Abstract

Filamentous green microalgae of the genus *Zygnema* belong to the most common primary producers in the polar hydro-terrestrial environment. In such unstable habitats, organisms are subject to various stress factors, e.g., freeze–thaw cycles, desiccation and high irradiation levels. However, the stress resistance mechanisms that enable *Zygnema* spp. to thrive in this extreme environment are only partially understood. Therefore, polar *Zygnema* spp. were examined under various stress conditions using both field samples and cultures. Moreover, molecular phylogeny methods were applied that provided first insights into the diversity of polar *Zygnema*. Sequencing of the chloroplast gene *rbc*L revealed several different *Zygnema* genotypes and, surprisingly, one *Zygnemopsis* sp. with vegetative *Zygnema* sp. morphology. First set of experiments examined the effects of UV exposure. It turned out that polar strains of *Zygnema* produce phenolic substances as UV screens. These substances are most likely stored in vacuoles and other vesicles at the cell periphery, providing protection for other organelles. In the next study, *Zygnema* spp. were investigated under natural conditions in the Arctic. At the end of summer, the cells gradually lose their typical vegetative appearance (with large vacuoles and stellate chloroplasts) and form pre-akinetes, which are stationary-phase-like cells filled with storage material and characterized by reduced chloroplast lobes and thickened cell walls. While all natural populations consisted of pre-akinetes regardless of their water status, significant differences were revealed in their osmotic stress tolerance. These results indicated that formation of pre-akinetes was not triggered by desiccation, but hardening during slow dehydration was required for the pre-akinetes to become stress-resistant. Subsequent laboratory experiments showed that the formation of pre-akinetes was induced by nitrogen starvation. In general, viability and recovery rate after experimental desiccation depended on pre-cultivation conditions and drying rate. Moreover, the pre-akinetes survived even rapid drying (at 10% relative air humidity) when hardened by mild dehydration stress. Presented thesis contributes to our understanding of algal stress resistance mechanisms in polar hydro-terrestrial environment. The results indicate that naturally hardened pre-akinetes play a key role in survival under extreme conditions, while the production of other types of specialized cells (e.g., zygospores) is largely suppressed. Moreover, desiccation-tolerant cells derived from disintegrated filaments can act as airborne propagules.