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ASTROBIOLOGY

Extremotolerance and Resistance of Lichens: Comparative Studies on Five Species Used in Astrobiological Research II. Secondary Lichen Compounds

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Abstract Lichens, which are symbioses of a fungus and one or two photoautotrophs, frequently tolerate extreme environmental conditions. This makes them valuable model systems in astrobiological research to fathom the limits and limitations of eukaryotic symbioses. Various studies demonstrated the high resistance of selected extremotolerant lichens towards extreme, non-terrestrial abiotic factors including space exposure, hypervelocity impact simulations as well as space and Martian parameter simulations. This study focusses on the diverse set of secondary lichen compounds (SLCs) that act as photo- and UVR-protective substances. Five lichen species used in present-day astrobiological research were compared: *Buellia frigida*, *Circinaria gyrosa*, *Rhizocarpon geographicum*, *Xanthoria elegans*, and *Pleopsidium chlorophanum*. Detailed investigation of secondary substances including photosynthetic pigments was performed for whole lichen thalli but also for axenically cultivated mycobionts and photobionts by methods of UV/VIS-spectrophotometry and two types of *high performance liquid chromatography* (HPLC). Additionally, a set of chemical tests is presented to confirm the formation of melanic compounds in lichen and mycobiont samples. All investigated lichens reveal various sets of SLCs, except *C. gyrosa* where only melanin was putatively identified. Such studies will help to assess the contribution of SLCs on lichen extremotolerance, to understand the adaptation of lichens to prevalent abiotic stressors of the respective habitat, and to form a basis for interpreting recent and future astrobiological experiments. As most of the identified SLCs demonstrated a high capacity in absorbing UVR, they may also explain the high resistance of lichens towards non-terrestrial UVR.

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