

SUMMARY

Changes of benthos and ichthyofauna composition in small lowland streams colonized by European beaver *Castor fiber* L.

The flow of water and factors associated with this parameter significantly affect the structure of benthic macroinvertebrates and ichthyofauna. A disruption of the continuity of the river flow by the construction of a dam changes the abiotic environment being the basis for the transformation of the biocenoses. In this context, the engineering activity of a beaver is an important manifestation of environment-forming activity in small mid-forest streams. Recently, ecological assessment of the role of the beaver referred mainly to the American species. Researches on the effects of the European beaver activity on the groups of aquatic organisms were less frequently performed and they concern mainly mountains or the northern parts of Europe.

The aim of this study was to evaluate the effect of dam building by the European beaver in lowland streams on benthic macroinvertebrates and ichthyofauna. Additionally, it was assessed whether the beaver ponds can act as refugia for fish during the drastic reduction of the water level in the stream. Therefore, small mid-forest streams were researched: the Kanał Białoborski, the Papiernia and the Ligejska Rzeczka, which flow through the Sandomierz Basin. The studies were conducted in 2008-2010 in 16 study sites. Five locations were selected in the Kanał Białoborski and the Papiernia, whereas in the Ligejska Rzeczka six sites. At each stream the samples were collected from three ponds located respectively in the upper, middle and lower section of a watercourse and two sites with running water: one above and the other below the beaver ponds. Due to the largest number of beaver dams in the Ligejska Rzeczka, additional sampling site was set in the beaver pond.

The temperature, pH, conductivity and oxygen dissolved in the water were directly measured in each site, while ion content in a laboratory using spectrophotometric method. Each year, benthic samples were collected three times (spring, summer, autumn) and taxonomic composition, the structure of dominance, density and biomass were evaluated. The benthic invertebrates were divided into five functional feeding groups. The assessment

of species composition, abundance and biomass of ichthyofauna were based on 5 electrofishing catches carried out in each stream. Shannon-Wiener (H') index was calculated to compare benthic and fish taxonomic diversity. Statistical analysis was performed using one-way ANOVA or non-parametric Kruskal–Wallis test. Analysis of the frequency of benthic invertebrates was based on the analysis of multi-way tables (χ^2). The data were also the subject of ordination analysis using the constrained ordering method RDA in order to detect the relationship between the occurrence of taxa and environmental variables.

Changes in physical and chemical parameters varied in the analyzed streams, but in each tested stream significantly higher values of dissolved oxygen were recorded in the lower flowing sections in comparison with the beaver ponds.

Total of 47 taxa of benthic invertebrates were found in the Kanał Białoborski, 45 in the Ligejska Rzeczka and 51 in the Papiernia. The ponds were characterized by a lower taxonomic richness in comparison with stream sections. The values of Shannon-Wiener index differed significantly only in the Ligejska Rzeczka, higher value was noted at the lower site. It can be stated, that density and biomass of benthos were higher in almost every pond compared with the flowing sections. The taxa showing significantly higher abundance and biomass in the beaver ponds in all streams were ostracods. Significantly higher abundance and biomass of Oligochaeta, Chironomidae, *Asellus aquaticus* and Ephemeroptera was observed in the ponds, while Gammaridae in the running water sections of two streams. Differences in other taxa varied among the streams. In general, collectors and predators achieved significantly higher numbers in the beaver ponds, while filter feeders dominated in the flowing water sections.

In the case of fish, abundance and biomass did not differ significantly between the sampling sites in the streams. Significantly higher values of H' index were recorded in the lower section of flowing water of the Ligejska Rzeczka, whereas in the Kanał Białoborski in the beaver pond. Stone loach and common minnow showed the highest prevalence of stability. Diminished water flow and a large depth of the beaver ponds created favorable conditions for the occurrence of species characteristic for different habitats and

geographical regions. The beaver ponds acted as refugia during the hydrological drought maintaining a high level of water in the summer.

Important environmental variables for the occurrence of the fish were shading of the stream, average water depth, age of the pond, the concentration of oxygen dissolved in water and the rate of water flow. The number of common minnow, gudgeon and sunbleak were strongly positively correlated with the average depth, age of the pond, and the surface occupied by macrophytes. The oxygen content in water influenced the number of stone loach positively.

Apart from the above-mentioned parameters, the occurrence of zoobenthos was determined by the surface of the pond, the presence of sand and the amount of sediment at the bottom of the stream and ponds. The density of mayflies, leeches, beetles and dragonflies was strongly correlated with the surface of the pond, while the density of gammarids, black flies and mussels was positively correlated with the movement of water and sand. The number of *Asellus aquaticus*, Ostracoda, Oligochaeta, Chironomidae and Megaloptera was positively associated with such variables as sediment, average depth, macrophytes and age of the pond.

Considering a small number of fish species in the streams and probable anthropogenic impact disturbing the fish structure at the sections transformed by beavers, benthic macroinvertebrates were a better indicator of changes in the groups of aquatic organisms in the study area.