Micro-allies during the mega-crisis? The role of the microbiome in insect community responses to climate change

Many aspects of insect biology are determined by microorganisms (bacteria and fungi) that live on or within their bodies. These microbial symbionts can affect insects in many ways, for example, by manipulating the reproduction or providing protection against pathogens, parasites, predators, but also toxic chemicals and heat shock. At the same time, some of them are inherited across insect generations and can occasionally transmit across species. Because of these properties, **symbioses may serve as an important mechanism of rapid insect response and adaptation to changing environmental conditions.** As the climate-ecological crisis progresses, increasingly affecting natural populations and communities of insects, such dynamic relationships with microorganisms may be of particular importance. However, while rapid advances in DNA sequencing and bioinformatic techniques have allowed us to unravel many aspects of symbiosis biology, **our understanding of the diversity and importance of symbiotic relationships in natural communities is fragmentary**.

This project aims to comprehensively describe the variability of insect communities and their symbiotic microorganisms in one of the most rapidly changing regions of the world from the climate perspective - the High Arctic. More than a decade of sampling and research in the Zackenberg Valley in North-East Greenland has led to an exceptionally good understanding of this species-poor ecosystem, including the nearly complete list of species occurring there and extensive information on how they interact. During the current project, we will apply innovative molecular techniques to tens of thousands of insect specimens sampled there since 2009, as well as those that we are planning to sample between 2023 and 2025. These data will allow us to **describe changes in the composition of insect communities** in various habitat types in Zackenberg and East Greenland more broadly. For each of the insects, we will obtain information on the abundance and identity of its associated microorganisms, **describing the variability within species and the transmission of microbial strains across species**. Comparative analyses of the genomes of selected microbial strains and mathematical modeling of interspecific interaction data will allow us to **understand the symbionts' effects on the host biology and their responses to changing environmental conditions.** Finally, we will conduct a series of field experiments to assess the selected effects of symbionts on host biology.

The project will be one of the first attempts to systematically describe the distribution, diversity, transmission, and importance of symbiotic microorganisms at the level of not only single species but entire multi-species communities. **It will enable the detailed description and understanding of processes that are likely to be of key importance in natural communities, especially as they face environmental and climate changes.** The planned comparisons will make it possible to relate the results for species-poor Greenland ecosystems to those from more diverse temperate and tropical zones, including Poland. The data obtained, the extensive collection of DNA samples generated by this project, and a set of optimized methods for researching biodiversity and interspecific interactions will be a valuable resource for the international research community as it intensifies efforts to accurately describe changes that occur within ecosystems during the climate-ecological crisis.