In situ detection of pigments of snow algae using lightweight handheld Raman spectrometers

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Snow algae are psychrophilic organisms that inhabit suitable alpine as well as polar sites. Most common of these microorganisms is the red snow alga *Chlamydomonas nivalis* (Chlamydomonadales, Chlorophyta). Besides chlorophyll *a*, they produce high amounts of secondary carotenoid pigment astaxanthin, which serves as efficient photoprotection, antioxidant, and energy transport agent [1].

The chemical properties of carotenoids originating from biota as well as from sediments are known in depth. Few studies have been undertaken of carotenoids distribution in vivo. Classical techniques of pigment identification and discrimination are absorption spectroscopy and HPLC. Raman spectroscopy has several advantages for carotenoid work: it is non-destructive and provides spectroscopic molecular and structural information. Handheld Raman spectrometers with suitable excitation have proven recently as useful tools for detection of microbial pigments. Carotenoid pigments of halophilic microorganisms in microbial communities in hypersaline environments were detected with handheld instrument [2]. Limits of application of the Raman spectroscopy for unambiguous discrimination of carotenoids were recently highlighted as well [3].

Here, we used the light handheld Raman spectrometers equipped with 532 nm and 785 nm laser excitation to show the presence of the photosynthetic and photoprotective pigments directly on the coloured patches formed by snow algae at the sites of their occurrence in the Tyrolean Alps.

[1] Remias *et al*. (2005) *Eur. J. Phycol* **40**, 259-268. [2] Jehlička & Oren (2013) *J. Raman. Spectrosc* **44**, 1285-1291. [3] Jehlička *et al*. (2014) *Phil. Trans. R. Soc. A* **372**, 20140199.