Biomarkers of halophilic Archaea, Bacteria and Eukarya: Terrestrial evaluation for exobiological missions

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Salts are abundant on Mars, and therefore the understanding of halophilic microorganisms is relevant for the search for life on Mars [1]. Halophilic life on Earth is very diverse: halophiles are found in all three domains of life: Archaea, Bacteria, and Eukarya. Many halophiles contain specific molecules such as pigments, organic osmotic solutes, and special lipds that can be used as biomarkers, and many of these can be detected by Raman spectroscopy. Carotenoid pigments of halophilic microorganisms (e.g. bacterioruberins of Archaea, β-carotene of the alga *Dunaliella*, salinixanthin of *Salinibacter*) can detected with high sensitivity in hypersaline brines and entrapped within salt crystals [2-4], also using miniaturized Raman instruments [5] [6]. Most halophilic microorganisms accumulate high concentrations of organic solutes to protect the cells against extreme osmotic pressures, and these can also serve as biomarkers. Examples are glycerol, glycine betaine, and ectoine, and these all have characteristic Raman signals [7]. This enabled their detection in cultures of halophilic bacteria [8] and within the microbial biomass within an evaporite gypsum crust in a saltern evaporation pond, where glycine betaine was found as the main osmotic solute [9]. Such studies are highly relevant as a miniaturized Raman spectrometer is scheduled to fly as part of the analytical instrumentation on an ESA remote robotic lander in the ESA / Roscosmos ExoMars mission.

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