The effects of simulated extraterrestrial and ionizing radiation on halophilic Archaea. S. Leuko[1] and P. Rettberg[1], [1]German Aerospace Center (DLR e.V.), Institute of Aerospace Medicine, Radiation Biology Department, Research Group 'Astrobiology', Linder Höhe, D - 51147 Cologne (Köln), Germany. Email presenting author: stefan.leuko@dlr.de

Introduction: Within the last 50 years, space technology has provided tools for transporting terrestrial (microbial) life beyond Earth´s protective shield in order to study its responses to selected conditions of space. Microorganisms are ubiquitous and can be found in almost every environment on Earth. They thrive and survive in a broad spectrum of environments and are true masters in adapting to rapidly changing external conditions. Although microorganisms cannot actively grow under the harsh conditions of outer space or other known planets, some microorganisms might be able to survive for a time in space or other planets as dormant, inactive spores or in similar desiccation-resistant resting states, e.g., enclosed in halite crystals or biofilms. Halite crystals are the realm of halophilic Archaea as they have adapted to life at extreme salt concentrations. They can stay entrapped in such crystals for millions of years without losing viability and therefore the family *Halobacteriaceae* belongs to the group of microorganisms which may survive space travel or may even be found on other planets. This hypothesis is currently tested as part of the EXPOSE-R2 mission in the frame of the BOSS (**B**iofilm **O**rganisms **S**urfing **S**pace) proposal.

Results: Three members of this family (*Halobacterium salinarum* NRC-1, *Halococcus hamelinensis*, and *Halococcus morrhuae*) have been exposed to simulated extraterrestrial radiation as well as ionizing radiation in form of X-ray radiation. Those organisms have been chosen based on their cell morphology, different salt requirements and environments they have been isolated from. Following exposure in a liquid state and at room temperature to simulated solar radiation, results indicate that *Hbt. salinarum* NRC-1 (F_{10} 10,8 kJ/m^2) and *Hcc. morrhuae* (F_{10} 21,28 kJ/m^2) are able to withstand significantly higher doses of simulated solar radiation compared to *Hcc. hamelinensis* (F_{10} 1,56 kJ/m^2). A similar picture emerges when these organisms are exposed in a dried state. *Hbt. salinarum* NRC-1 (F_{10} 17,0 kJ/m^2)and *Hcc. morrhuae* (F_{10} 24,31 kJ/m^2) survive radiation exposure significantly better in a dried than in a liquid state. For *Hcc. hamelinensis*, drying does not increase its ability to resist radiation (F_{10} 1,78 kJ/m^2). However, when *Hbt. salinarum* NRC-1 is exposed at 4°C, the survival rate decreases dramatically (F_{10} 4,56 kJ/m^2) but *Hcc. morrhuae* does not suffer a loss of viability with a similar F_{10} value (F_{10} 19,14 kJ/m^2) compared to exposure at room temperature. Interestingly, when the organisms are exposed to ionizing radiation, *Hcc. hamelinensis* (D_{10} 1,95 kJ/m^2) and *Hcc. morrhuae* (D_{10} 2,67 kJ/m^2) are more resistant then *Hbt. salinarum* NRC-1 (D_{10} 1,42 kJ/m^2). The genomic integrity following exposure to radiation was investigated for all three organisms by means of randomly amplified polymorphic DNA (RAPD) assay. After exposure to solar radiation, only samples of *Hcc. hamelinensis* showed a strong alteration in pattern, whereas *Hbt. salinarum* NRC-1 and *Hcc. morrhuae* showed a relative stable pattern.

Conclusion: According to the obtained results it can be concluded that the natural occurring cell clustering of *Hcc. morrhuae* is very beneficial for the survival of radiation. By forming these cell aggregates, the upper layer of cells is exposed to detrimental environmental factor, however, cells within the cluster are protected and therefore allowing the strain to survive harsh conditions. Interestingly, *Hcc. hamelinensis* is very sensitive to simulated solar radiation compared to the other two tested strains. This may be due to a) *Hcc. hamelinensis* is not accumulating KCl for osmotic balance, but trehalose and betaine-glycine instead [1] b) *Hbt. salinarum* NRC-1 and other halophilic archaea have optimized their genome and proteome structure to reduce damage induced by radiation [2] and c) recent work by Gudha *et al*. (2015) [3] revealed an abundance of TC bases within the genome of *Hcc. hamelinensis*, a base combination known for being the most photoreactive [4]. Interestingly, ionizing radiation is tolerated at a comparable level in *Hcc. hamelinensis* and Hbt. salinarum, only *Hcc. morrhuae* is more resistant.

These results show that although halophilic archaea are considered resistant against radiation and desiccation, however, some members of this family don't follow this trend. It is of great interest for further research to elucidate the molecular reasons for this discrepancy in resistance to radiation.

References:

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