ABSTRACT (ENGLISH VERSION)

Diatoms are microalgae characterised by a golden-brown colour and ornamented silica shells. They thrive in various environments worldwide ranging from aquatic marine and freshwater to terrestrial. Together with cyanobacteria and green algae, they are important primary producers in both polar regions (Arctic and Antarctica). The polar environment is characterised by extreme natural conditions, which microalgae have to overcome, such as low and freezing temperatures, desiccation, long periods of dark and irregular nutrient and liquid water availability. Many microorganisms overwhelmed by unfavourable conditions use dormancy and create stress resistant stages. Yet, freshwater pennate diatoms are not known to form such morphologically distinct stages. Despite this fact, they prosper well in many polar habitats.

This doctoral thesis presents a summary of the challenges of life in polar environments and reviews the current knowledge of survival strategies of microalgae with the focus on freezing stress. The conducted research provides a deeper insight into survival of freshwater pennate diatoms in the severe conditions of the polar environment. Their tolerance to freezing stress was evaluated experimentally under laboratory conditions and by field observations over a one-year period in Svalbard (High Arctic). Multiparameter fluorescent staining was introduced for the evaluation of the physiological status at a single-cell level. The studies found that diatoms originating from freshwater polar environments are able to survive mild freezing (−4 °C) without any harm, though they appeared to be rather sensitive to lower temperatures (−20 °C). The very low survival of severe freezing (−40 °C and liquid nitrogen) suggests that the freezing conditions in natural habitats are less extreme, which was supported by data obtained during field study temperature measurements. Furthermore, formation of resting cells was evaluated. No morphologically distinct stress resistant stages were detected. Nevertheless, vegetative-looking resting cells were induced by nutrient starvation under dark and cold conditions. Their importance for freezing survival was proved for the mild and middle freezing temperatures. Diatoms withstand laboratory freezing successfully also as common vegetative cells. Both the laboratory experiments and the field study suggested that the diatom overwintering strategy in polar environments seems to be associated with survival of a small number of vegetative cells, which later provide an inoculum for population growth in the next vegetative season.