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The organic matter of silt aggregates on the breakwaters in the Bays of Sevastopol, Black Sea

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Abstract

For the first time the organic substance of silts settling on the underwater base of breakwaters in Sevastopol and in Kamyshovaya bays (southwestern Crimea) was studied. On the eastern breakwater the content of total organic matter (TOM) varied from 14 to 36% (23% on the average) of the total silt mass and on the southern breakwater from 18 to 70% (38% on the average). Estimated on the inner and the outer side of the eastern breakwater the content of TOM is almost the same; on the outer side of the southern breakwater it is greater compared with the inner side that is probably due to the nearby sewage discharge outlet. Lipids are the largest fraction in the TOM on the southern breakwater and proteins on the eastern breakwater (43-44% and 4[*]5-37%, respectively).

Keywords: Total organic matter, silt aggregates, breakwaters, southwestern Crimea

Introduction

The submarine base of hydrotechnical constructions provides an additional settling area for numerous fouling organisms which increase the self-purification capacity of the seawater area and thereby change the local hydrological regimen. Bioresidue from the epibiota may increase sedimentation. Silting hampers growth of benthic organisms, e.g. mussels (Zaika *et al.*,1990), in natural environment and may similarly obstruct development of epibiota on hydrotechnical constructions. Along with the mechanical impact, chemical composition of the silt, organic fraction in particular, is also an important factor inasmuch as under decay organic substances consume oxygen and may cause oxygen deficiency.

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The results of the investigation of organic matter found in the sea water and bottom sediments of Sevastopol bay were recently reported (Mironov *et al.,* 2003a). However, scientific evidence about organic substances in silt aggregates of hydrotechnical constructions is insufficient. This paper adds to the scientific knowledge and presents results of a study of organic substances - total organic matter (TOM) and its major components (protein, carbohydrates, lipids) – in silts collected from the breakwaters in Sevastopol Bays.

Material and methods

Samples of silts were collected from the southern breakwater constructed in the mouth of Sevastopol Bay and from the eastern breakwater at the entry into Kamyshovaya Bay from May 2005 to April 2006. The southern breakwater is built of stone blocks fortified with concrete cubes in the central and the external parts (facing the open sea), and the eastern breakwater is of arbitrarily positioned concrete cubes. Samples were collected from the external and the internal sides (facing the open sea and the bay, respectively) of the breakwaters, at the basal, central and terminal parts.

Taking into consideration the total seawater depth at the sampling sites, silts were collected from three depths – 1, 7-8 and 15 m, denoted as the upper, middle and lower strata, respectively.

Figure 1 shows the position of sampling points on the submarine base of the breakwater. The number of sampling points was largest (6) in the upper stratum and less in the middle and lower strata – 4 and 2, respectively. Divers collected silt with 20-ml syringes from 2 x 2 cm-large areas on the rocks and concrete cubes. In the laboratory the content of the syringes was filtered through Sartorius membrane filters with a pore size of 0.2 mcm and then thoroughly dried. For each sample the chemical composition of silt was determined in triplicate. Proteins were determined using Folin reagent, carbohydrates through colour reaction with L-triptophane (Mironov *et al.,* 2003b) and the lipid complex was extracted using chloroform mixed with ethanol (Mironov *et al.,* 2004). Altogether, 96 samples of silt were handled.

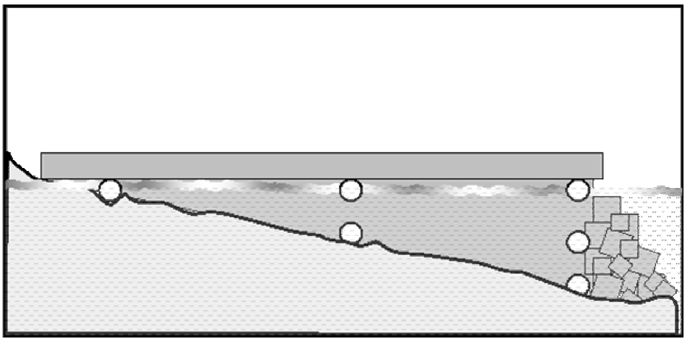

Figure 1. The scheme of the sampling points located on the breakwater

Results and discussion

Figure 2 shows the content of TOM (average estimates computed for the entire investigation period) in silts collected from the southern and eastern breakwaters. On the eastern breakwater TOM was estimated to be 25.0 ± 2.8 mg/100 mg on the internal and 21.3 ± 2.3 mg/100 mg on the external side; on the southern breakwater the estimates were 31.5 ± 2.9 and 44.2 ± 7.5 mg/100 mg, respectively. Higher estimates of TOM on the outer side of the southern breakwater are probably owing to the nearby outlet of municipal sewage discharge.

Figure 3 shows the percentage of major organic fractions in TOM of the silts. On the southern breakwater protein, lipids and carbohydrates yielded estimates which almost did not differ between the internal and external sides. Evaluated for the inner and the outer parts of the breakwater, the percentage of lipids is 43 ± 1 and 44 ± 5 %, protein - 26 ± 2 and 25 ± 1.5 %, and carbohydrates - 7 ± 2 % and 9 ± 2 %.

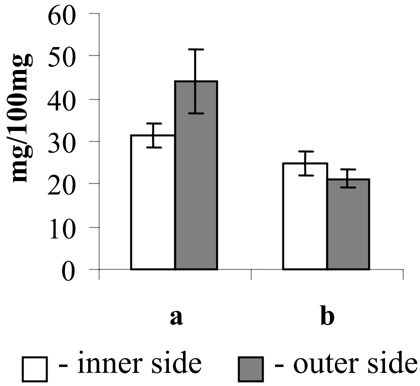

Figure 2. TOM of silts on the breakwaters:
a –southern, b – eastern

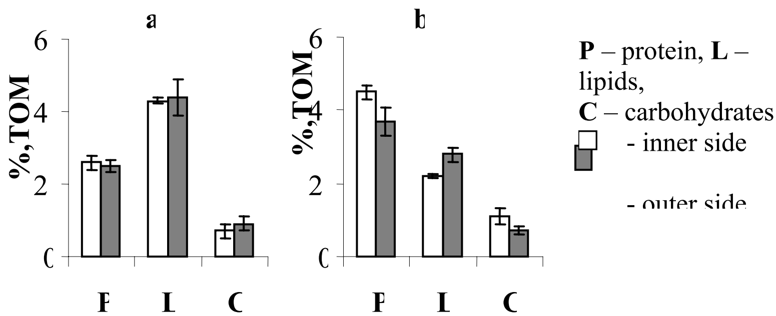

Figure 3. The portion of organic substances (% of TOM) in silt on the breakwaters: a – southern, b – eastern

On the inner and the outer sides of the eastern breakwater protein contributes the major share - 45 ± 2 and 37 ± 4 %, lipids - 26 ± 0.6 and 28 ± 2 %, and carbohydrates - 11 ± 2 and 7 ± 1 %. It is noteworthy that the contents of protein and carbohydrates were greater on the internal and that of lipids on the external side.

It is a fact that allochthonous organic substances may enter coastal sea water with urban sewage and rain-off (Mironov *et al.,* 2003a). Therefore, our study also focused on how the organic substances of silt distributed from the basal part towards the extremity of breakwater.

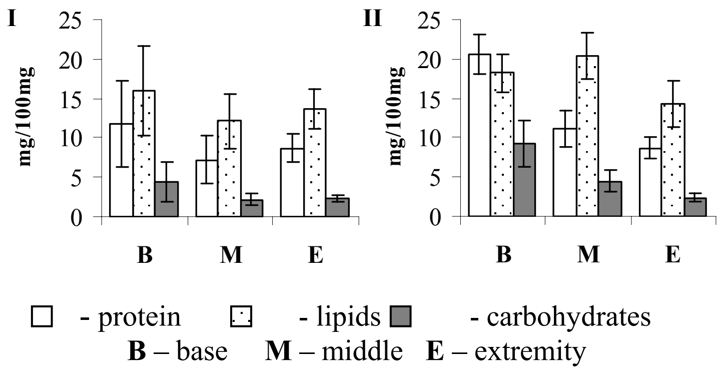

Figure 4. Distribution of the organic substances of silt from basal to terminal part of the southern breakwater: I –inner side, II – outer side

Figure 4 shows the pattern of distribution of the organic substances on the southern breakwater. The content of protein, lipids and carbohydrates reached maximum in silt on the basal part. Increased concentrations of these substances were registered on the outer side of the southern breakwater that, as has been stated above, may be owing to the effluent from the sewage outlet. Measured from the base towards the extremity, the content of protein decreased two times and that of carbohydrates four times. Measured on the internal side, the protein content decreased from 11.8 ± 5.4 mg/100 mg at the basal part to 8.7 ± 1.8 mg/100 mg near the extremity, lipids from 16.0 ± 5.7 mg/100 mg to 13.6 ± 2.5 mg/100 mg, and carbohydrates from 4.4 ± 2.6 mg/100 mg to 2.3 ± 0.5 mg/100 mg, respectively. Though the obtained estimates considerably fluctuate, the tendency towards a decrease towards the terminal part of breakwater is evident.

On the submarine part of the eastern breakwater (Figure 5) the values of these organic substances were also highest: 13.6 ± 1.7 and 12.2 ± 2.3 mg/100 mg for protein; 7.6 ± 0.1 and 7.5 ± 0.6 mg/100 mg for lipids, and 7.3 ± 1.7 and 2.8 ± 0.4 mg/100 mg for carbohydrates (measured on the internal and the external sides, correspondingly). The obtained estimates decreased almost twice on both sides towards the far end of breakwater.

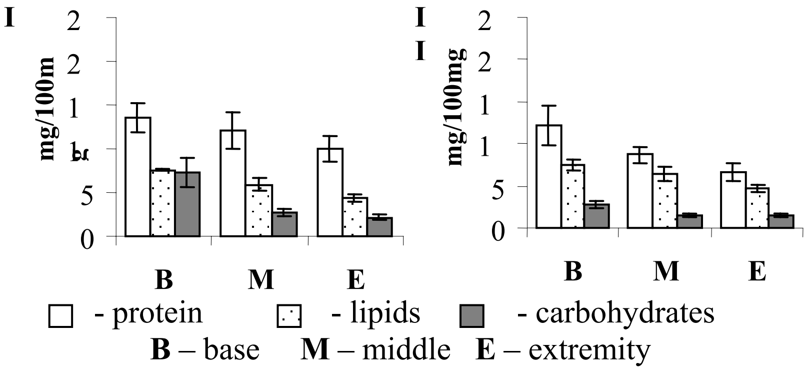

Figure 5. Distribution of the organic substances of silt from basal to terminal part of the eastern breakwater: I –inner side, II – outer side

Analysis of the data points out that the concentrations of the major organic substances decrease from the upper to the lower stratum (Figures 6, 7). The fact that higher concentrations were registered in the upper stratum is owing to the presence of autochthonous and allochthonous organic matter (Mironov *et al.,* 2003a).

As Figure 6 demonstrates, concentrations of protein, lipids and carbohydrates are high in the upper stratum on both examined sides of the southern breakwater. On the external side the content of these substances was usually greater; with increasing depth, the protein, lipid and carbohydrate concentrations decreased as markedly as 3, 2 and 5 times, respectively. On the internal side protein and carbohydrate content measured from the upper to the lower stratum decreased almost 2 and 1.5 times, respectively.

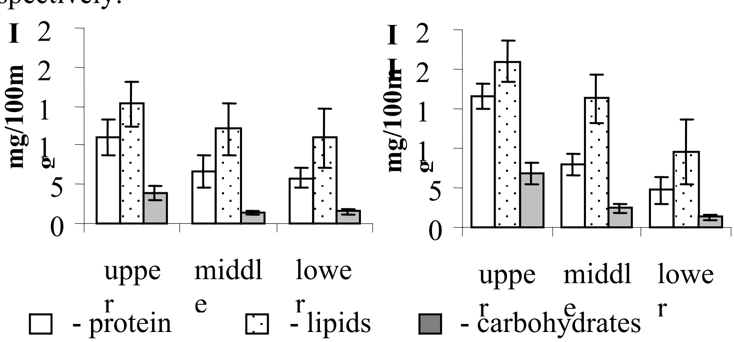

Figure 6. Distribution of the organic substances in silt by strata: I – inner side, II – outer side of the southern breakwater

On the eastern breakwater (Figure 7) protein, lipid and carbohydrate concentrations were also higher in the upper stratum. The depth-depended decrease was more evident on the inner side – the contents of protein, lipids and carbohydrates decreased about 2, 1.5 and 3 times, respectively. On the outer side lipid concentrations did not change with depth and those of protein and carbohydrates decreased 1.5 times.

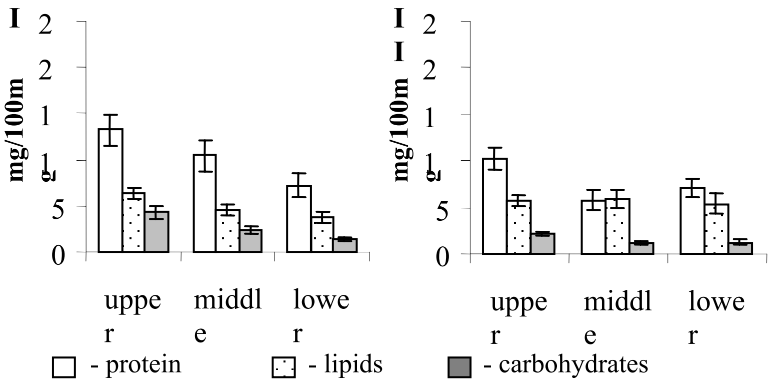

Figure 7. Distribution of the organic substances in silt by strata: I – inner side, II – outer side of the eastern breakwater

In the silty sediments collected from the sea floor close to the investigated breakwaters the ratio between carbohydrates, protein and lipids was estimated to be 2-5 : 1 : 1-4 in Sevastopol bay and 2-5 : 1-2 : 1 in Kamyshovaya bay. The labile organic matter has amylo-lipoprotein composition, i.e. carbohydrates predominate (Mironov *et al.,* 2003a). At the same time in the silt aggregates collected from the breakwaters the content of carbohydrates is significantly less than that of protein and lipids. The ratio between carbohydrates, protein and lipids was evaluated to be 1 : 4 : 6 for the southern and 1 : 5 : 3 for the eastern breakwater.

Conclusion

It is the first time the organic substance of silts settling on the underwater base of breakwaters in Sevastopol and in Kamyshovaya Bays (southwestern Crimea) was studied. On the eastern breakwater the content of TOM varied from 14 to 36% (23% on the average) of the total silt mass and on the southern breakwater from 18 to 70% (38% on the average). Estimates on the inner and the outer side of the eastern breakwater the content of TOM is almost the same; on the outer side of the southern breakwater it is greater compared with the inner side that is probably due to the nearby sewage discharge outlet. Lipids are the largest fraction in the TOM on the southern breakwater and proteins on the eastern breakwater (43-44% and 45-37%, respectively).

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