Pigment development in arctic snow adapted microorganisms.

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Snow algae are extremophile, psychrophillic microorganisms known from permanent snow fields in arctic, antarctic and high alpine environments. Their adaptive strategies to survive extreme temperature fluctuations, repeated dessication, low nutrient levels, large osmotic variations during freezing and thawing as well as extreme UV radiation regimes have particular relevance for the detection of extinct or extant terrestrial and extraterrestrial life and as such snow algae are an excellent terrestrial analogues for conditions at the polar ice caps of Mars. However, the specific survival strategies developed by snow algae in these extreme environments have so far been little studied.

We have carried out a comprehensive biogeochemical, spectroscopic, and genetic analyses of red snow algal communities from the Mars analogue site in the Murchison Fjord area of Svalbard (80˚N). Our data reveals that snow algae survival is dependend on the production of a suite of protective biochemical compounds including scytonemin, various carotenoids as well as specific antifreeze glycoproteins. These compounds are often located in the outher layers of the cell cytoplasm where they shield the chloroplast and nucleus and thus protect the cellular material from radiation damage. However, their distribution and function still allows the crucial photosynthethially active radiation to access the chloropyll and thus permit cellular metabolism despite the adverse radiation conditions. Previous HPLC studies on extracted pigments from snow- and other fresh water algae, showed astaxanthin – a hydroxy-keto β-carotene derivative – as the dominant carotenoid in snow algae cells. However, we show here that non-intrusive *in situ* Raman analyses of non-extracted cells only show the presence of the simpler β-carotene derivatives, zeaxanthin and canthaxanthin (the hydroxy- and keto- derivatives) as the dominant carotenoids in the red cells, while astaxanthin was not detected in the *in situ* analyses. This discrepancy as well as the isotopic, chemical and genetic results will be discussed.