BLUE-ICE

Sagarika Pal
Exploring Cyanobacterial Diversity and Resilience in Polar and Alpine Ecosystems

Faculty of Science
Krkonoše National Park

Cyanobacteria are a specialized and essential group of microorganisms in microbial communities that play a vital role in maintaining the ecosystems and exhibit remarkable adaptability to extreme environmental conditions. The project BLUE-ICE, aims to conduct an extensive taxonomic investigation of cyanobacteria from the Polar and alpine ecosystems. To correctly identify these organisms, a molecular-based polyphasic approach that combines morphological, ecological, molecular, and phylogenetic tools will be utilized, which offers better taxonomic resolution. This project will conduct 16S rRNA gene analysis along with the 16S-23S ITS region to study cyanobacteria from polar habitats (Arctic and Antarctic) and alpine regions (Krkonoše National Park), while also comparing the genetic diversity between the two regions. Additionally, environmental sequencing will be performed to understand the microbial communities of both the regions. To enhance ecological or functional diversity, NMR-based metabolomics will be utilized to determine the metabolic profiles of genetically identical strains cultivated under the same conditions. Considering the immense variety of bioactive compounds that cyanobacteria produce, combining molecular taxonomy with metabolomics strengthens biodiversity studies and can contribute to the development of novel metabolites with future medicinal or industrial applications. With the looming threat of rapid climate change, it is crucial to approach polar microbial life by identifying, conserving, and understanding it through this integrative method.

Sustainable Development Goals

Meet the Project

If you had to explain your project to someone outside your field, how would you describe it in three sentences?

My project BLUE-ICE is an initiative to study a specialised type of microorganisms, called cyanobacteria (an extremely diverse group and among the most important primary producers on Earth) from extreme environments like the Arctic and Antarctic, along with the Krkonoše National Park of the Czech Republic. The study intends to investigate how these microbial communities survive under extreme environmental stress, identify climate-resilient lineages, and evaluate their potential to produce useful bioactive compounds. With the growing threat of climate change, the project takes an integrative approach to better understand, protect, and potentially utilise microbial life in these fragile ecosystems

What fascinates you most about the topic of your research project?

Cyanobacteria are ancient, prokaryotic organisms that fix nitrogen and were mainly responsible for transforming Earth's early anaerobic atmosphere into the oxygen-rich one we depend on today. Even though they are one of the most interesting and important groups of microorganisms, many of these lineages remain taxonomically unresolved, making them both a challenge and an opportunity for discovering new life forms. The polar regions are one of the most climate-sensitive zones and are home to these extraordinary microorganisms. As model organisms, they reveal remarkable survival strategies under extreme stress, while also acting as sensitive indicators of climate change. At the same time, their unique metabolic capabilities make them promising sources of novel bioactive compounds with potential applications in biotechnology.

How does your research contribute specifically to achieving the UN Sustainable Development Goals?

My research contributes directly to United Nations Sustainable Development Goals, particularly SDG 13 (Climate Action), SDG 14 (Life Below Water), SDG 9 (Industry, Innovation and Infrastructure), and SDG 4 (Quality Education). By studying cyanobacteria and microbial communities in extreme environments like the polar regions (Arctic and Antarctic) and the mountain region (Krkonoše National Park), my work aims to improve our understanding of how ecosystems respond to climate change. BLUE-ICE also aims at identifying microbial indicators that can serve as early warning systems for environmental shifts. The knowledge generated here will support conservation planning, particularly for threatened microbial communities that are sensitive to global warming and ice retreat. Beyond academia, this research has strong societal and environmental relevance. It helps inform conservation strategies for fragile ecosystems, supports sustainable management of biodiversity, and explores the potential of climate-resilient microbes as sources of novel bioactive compounds for biotechnology and medicine. Additionally, the project promises improved climate and biodiversity literacy among thousands of students across Europe and India. This will contribute to long-term societal

awareness of sustainable development, empowering younger generations as informed global citizens who appreciate the value of the SDGs. Therefore, bringing scientific awareness and education about the importance of microbial life in sustaining our planet.

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