Wide audience summary

Monitoring the health of ecosystems is crucial for biodiversity conservation and natural resource management. Current biomonitoring methods typically use representatives of relatively large species (e.g. macrofauna) that are easy to observe and identify and whose ecology is relatively well understood. However, these species represent only a small fraction of biodiversity and their response to rapidly changing environmental conditions is often hampered by long generation times and high adaptive potential. The aim of this project is to extend the range of marine bioindicators to include small animals and single-celled eukaryotes. These organisms dominate the seafloor where they reproduce rapidly and are very sensitive to environmental changes. However, their small size and inconspicuous appearance make their identification extremely difficult. To overcome these limitations, we will use the tools of environmental genomics, which involves identifying species based on their DNA isolated from environmental samples.

Our project will focus on two groups of animals associated with the seabed (nematodes and copepods) and a group of unicellular eukaryotes (foraminifera) that are already used for bioindication. We will analyse their diversity in the Gulf of Gdansk and the Bay of Puck, which are particularly exposed to major environmental changes related to industrialisation, urbanisation and agricultural development, and we will analyse the effects of rapidly developing anoxic conditions in the deepest regions of the Baltic Sea. We will carry out biodiversity surveys using new high-throughput sequencing technology, which allows us to obtain results rapidly and at reduced cost. Based on analyses of environmental DNA, we will select the most promising bioindicators that respond to different types of anthropogenic impacts in coastal environments and to hypoxic conditions in the deep sea. We will compare the new bioindicators with conventional ones and test their behaviour in time and space by conducting seasonal studies and assessing their geographical variability. We will also use ancient DNA preserved in sediment cores to investigate changes in biodiversity in the Gulf of Gdansk over the last century during the transition from pre-industrial to industrial conditions, and to analyse changes in biodiversity in an area of the Baltic Sea particularly exposed to increasing hypoxia. Finally, we will promote the use of these new bioindicators by conducting outreach activities to both environmental management professionals, the academic community and the wider public.

The project will open the door to more sensitive, rapid and cost-effective marine biomonitoring. The benefits of our approach lie not only in the reduction of time and costs, from sampling to data analysis, but most importantly, the new bioindicators will allow a much more accurate assessment of the state of ecological quality. In the face of rapidly increasing anthropogenic pressures, environmental managers and decision-makers urgently need new tools to effectively monitor the impact of environmental change on biodiversity. We are confident that the new ecogenomic bioindicators developed in this project will meet this need.