

SUMMARY

Biological invasions are currently one of the most significant causes of global biodiversity loss and severe losses in the global economy. Aquatic ecosystems are particularly vulnerable to the introduction of alien species due to the ecosystems' overall resemblance, similar ecological requirements of the organisms that inhabit them and the high dispersion ability of aquatic species. The ecosystems' susceptibility to biological invasion increases as a result of anthropopressure and climate changes. The development of water transport and the construction of many artificial waterways, that connect previously isolated catchments, facilitate the spread of alien species beyond their natural range. To protect local biodiversity, it is necessary to prevent, combat and reduce the effects of the biological invasions. Knowledge of the native biocoenoses, potential interactions between alien and native species, as well as dispersion vectors of alien species and the role of humans in this process is therefore imperative.

Hydrobiological research conducted so far in the Kłodnica River has focused mainly on molluscs at the river's upper course, which flows through the heavily transformed and degraded areas of the Upper Silesian Coal Basin. Until now, no comprehensive study of benthic fauna (including alien species) along the entire length of the river, its tributaries and reservoirs located in the catchment area has been carried out. The vectors used by alien species during the colonization of this area are also poorly known. The above considerations were the reason for undertaking this research aimed at assessing the role of the inland Oder River - Gliwice Canal waterway in the dispersion of alien benthic macroinvertebrates in the Kłodnica River catchment and determining factors facilitating their colonization of aquatic environments in this area.

The research was conducted in 2017-2018 on 60 sites in the upper course of the Oder River, the Gliwice Canal, the preserved section of the Kłodnica Canal, the Kłodnica River, its selected tributaries, and three anthropogenic reservoirs related to the Gliwice Canal (Pławniowice, Dzierżno Duże and Dzierżno Małe). During the study, a total of 76906 live benthic macroinvertebrates belonging to 75 families were collected, including 45194 individuals of alien species. Among them 17 alien species were found - 2 species of polychaetes (*Hypania invalida*, *Laonome xeprovala* (sp. nov.)), 5 species of oligochaetes (*Branchiura sowerbyi*, *Potamothrix bavaricus*, *Potamothrix moldaviensis*, *Psammoryctides albicola*, *Psammoryctides barbatus*), 5 species of crustaceans (*Chelicorophium curvispinum*, *Dikerogammarus haemobaphes*, *Dikerogammarus villosus*, *Gammarus tigrinus*, *Orconectes limosus*), 3 species of snails (*Ferrissia fragilis*, *Physa acuta*, *Potamopyrgus antipodarum*) and

2 species of mussels (*Corbicula fluminea*, *Dreissena polymorpha*). 14 alien species were identified in Upper Oder River, 7 in Kłodnica Canal, 9 in Gliwice Canal, 9 in Kłodnica River, 5 in Kłodnica River tributaries, and between 4 and 8 species in reservoirs associated with the Gliwice Canal.

The range of the particular alien species varied. Some of them occurred only in the Oder River (*B. sowerbyi*, *Ch. curvispinum*, *P. moldaviensis*), others in the Oder River as well as in the initial section of the Gliwice Canal (*H. invalida*, *D. haemobaphes*, *C. fluminea*) and the estuary section of Kłodnica River (*L. xeprovala* (sp. nov)). The remaining species were found in a higher number of aquatic environments. The most frequent and numerous alien macroinvertebrates were *Potamopyrgus antipodarum* and *Gammarus tigrinus*, invasive species, which at some sites reached a density of several dozen thousand individuals per square meter. The share of non-native species in benthic fauna was diversified and ranged from less than 1% to as much as 100%. There were only 5 sites where the occurrence of alien species was not recorded.

The distribution of alien species in the study area indicates that some of them (*G. tigrinus*, *D. villosus*, *P. antipodarum*, *P. acuta* and *D. polymorpha*) could have used the Oder River - the Gliwice Canal waterway to spread along the Kłodnica River, its tributaries and reservoirs associated with the Gliwice Canal. The undertaken research enabled enumerating the species (*H. invalida*, *L. xeprovala* (sp. nov.), *D. haemobaphes*, *C. fluminea*) that occurred only in the Oder River or in the Oder River and in the initial section of the Gliwice Canal and the estuary section of Kłodnica River and which in the future may use this waterway to spread up the Kłodnica River and within its catchment area. The conducted study also confirmed the further dispersion of non-native species in the Oder River and allowed for the identification of new localities of many of them (*B. sowerbyi*, *H. invalida*, *Ch. curvispinum*, *D. haemobaphes*, *D. villosus*, *G. tigrinus*, *P. antipodarum*, *D. polymorpha*, *C. fluminea*), shifting their ranges upstream. The first locality of the alien polychaeta *L. xeprovala* (sp. nov.) in inland waters of Poland was also identified during this research - previous studies identified this species in Poland only on the Baltic coast.

The analysis of the environmental factors showed an association between the occurrence of alien species and environments with increased water salinity. The leading cause of excessive water salinity is the discharge of salty underground waters from hard coal mines to the upper course of the Kłodnica River and some of its tributaries located in the Upper Silesian Coal Basin. The results of the conducted research confirm that disturbed aquatic ecosystems are vulnerable to biological invasions.

The conducted study enabled the creation of a comprehensive description of the distribution of alien species in the Kłodnica River catchment, which may be a vector of their further dispersion to the aquatic environments of the Silesian Upland including areas transformed by industrial activities and urbanization processes. The results of the conducted research indicate the need for further monitoring of aquatic environments, especially those under the influence of anthropopressure, in order to assess the dispersion of alien species and their impact on native ecosystems and ecosystem services. The data on the distribution of alien species and the aquatic environments colonized by them will allow supplementing the data in the database on alien species in Poland. They may be useful in undertaking biological invasion prevention and social education activities.