Macrozoobenthos of various habitats in the Vistula Lagoon

Abstract

Macrozoobenthos is of great importance for the functioning of water ecosystems. The participation of zoobenthos in secondary production in a water body can reach up to 90%. Benthic invertebrates interact with other ecological communities based on the principle of predation, parasitism, or competition. They also serve as food for fish and nektobenthos. Through its activity such as food intake and the related processing or organic matter and sediment burrowing (bioturbation), macrozoobenthos plays an important role in shaping habitat conditions. Knowledge in the species composition, distribution, role, and habitat and food requirements of this ecological formation in a water body is therefore vital for the understanding of ecological processes in aquatic ecosystems.

Studies to date regarding macrozoobenthos of the Vistula Lagoon have been usually conducted in the open water zone, with disregard for the littoral. Research on benthos has also been rarely conducted in the littoral of lagoons and coastal lakes in other regions around the globe. The issue of the vertical distribution of zoobenthos in the bottom sediment profiles of coastal ecosystems, particularly in their near-shore zones, is also weakly investigated.

Based on the contemporary state of knowledge, research on zoobenthos was conducted in the Vistula Lagoon in the years 2010-2014, with particular emphasis on the littoral. The results were published in four articles in Journals from the JCR list:

1. Kornijów R., Pawlikowski K., Błędzki L.A., Drgas A., Piwosz K., Ameryk A., Całkiewicz J., 2021. Co-occurrence and potential resource partitioning between oligochaetes and chironomid larvae in a sediment depth gradient. Aquatic Sciences 83(51): 1-10. https://doi.org/10.1007/s00027-021-00800-z

2. Pawlikowski K., Kornijów R., 2019. Role of macrophytes in structuring littoral habitats in the Vistula Lagoon (southern Baltic Sea). Oceanologia 61: 26-37. https://doi.org/10.1016/j.oceano.2018.05.003

3. Pawlikowski K., Kornijów R., 2022. Distribution of benthic macroinvertebrates across a reed stand in a brackish Baltic lagoon. Oceanologia 64: 433-444. https://doi.org/10.1016/j.oceano.2022.02.004

4. Pawlikowski K., Kornijów R., 2022. Above- and belowground habitat complexity created by emergent and submerged vegetation drives the structure of benthic assemblages. Oceanologia. https://doi.org/10.1016/j.oceano.2022.10.002

The objective of this study was to find answers to the following questions:

1. How does the degree of differentiation of habitats affect zoobenthos?
2. What is the effect of vegetation on the habitat and food conditions of zoobenthos in the littoral zone?
3. How is the species composition, dominance structure, abundance, and vertical distribution in bottom sediments shaped in the littoral and open water zones?

The following five research hypotheses were stated:

H_1. The species composition and density of macrozoobenthos depend on the degree of habitat diversity.

H_2. The presence of macrophytes affects the habitat and food conditions of zoobenthos in the littoral zone.

H_3. The vertical distribution of zoobenthos in the bottom sediment profile is affected by the grain size distribution of the sediments and the presence and degree of packing of root systems of plants.

H_4. The species composition and density of zoobenthos within patches of helophytes change depending on the distance from the pelagic zone, reflecting the zonality marked by the physico-chemical conditions.

H_5. The occurrence of Tubificinae and *Chironomus balatonicus* larvae in the same sediment layers is not antagonistic in character.

Depth at the study sites was 3 m in the open water zone and 0.25-1 m in the littoral. Zoobenthos samples were collected by means of a tube sampler. Sample collection was accompanied by measurements of water salinity, oxygenation, temperature, and water level. In selected terms, measurements of a number of other biotic and abiotic environmental factors were also conducted. The density of invertebrates and their biomass were determined, as well as their taxonomic affiliation.

Implementation of the study objective

1. **The degree of differentiation of habitats affects zoobenthos.** The study covered habitats with variable degrees of differentiation: the littoral – zone of emergent plants, littoral – zone of submerged plants, and the open water zone (publication 1 and publication 4). It was evidenced that the species composition and density of macrozoobenthos depend on the degree of habitat diversity (hypothesis H_1). It was also evidenced that the species composition and density within patches of helophytes change depending on the distance from the pelagic zone, reflecting the zonality marked by the physico-chemical conditions (publication 3) (hypothesis H_4).

2. **Vegetation affects the habitat and food conditions of zoobenthos in the littoral zone.** The obtained results show that in the littoral zone of the coastal lagoon that is the Vistula Lagoon, both elodeids and helophytes can modify habitat conditions (publication 2). However, strong horizontal variability of habitat conditions such as temperature, oxygenation, salinity, and content or organic matter in bottom sediments was only recorded in the reed belt. The validity of hypothesis H_2 was therefore confirmed completely for the helophyte zone, and partially for the elodeid zone. A diagram of processes and dependencies related to the occurrence of macrophytes in the study area was proposed.

3. **In the vertical profile of bottom sediments, the composition, dominance structure, and abundance of zoobenthos are shaped differently in various habitats.** Vertical distribution of zoobenthos in bottom sediments of particular habitats of the Vistula Lagoon (littoral – helophyte and elodeid zone and open water zone) depended on different factors. In the littoral zone, vertical distribution of fauna in the profile of bottom sediments was primarily affected by the grain size structure of sediments and the presence and degree of

packing of root systems of plants (publication 4), which confirms the validity of hypothesis H_3. In the open water zone, sediments were homogenous, and the vertical distribution of fauna in the sediments appeared to primarily depend on oxygen and food conditions. The relations between detritivorous Tubificinae and chironomid larvae in the same layers of bottom sediments proved non-antagonistic, which confirms the validity of assumptions of hypothesis H_5. A hypothetical model of mutual interactions between *C. balatonicus* and Tubificinae and their life activity in bottom sediments was proposed (publication 1).

Key words: littoral, coastal lagoon, species composition, vertical zoobenthos distribution, habitat conditions, macrophytes, trophic guilds