

Algae are a diverse group of plant organisms commonly found in various aquatic and terrestrial ecosystems. These include microscopic unicellular (single-celled) organisms (e.g. plankton) and multicellular organisms, such as macroscopic algae (macroalgae), forming even several meters long thallus. They have structures similar to typical leaves or stems, but unlike other plants, they do not have roots, stems or leaves. Macroalgae, like other autotrophs, primarily transform solar energy and oxygenate the water and are an essential part of organic matter and the food webs. These organisms are very good (precise) bioindicators of changes taking place in the aquatic environment. They accumulate, e.g. toxic heavy metals, but during bloom (very intensive development), they can also cause problems with water intake and some other human activities, especially in recreation places (e.g. at beaches) and for tourist attractions (e.g. canoeing and fishing). Currently, there is no extensive and comprehensive research on the ecology of this group of organisms in the rivers of Poland. This includes taxonomic verification and a better understanding of the physiology of macroalgae in a dynamically changing climate under the influence of pollution. Macroalgae include algae that are easily visible, and their initial identification is possible by the naked eye and without specialised equipment. Initial identification of macroalgae is often based on assessing the characteristic morphology, i.e. the structure of the outer thallus. Among macroalgae, we observe high morphological plasticity resulting from the response to changing environmental factors, e.g., the river's water flow speed. That is why we plan to identify individual species using both morphological and DNA barcoding methods.

Considering their relatively small area, freshwaters are ecosystems with overall high biodiversity. At the same time, they are one of the most endangered environments due to numerous human pressures. Lowland rivers play a crucial role in shaping the diverse habitats for rare species of plants and animals, significantly increasing biodiversity. The river flow's energy, the bottom's specificity, the degree of modifications and regulation of the river bed and the land use in the nearby areas determine the species richness of aquatic organisms, including macroscopic algae. The ability of some macroalgae to attach to artificial substrates, such as concrete reinforcements on river banks, contributes to the spread of these organisms to new anthropogenic habitats. Moreover, the high levels of nutrients (nitrogen, phosphorus) in the water change the species composition of the ecosystem; e.g. an increase in phosphorus significantly reduces the richness of vascular plants and mosses. In contrast, in this condition, the occurrence and coverage of some macroalgae increase.

The project will concern the analysis of the biology of river macroalgae by defining detailed ecological and physiological requirements for individual species. Therefore, the potential use of macroalgae in monitoring the level of environmental contamination in Poland will be verified. By this, the existing methods of water ecosystem assessment using macroalgae could be more precise and consistent. Our project aims to refine and adapt them to the conditions typical for lowland rivers. The proposed field studies will determine the distribution and assessment of the diversity of river macroalgae. On the other hand, some laboratory tests will assess the demand of these organisms for oxygen and, thus, the possibility of obtaining energy depending on the mitochondria. A preliminary bioenergy description will allow us to estimate the growth rate and, therefore, the expansion potential of these plants.

The project's realisation will make it possible to obtain comprehensive information on the occurrence, abundance, distribution, morphology, and diversity of macroscopic algae in lowland rivers in Poland in an anthropopressure gradient, including climatic factors and human activity. Interactions of macroalgae with aquatic plants of other taxonomic groups are also attractive to the project. Characteristics of river habitats will consider the physicochemical parameters of water, including the concentration of specific ions and the physical attributes of watercourses. Our research will also be among the first to conduct this type of analysis in a wide range of sites concerning the relationship between the isotopic signature of water and macroscopic algae development. Ultimately, we will create models to explain the relationship of macroalgae to the environment and provide a new basis for future health and environmental assessment strategies.