SURVIVAL OF HALOARCHAEA IN STRATOSPHERIC CONDITIONS.
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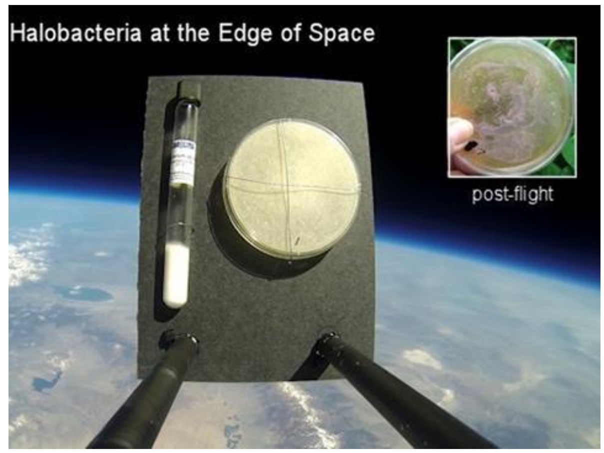
Introduction: Extremely halophilic microorganisms (also known as Haloarchaea) are well-known for their tolerance to multiple environmental extremes, including high salinity, desiccation, ionizing and ultraviolet radiation, cold temperatures, and oxygen limiting conditions [1-3]. They are ubiquitous and serve as ideal terrestrial analogs of potential extraterrestrial life forms. We are using a laboratory strain, *Halobacterium* sp. NRC-1, which is genetically tractable, and *Halorubrum lacusprofundi*, an environmental isolate from Antarctica [4], to better understand how life forms may survive multiple extremes reminiscent of Mars and space-like conditions.

Laboratory studies: A substantial number laboratory experiments have been conducted to address growth limits and molecular mechanisms of extremophily of Haloarchaea. Through comparative genomic analysis, we have established that 800 proteins in this family of microorganisms are conserved and have established their highly acidic nature [5]. Acidic proteins are able to bind more tightly to water and function at low water activity [6]. Our transcriptomic studies have established the genes which are regulated by environmental extremes [7-8], and contribute to success under extreme conditions, including several expanded gene families involved in DNA repair and replication, and gene regulation [9-11]. Finally, after a thorough analysis of a model protein enzyme, β-galactosidase, we indentified the amino acid residues important for the underlying stability at high salinity and low temperature [12].

Haloarchaea in the stratosphere: In a recent collaborative effort, we have been using helium balloons to launch Haloarchaea into the stratosphere and determine the effect on survival. These sub-orbital balloons routinely transport cultures of Haloarchaea to altitudes of 32 km. At these heights, cells are inside the ozone layer and are exposed to cosmic ray dose rates more than 40 times higher than dose rates at ground level. During these flights, temperatures drop as low as -70 ^{o}C. As a result, cells are exposed to multiple extreme conditions not easily achievable in the laboratory. Initial indications are that *Halobacterium* sp. NRC-1 is able to survive flights of 2.5 or more hours.

Conclusions: Our laboratory studies have shown that Haloarchaea are able to tolerate exposure to multiple extreme conditions in the laboratory relevant to survival in space and on Mars. Similar studies are underway for survival of Haloarchaea in Earth's stratosphere.



References: [1] DasSarma, S. (2006) *Microbe 1*, 120-127. [2] DasSarma, S. (2007) *American Scientist 95*, 224-231. [3] Leuko, S., Rettberg, P., Pontifex, A.L., and Burns, BP. (2014) *Life* (Basel) *4*, 66-76. [4] Reid, I.N., Sparks, W.B., Lubow, S., McGrath, M., Livio, M., Valenti, J., Sowers, K.R., Shukla, H.D., MacAuley, S., Miller, T., Suvanasuthi, R., Belas, R., Colman, A., Robb, F.T., DasSarma, P., Müller, J.A., Coker, J.A., Cavicchioli, R., Chen, F., and DasSarma S. (2006) *J. Astrobiol*. *5,* 89-97. [5] Capes, M.D., DasSarma, P., and DasSarma, S. 2012. The core and unique proteins of haloarchaea. *BMC Genomics 13*, 39. [6] Karan, R., Capes, M.D., and DasSarma, S. (2012) *Aquatic Biosystems 12*, 4. [7] Coker, J.A., DasSarma, P., Kumar, J., Müller, J.A., and DasSarma, S. (2007) *Saline Systems 3*, 6. [8] DasSarma P., Zamora, R.C., Müller, J.A., and DasSarma, S. (2012) *J. Bacteriol*. *194*, 5520-5537. [9] Capes, M.D., Coker JA, Gessler, R., Grinblat-Huse, V., DasSarma, S.L., Jacob, C.G., Kim, J.M., DasSarma, P., DasSarma, S. (2011) *Plasmid 65*, 77-101. [10] Boubriak, I., Ng, W.L., DasSarma, P., DasSarma, S., Crowley, D.J., and McCready, S.J. (2008) *Saline Systems 4*, 13. [11] Karan, R., DasSarma, P., Balcer-Kubiczek, E., Weng, R.R., Liao, C.C., Goodlett, D.R., Ng, W.V., and DasSarma, S. (2014) *Appl Microbiol Biotechnol. 98,* 1737-1747. [12] Karan, R., Capes, M.D., and DasSarma, S. (2013) *BMC Biotechnology 13*, 3.