ГІДРОБІОЛОГІЯ

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THE ROLE OF ENVIRONMENTAL FACTORS IN THE FORMATION OF TEMPORARY MEIOFAUNA OF THE ODESSA SEA REGION OF THE BLACK SEA

An analysis of long-term studies has made it possible to characterize the formation density of pseudomeiobenthos (temporary meiofauna) settlements depending on the substrate, depth, and seasons of the year in the Odessa Sea region of the northwestern Black Sea by the example of oligochaetes, polychaetes and juvenile mollusks. Their largest accumulations (the total density of settlements was 30865.8±5384.3 ind m^{-2}) are characteristic of the ground sand/shell, the smallest for silty substrate (averaged 11705.5±1337.8 ind.m^{-2}). The maximum indices of the total number of temporary meiofauna were recorded on depth of 10-15 m (20826.3±5010.4 ind.m^{-2}). As shown by long-term studies, the average indicators of the total number of meiobenthos are highest in the winter period. The same applies to the density of the temporary component.

Keywords: Odessa Sea region, temporary meiofauna, substrate, depth, season.

In the meiobenthic community of organisms, it is customary to distinguish the permanent and temporary components of the meiofauna [9] or in the terminology of L. L. Chislenko – eumeiobenthos and pseudomeiobenthos [8]. In terms of population density and biomass, the majority of pseudomeiobenthos in the northwestern Black Sea is represented in most cases by young bivalves and polychaetes.

V. V. Galtsova regrets that many meiobenthologists often neglect the study of pseudomeiobenthos, motivating them to have a lower abundance compared to eumeiobenthos [3]. Unfortunately for the Black Sea there are few special studies that would show the features of the formation of the temporary component of meiobenthos [2, 16]. At the same time, juvenile macrofauna can comprise a significant part of the meiobenthos biomass [15] and its products [19]. According to our data, with a favorable hydrochemical regime, the indices biomass and production are very significant. Among representatives of the temporary component, the densest clusters are characteristic of juvenile individuals of polychaetes and bivalve mollusks. Under the crisis conditions for marine benthos organisms (high anthropogenic load, oxygen deficiency in the bottom layers of the water, low salinity, etc.) their share in the total indices sharply decreases even during periods of favorable seasonal periods for the mass larvae settling to the bottom.

Material and Methods

The description of the ecological characteristics of the pseudomeiobenthos of the Odessa Sea Region is based on the analysis of 327 samples (2005–2015). The sampling area and methods for collecting and processing them are described previously [2].

Results and Discussion

The large volume of samples made it possible to establish the features of the formation of the total number of pseudomeiobenthos (temporary meiofauna) and its individual groups depending on the type of substrate on which they live. During the period of mass sedimentation, the larvae and juveniles of bivalve mollusks are characterized by mosaic patterns in the distribution of their quantitative indicators. There is a fairly pronounced selectivity of larvae of different species with respect to the substrate [7]. Of great importance are the size of the particles and the gaps between them in the bottom sediments [18]. In addition, its chemical properties are of great importance when choosing a suitable substrate for sedimentation of larvae [11, 17]. Active subsidence of larvae and successfully completed (finishing) of metamorphosis makes it possible to replenish and restore bottom communities.

On silty substratum (154 samples), prevailed oligochaetes, polychaetes and mitillids. The total number of invertebrates in this category averaged 11705.5±1337.8 ind.m-2 (maximum – 118000 ind.m-2). Polychaetes dominate, accounting for 46 % of the total number of organisms with an average number of 5343.3±914.7 ind.m-2. The subdominant group – oligochaetes (32 %), their average number was 3693.0±509.6 ind.m-2.

On the silted shell (42 samples), meiobenthos was represented by only seven large taxon, of which three belong to pseudomeiobenthos. Its total abundance was formed mainly by polychaetes (48 %) and juvenile bivalve mollusks (46 %), the average of polychaetes density reached 12439.5±3898.5 ind.m-2 (maximum 125000 ind m-2), mollusks – 12145.1±6867.0 ind.m-2 (maximum 286000 ind.m-2). The average indicator density of oligochaetes was 1466.5±541.6 ind.m-2 (maximum – 16000 ind.m-2). The low density of oligochaetes settlements can be explained by the fact that on this substrate they are poorly provided with food.

On the shell substrate meiobenthos was very poor, during our research only six large taxon were present, of which two belonged to the temporary component, which makes up 20.3 % of the total abundances of meiobenthos. The total indices density of pseudomeiobenthos organisms was formed by polychaetes and mitilides – 15815.4±9574.6 ind.m-2. The proportion of polychaetes reached 56.7 % of the total abundance of pseudomeiobenthos (7646.15±8574.2 ind.m-2).

On the ground, sand/shell pseudomeiobenthos was the most diverse, average for 11.7 % of the total abundance of meiobenthos. Oligochaetes, polychaetes, mitilides and gastropods were found, the total density of settlements of which was 30865.8±5384.3 ind.m^{-2}. Polychaetes dominated (49 %) with average 15031.3±2564.8 ind.m^{-2}, subdominant – bivalvia (30 %), the density of which was 9376.3±2605.3 ind.m^{-2}. The number of oligochaetes was 3.5 times higher than on silted shells and silted sand and 1.5 times higher than on silts (17 % of the total number of meiobenthos) with an average density (5253.1±1447.1 ind.m^{-2}. We found gastropods only on this soil.

Thus, an analysis of the data obtained allows us to conclude that the in guantities of pseudomeiobenthos is characteristic of the shell/sand substrate, which was formed by almost 50 % due to polychaetes, which generally applies to all other substrates except silty sand where they accounted for 36 %. As mentioned above, mitilides on almost all types of soil have a significant density, with the exception of silts and, to a lesser extent, shell and sand.

The work of many authors [3, 10, 12] confirms the existence of direct or indirect relationships between the number of meiobenthos in and the depth of the sea water. It should be noted that the relationship between the concentration of meiobenthos and depth is an important integral [6]. This factor is important for the northwestern part of the Black Sea, which has heterogeneous and dynamic conditions of abiotic factors. Long-term studies in the Odessa Sea region made it possible to establish the heterogeneity of quantitative indicators of the temporary component of meiobenthos even at such relatively shallow depths of the shelf zone.

From a depth of **5-**10 m, 172 samples were processed. The total number of pseudomeiobenthos at this depth was average 12839.0±2710.3 ind.m^{-2} (6.16 % of the total of the meiobenthos). Polychaetes prevailed (5417.2±852.9 ind.m^{-2}). Their share in the total population density of pseudomeiobenthos was 42 %. Young bivalvia (3721.8±907.7 ind.m^{-2}) were represented by 29 %. Oligochaetes (2753.2±852.9 ind.m^{-2}) occupied the third place with 21 %. The occurrence of gastropods was low (13.4 %), their average density of settlements on average at the considered depth

was 774.4±368.2 ind.m^{-2}.The formation of total biomass occurs both due to eumeiobenthos (62 %) and due to the temporary component (38 %). The biomass of the temporary component is mainly formed by polychaetes and oligochaetes.

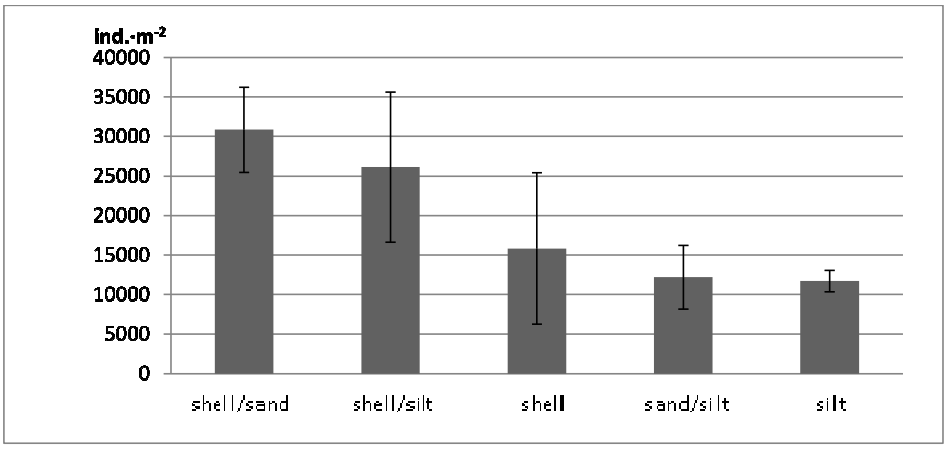

Fig. 1. Average abundance of the temporary components of meiobenthos on a different type of substrate

With an increase in depth (10–15 m), a silty substrate, silted shell, silted sand prevail. Sand with shells was rarely observed. 96 samples of meiobenthos were collected and processed. The total number of pseudomeiobenthos was 20826.3±5010.4 ind.m-2 – 7.0 % of the total number of meiobenthos. Juveniles of bivalve mollusks dominated (average 9515.5±3787.0 ind.m-2), accounting for 46 % of the total pseudomeiobenthos. Polychaetes (37 %) were the subdominant group with an average density 7789.4±1430.2 ind.m-2. The number of oligochaetes and their participation in the formation of the total number of representatives of the temporary component remained practically unchanged. The average number of gastropods was (309.3±137.8 ind.m-2), its share in the total index decreased from 6 % to 1 %.

The role of pseudomeiobenthos in the formation of the total abundance of all meiobenthos sharply decreases at depths of 16–20 m (to 2.7 %). Of the 103 stations were collected and processed at this depth, 82.5 % of the soil was represented by black, gray, and meline silts. At the considered depth, the total number of pseudomeiobenthos averaged 10128.9±1744.8 ind.m-2. Oligochaetes dominated (average 36 % of the total number of the temporary component), with an average density 3653.6±709.8 ind.m-2. Polychaetes and Bivalvia (33 % and 28 % respectively) were subdominant groups; the average 3363.4±787.6 ind.m-2 and 2834.6±898.7 ind.m-2 respectively. The average density of gastropods has not changed.

At a depth of 21–25 m during the research period, 182 stations were collected, 92.5 % of which had silty soil. The total number of pseudomeiobenthos sharply decreased and amounted to 7195.2±1333.4 ind.m-2 (2 % of the total number of meiobenthos). Polychaeta dominated with an average settlement density 507.4±993.6 ind.m-2; their share in the total number of pseudomeiobenthos reached 48 % (Fig. 1).

Subdominant in numbers was Oligochaeta and Bivalvia, whose share was 25 % and 24 % respectively. Gastropods are noted only at one station

In the spring, the occurrence of temporary meiofauna in the studied water area was 74.35%, its total number varied from 250 ind.m^{-2} to 16,000 ind.m^{-2}, averaging 4195.9±814.6 ind.m^{-2}. These indicators formed three groups of meiobenthos: oligochaetes, whose average density was 2594.2±540.0 ind.m^{-2}; polychaetes with an average density of 1062.3±224.9 ind.m^{-2} and juveniles of bivalve mollusks with an average number of 2025.8±984.3ind.m^{-2}. The proportion of pseudomeiobenthos was 1.79% of the total number of meiobenthos. The first most massive removal of sexual products from rock mussels occurs when sea water in the upper layers is heated to 8–10º C. Typically, this temperature regime in the Odessa Sea region is reached in late March and early April. Thus, sedimentation of juvenile mitilides on the ground occurs in early summer.

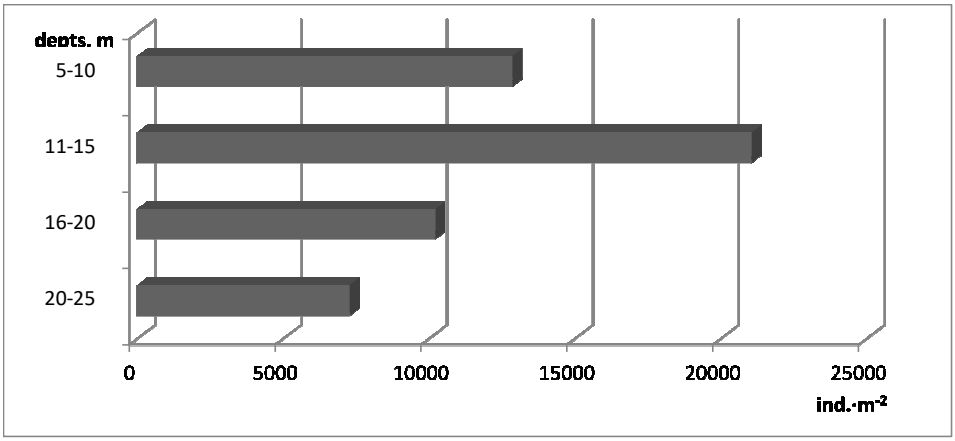

Fig. 2. Average abundance of the temporary component of meiobenthos at various depths

The occurrence of oligochaetes in the period under review was 50 %, with an average 2368.2 ind.m^{-2}, with the density of their settlements from 300 ind.m^{-2} up to 12000 ind.m^{-2}. The minimum concentration was observed on silted shells, the depth was 11–15 m. The maximum indicator was on silts, the depth was 21–25 m. The average density of oligochaetes over a long period (1994–1998, 2005) was 1748.2 ± 489.3 ind.m^{-2}.

The occurrence of polychaetes is about 55 %, the density of settlements ranged from 100 ind.m^{-2} on a silted shell at a depth of 11–15 m. At a water temperature of 9°C at the bottom and 14 ‰ salinity, 10 mg/l of dissolved oxygen at the bottom – to 15000 ind.m^{-2} (silt, depth 20–25 m). The total biomass of invertebrates was 284.9±47.6 mg m^{-2}, oligochaetes (181.63±37.8 mg m^{-2}), polychaetes dominated.

In the summer period, the total number of pseudomeiobenthos averaged 18847.8±2918.1 ind.m^{2}, its share in the total number of meiobenthos was 5.69 %. In 1982, it was only 0.8 %. These indicators may indicate that the situation in the Odessa region has now improved**.** 77 % of it was juvenile bivalves and polychaetes. The average density of settlements of juvenile mitilides is –7406.3±2036.1 ind.m^{-2}, polychaetes – 7535.9±1151.7 ind.m^{-2}, oligochaetes – 4030.9±543.5 ind.m^{-2}. The maximum (125540.6 ind.m^{-2} and 250500.2 ind.m^{-2}) were noted in 2006. The first – at a depth of 5–10 m on silty sand at a temperature of 10º C, salinity 16 ‰ with good oxygen conditions. The second – at a depth of 11–15 m witch the same good hydrochemical conditions.

In autumn, representatives of temporary meiofauna the greatest part in the formation of general indicators of the meiobenthos, they accounted for 9.14 %. Comparing this indicator with its counterpart in 1982–1983 (0.04–0.9 %, respectively), we can once again emphasize that the ecological state of the considered water area in the current period is significantly different for the better. The total number of the meiobenthos is 15289.7±3407.5 ind.m^{-2}, its maximum rate is 129000 ind.m^{-2}. Polychaetes dominated with an average density 8848.4±1912.1 ind.m^{-2}. The subdominant group in pseudomeiobenthos was oligochaetes (3282.8±844.4 ind.m^{-2}).

The average number of mitilids in the autumn is more than in the summer. Gastropoda are represented by average indices of 844.8±311.8 ind.m^{-2}.

In winter, the density of pseudomeiobenthos (29955.8±6063.6 ind.m^{-2}) was 7.3 % of the total number of meiobenthos, which was significantly higher than in other seasons. Its maximum total number was 137500 ind.m^{-2}. Polychaetes dominated (58 %) with an average density of 17701.9±3,542.9 ind.m^{-2}. In addition to polychaetes, mitilids took an active part in the formation of the total number of the temporary component; their share in the total number of meiobenthos was 39 % (11673.1±3062.4 ind.m^{-2}). The average abundance of oligochaetes and gastropods is extremely low (384.6±192.7 ind.m^{-2}.

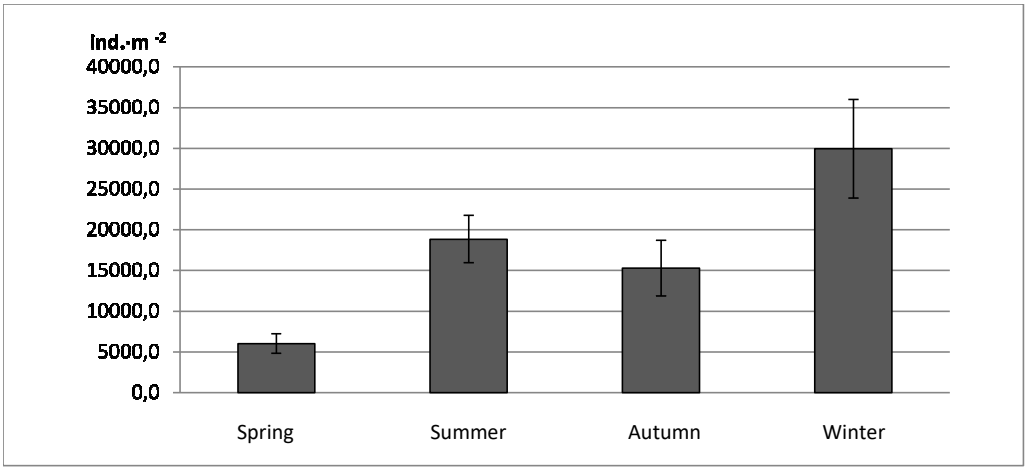

Fig. 3. Average abundance of the temporary component of meiobenthos in different seasons of the year

As shown by long-term studies, the average indicators of the total number of meiobenthos are highest in the winter period [2]. The same applies to the density of the temporary component.

Conclusions

The temporary component of meiobenthos plays an important role in the formation of the productivity of water bodies, since it serves as the main food for a number of larvae, juveniles, and adult individuals of commercial benthos fish.

Depending on the set of different abiotic factors, the dynamics of their quantitative characteristics in meiobenthos can vary significantly.

During the period of mass settling of larvae within the bottom communities, many of them, after reaching the bottom, are destroyed by adult invertebrates of bottom [13, 14, 15]. In these cases, the future structure of adult populations of certain species may be a influence on those species that are mutually neutral in adulthood [6].

Under favorable conditions for passing through the stages of metamorphosis for temporary meiofauna, the abundance and biomass of juvenile mollusks and polychaetes can play a significant role in the formation of density and biomass indices common to the entire meiobenthic community

As can be seen from the data presented, the most favorable conditions for the development of representatives of pseudomeiobenthos are in the depth range up to 16 m, then with increasing depth, the number of the considered category of meiobenthos decreases. In the Odessa Sea region a higher abundance of the temporary component of meiobenthos is noted on the shell/sand and silted shell.

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РОЛЬ ЕКОЛОГІЧНИХ ФАКТОРІВ У ФОРМУВАННІ ПСЕВДОМЕЙОБЕНТОСУ (TEMPORARY MEIOFAUNA) ОДЕСЬКОГО РЕГІОНУ ЧОРНОГО МОРЯ.

Аналіз багаторічних досліджень дозволив встановити залежність формування щільності поселень псевдомейобентосу від типу субстрату, глибини і пори року в Одеському морському регіоні північно-західній частини Чорного моря на прикладі олігохет, поліхет і ювенільних. молюсків. Їх найбільші скупчення (середня загальна щільність поселень - 30865,8±5384,3 екз. $м^{-2}$) характерні для піску і черепашки, найменше - для мулистого субстрату (в середньому 11705,5±1337,8 екз $м^{-2}$). Максимальні показники загальної чисельності псевдомейобентосу зафіксовані на глибині 10–15 м (20826,3±5010,4 екз $м^{-2}$). Як показали багаторічні дослідження, середні показники загальної кількості мейобентосу найвищі в зимовий період. Це саме можна характерне і до щільності тимчасового компоненту.

Ключові слова: Одеський морський регіон, псевдомейобентос (temporary meiofauna), субстрат, глибина, сезон.

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