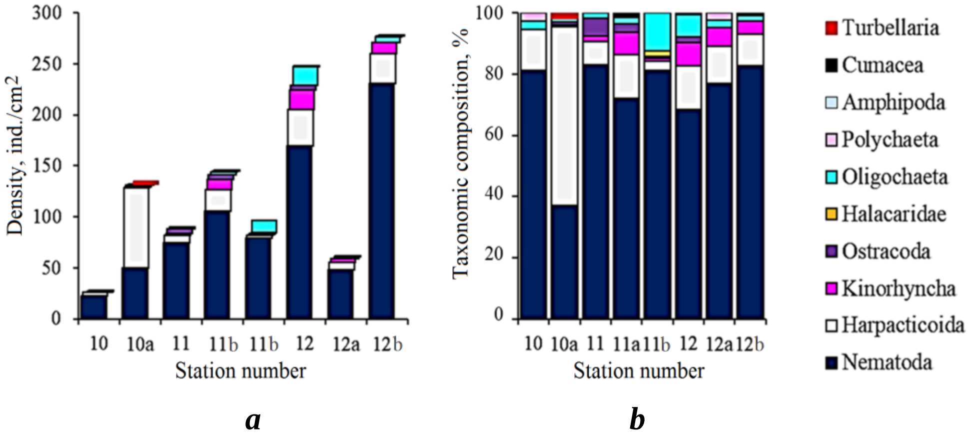


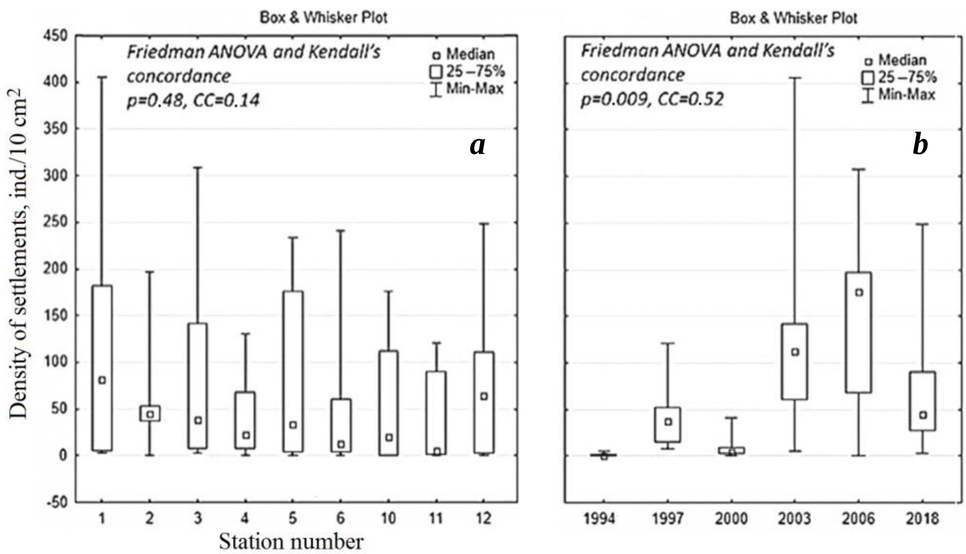
Fig. 4. Density (*a*) and taxonomic composition (*b*) of meiobenthos at the top third of Sevastopol Bay, 2018



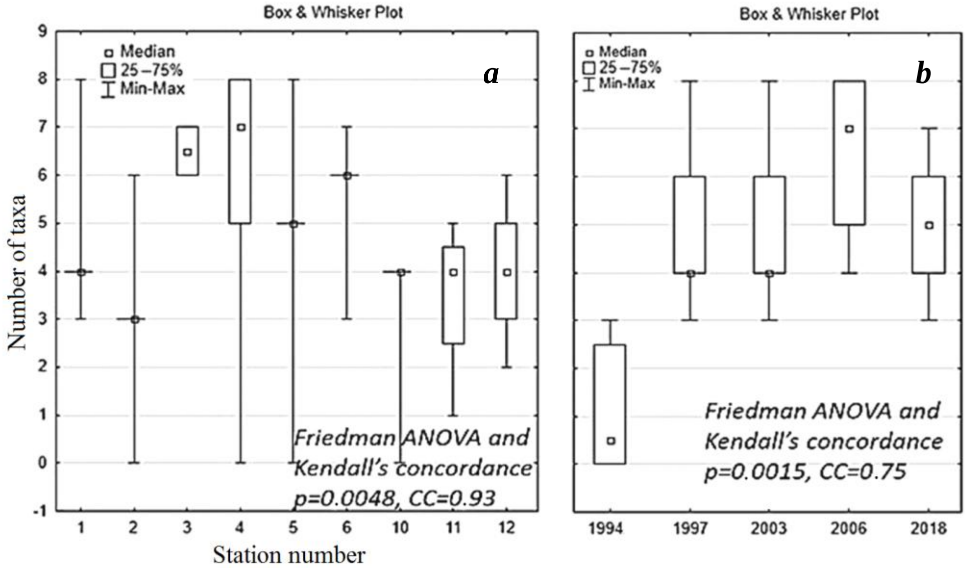
F i g . 5 . Density (*a*) and taxonomic composition (*b*) of meiobenthos of Yuzhnaya Bay, 2018

Friedman ANOVA and Kendall's coefficient of concordance were used to test the validity of the hypothesis about the spatial and interannual variability of the meiobenthos density of settlements and taxonomic diversity. Differences were considered statistically significant at a significance level of 0.05. Data processing was carried out using *Microsoft Excel* and *Statistica 12* software packages.

Analysis of variance showed the absence of statistically significant differences in the change in the density of the meiobenthos settlement at the stations of transects I, II, V (p = 0.48, concordance coefficient (*CC* = 0.14)) (Fig. 6, *a*).



F i g . 6 . Changes in the density of meiobenthos settlements at stations of transects I, II, V in 1994–2018: *a* – by stations; *b* – by years



F i g . 7 . Changes in the number of meiobenthic taxa at stations of transects I, II, V in 1994–2018: *a* – by stations; *b* – by years

Time analysis showed the reliability of differences in the density of maiobenthos in transects I, II, V in different years (Fig. 6, *b*). Thus, higher values were observed in 2003 and 2006, minimum ones – in 1994 and 2000. It was noted earlier that at the beginning of the 21st century there had been an increase in the density and biomass of meiobenthos both in the eastern part of the Black Sea and in the estuarine zone of the Danube [12, 13].

Analysis of data on the taxonomic diversity of Sevastopol Bay meiobenthos shows a significant difference both among the stations (Fig. 7, *a*) and among individual years of studies (Fig. 7, *b*).

Conclusion

The presented results reflecting the current state of Sevastopol Bay meiobenthos, have shown that the previously noted so-called depressed areas are preserved in the bottom sediments of the water area – these are Artilleriyskaya Bay and central part of Sevastopol Bay. Yuzhnaya Bay, on the contrary, in 2018 had the highest indices of taxonomic diversity and density of meiobenthic organisms' settlements. High density and diversity are also noted at the top of Sevastopol Bay.

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Contribution of the authors:

Elena V. Guseva – analysis of composition and abundance of meiobenthos, preparation of graphic materials, literature data analysis, analysis of the results and their interpretation, article composition

Sergey V. Alyomov – research problem statement, analysis and discussion of the results, manuscript editing

All the authors have read and approved the final manuscript.