DESCRIPTION FOR THE GENERAL PUBLIC

Anhydrobiosis (from the Greek for “life without water”) was first described in 1702 by the Dutch microscopist Antoni van Leeuwenhoek. It is an astounding strategy that allows certain organisms including plants and invertebrate animals to survive severe dry they encounter in their environment. Strictly speaking, anhydrobiosis denotes the ability to survive almost complete drying (dehydration) without sustaining damages resulting from a tolerance against desiccation. Among animals capable of anhydrobiosis tardigrades are notable for being perhaps the most known ones and for application as a model in the phenomenon studies including astrobiology. The tardigrade phylum currently includes about 1200 terrestrial, freshwater and marine species. The terrestrial tardigrades need a film of water to be active, and therefore they are termed limno-terrestrial (also semi-terrestrial or semi-aquatic). This group of tardigrades includes most of the species undergoing successful anhydrobiosis whereas aquatic tardigrades are less capable of anhydrobiosis. The successful anhydrobiosis includes entering, permanent and leaving stages corresponding to the dehydration, tun and rehydration stages, respectively.

At present anhydrobiosis is still far from explanation despite increasing number of studies concerning the phenomena molecular basis. Moreover, the only available true evidence of successful tardigrade anhydrobiosis is successful recovery from the tun stage to the active stage. According to common hypothesis, anhydrobiosis consists in metabolic shutdown and consequently is regarded as a form of an ametabolic state. However, anhydrobiosis can be also regarded as an organized state and as such it requires some form of energy supply. It is clear that mitochondria guarantee the proper tun formation but the underlying mechanism as well as their contribution to the stage survival has not been addressed till now. Thus, mitochondria are strongly underestimated issue in the studies of cellular/molecular mechanisms of successful anhydrobiosis although the organelles are key element for cell survival. Consequently, further studies on mitochondria are required to better understand the mechanism of successful anhydrobiosis.

Therefore we are going to perform studies addressing functional and molecular aspects of mitochondria activity in specimens representing tardigrade species of anhydrobiosis different capability and anhydrobiosis different stages. Namely, the following points in question will be addressed: (1) mitochondrial energetic efficiency; (2) mitochondria mass and mitochondrial DNA copy number; (3) oxidative stress mediated by mitochondrial ROS production; (4) metabolites indicative for intracellular metabolic processes; (5) protein degradation, and (6) mitochondrial protein expression at the level of encoding transcripts. These investigations will combine environmental biology, biochemical, molecular and cell biology as well as bioinformatics approaches. Thus, bioenergetic methods will be complemented by microscopy, mass spectrometry, and bioinformatics analysis in studies based on tardigrade culturing.

Better understanding of anhydrobiosis mechanisms is crucial for development of reasonable model of anhydrobiosis and consequently indication of successful anhydrobiosis biomarkers. This, in turn, is important to build a unifying theory on “how the life without water” is biologically feasible. On the other hand, the data may contribute to development of new methods for preserving biological materials for industry and medicine as when in the anhydrobiotic state, tardigrades (and other capable invertebrates) display exceptional tolerance to physical extremes such as high and subzero temperatures, high hydrostatic pressure and even high doses of radiation. Accordingly, the results may contribute importantly to astrobiological studies because organisms which fulfill conditions for surviving open space environments require ability to be tolerant of extreme desiccation. The same may apply to survival on planet other than the Earth. Moreover, notably, it is suggested that the time spent in anhydrobiosis may be completely disregarded in the case of tardigrades that denotes that the animals do not age during anhydrobiosis (the Sleeping Beauty hypothesis). Verification of the assumption validity by estimation of mitochondria functioning, particularly during the tun stage, appears to be important for understanding of the mechanisms underlying aging described as one of the greatest social and economic challenges of the 21st century.