The dynamics of the development of biological soil crusts in a temperate climate and the impact of simulated extreme weather events on their physiology and biochemistry

The project concerns a comprehensive analysis of changes in ecophysiological parameters of biological soil crusts (BSCs) in various succession stages of inland sandy grasslands and the impact of simulated extreme weather events on their vitality, functioning, and physiological condition. BSCs were defined by a specialist in BSC biology, Jayne Belnap, as the "living skin" on the soil surface. BSCs create miniature ecosystems that consist highly specialised communities of different interacting organisms including cyanobacteria, algae, fungi, lichens, bryophytes, and various microorganisms. These crusts are found in arid areas around the world that cover ca 12% of the global land area. BSCs are pivotal ecological elements and play an important role in C and N cycle, contribute to the increase in soil fertility, improve soil microbial diversity, and facilitate plant colonisation. Consequently, the interest in understanding their role as ecosystem engineers has increased considerably during the past two decades. The development, ecophysiological traits and functioning of BSCs in temperate climate are still not well understood. We plan to take a holistic approach to the BSC as a whole functional unit and identify physiological/biochemical changes that occur in BSCs. Most previous research on this issue concerned long experimental time spans and focused on climate change-induced shifts in biocrust community structure. We plan to study their physiological/biochemical responses to simulated microclimatic conditions under controlled laboratory experiment to determine the impact of extreme weather events on their vitality and, thereby to recognise their adaptations to extreme conditions. Moreover, we plan to estimate the changes that will occur in them under the influence of the increased frequency of these phenomena associated with global climate change.

We plan two interconnected stages: field study and laboratory experiment. In field stage we plan to collect BSCs from 3 defined stages of spontaneous succession, **initial, middle, and late succession stages**, at three study sites located in southern Poland and study ecophysiological differences between them. Simultaneously, we will install data loggers to continuously monitor soil temperature and moisture, light conditions, and air temperature and humidity over one growing season. In the laboratory experiment we plan to determine the impact of simulated microclimatic conditions (temperature, moisture, light, humidity and rainfall) including extreme weather events on the physiological condition of the BSC as well as dominant lichen and moss species. During the 2-month experiments, the samples will be subjected to various conditions in a climatic chamber. The following physiological/biochemical analyses are planned to be performed: determination of chlorophyll, scytonemin, exopolysaccharides (EPS), ergosterol concentrations, dehydrogenase activity assay, membrane lipid peroxidation level, basal respiration rate, nitrogen mineralization, chlorophyll fluorescence measurements, determination of catalase activity and hydrogen peroxide content.

The studies in temperate regions focused mainly on floristic/phytosociological, rather than functional aspects of BSCs. Their dynamics and ecophysiology remain in fact unstudied. Little is known about the biochemical and physiological properties related to activity of the organisms that form the crusts. This project aim is to obtain the information about these properties which is crucial for understanding many of the processes taking place within BSCs formations and their effect on surrounding environment. Even less is known about their physiological response to extreme weather events. Most alarming recent reports showed that the increased temperature is predicted to reduce biocrust global coverage by 40%. Our project will allow to better understand the mechanisms responsible for this reduction at physiological/biochemical level. Since such phenomena can cause a negative biocrust C balance and death of BSC organisms, the topic seems to be of great importance. We believe that the innovative treatment of BSCs as an entire functional units will allow for a better assessment of their real condition than previous research focused mainly on responses of a single species or taxonomic group. The project will improve the understanding BSC functions in temperate climate which is especially important given the conservation value and ongoing threats to dry ecosystems, their management and restoration. It will make an important contribution to the debate on the effect of weather extremes on local ecosystems. This is particularly important given environmental problem of desertification and restoration of drylands.