Life at the limits: diversity, adaptation strategies and bioprospecting of microbes living in Arctic deep sea habitats.

The deep sea covers over half of the Earth's surface area. With an average depth of almost 4000 meters, the deep ocean basins are the most poorly explored places on Earth. It is estimated that the deep sea contains 80% of Earth's biosphere and harbours between two million and twenty million unique species. This biosphere represents the biggest living system on Earth, distinctive in its unparalleled complexity, although, massively integrated at all levels of ecological organisation. This enormous biosphere is often being considered as the life last frontier characterized by lack of light, high pressure, limited supply of nutrients and temperatures ranging from low (2-4°C) in majority of habitats to extremely high (above 100°C) in the seabed hot hydrothermal vents. The dimension, diversity and functioning of this biosphere is almost beyond comprehension. Researchers are poised to discover previously unknown landscapes, resources and organisms through deep sea diving with manned and unmanned submersibles equipped with advanced remote sensing, sampling and analytical technologies. This allows to study life at the limits where diverse extremophilic microorganisms thrive in conditions that seem to be hostile and extreme. Now it is well-established that the life in these extreme and in-hostile environments, is fuelled by chemosynthesis - rather than photosynthesis –that they are windows into the first lifeforms to have emerged on our planet and that they represent a biosphere significant for bioprospecting and biotechnology. Unfortunately, still, the vast majority of the microbial functional and biochemical diversity operating in these habitats is hidden in uncultured and yet-uncharacterized lineages. Therefore, starting at unique biodiversities of the vents found under Norwegian waters at the Arctic Mid-Ocean Ridge, INDEPTH aims to decipher the metabolic traits and biochemical/enzymological content of this hidden reservoir. Through Polish and Norwegian complementarity and distribution, we will combine expertise on extremophilic enzymes in Gdansk (University of Gdansk) and Poznan (Institute of Bioorganic Chemistry), adaptations of extremophiles in Warsaw (University of Warsaw) and ecology and bioprospecting of hot vents in Bergen (University of Bergen). We will integrate and develop our competence in the following areas: (i) bioinformatics-based metabolic predictions and phylogeny, (ii) adaptations, and (iii) structure/function analyses of enzymes. Fundamentally important results can be expected with important impact on our understanding of the ecology, on microbial metabolism with focus on carbon biogeochemical cycling, its evolution and the underlying molecular adaptation required to live under the extreme conditions. The project workflow has the potential to unleash an enormous resource and improve the knowledge on enzymes operating under extreme conditions, similar to those that are of interest for industrial applications. Today the deep sea is also becoming a frontier for resource exploration and bioprospecting. It is clear that our future relies in many aspects of a sustainable use of marine resources and that the marine resources will become more and more important to support blue growth in Europe.