ADAPTATION AND COMMUNICATION IN THE STROMATOLITES OF SHARK BAY AUSTRALIA

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The living stromatolites of Shark Bay on the western coast of Australia, represent a system where one can address fundamental questions in diverse fields ranging from microbiology, geology, evolution, chemical biology, functional genomics, and biotechnology. Australia not only has some of the oldest fossilised examples of these biotic structures but also possesses some of the most extensive living examples of these aquatic ecosystems [1, 2]. In addition to their established evolutionary significance, these stromatolites, located in a hypersaline environment, are an ideal biological system for studying survival strategies of bacteria and halophilic archaea as they are constantly exposed to high UV, desiccation, and a fluctuating hypersaline environment. To further our understanding of these geobiological structures, detailed analyses of associated microbial communities and their functional characteristics are crucial. To date ittle is know of the adaptive strategies employed by Shark bay stromatolite microorganisms. The characterisation of these strategies will give us a better insight into how particular organisms can thrive in such environments, as the morphogenesis and success of stromatolites over billions of years has been dependent on very well adapted and evolved organisms. In addition, although recent pioneering studies on cell signalling (or quorum sensing) have been undertaken on microbial mats in the Bahamas [3], analyses on this critical community phenomenon in the Shark Bay mats and stromatolites is lacking**.** Quorum sensing regulates many important microbial processes and may play a pivotal role in driving stromatolite microbial functional diversity and ultimately ecosystem function.

One of the goals of this ongoing study is to characterise adaptive and signalling mechanisms in Shark Bay stromatolite microorganisms. The focus here was a novel archeon isolated from the Shark Bay stromatolites, *Halococcus hamelinensis* [4]. Employing a range of analytical techniques including nuclear magnetic resonance spectroscopy and mass spectroscopy, mechanisms of adaptation to variable salinity was examined. In addition, a number of bioassays were employed to test for the presence of signalling compounds in both archaea and environmental samples [5]. As the level of divergence in genes involved in cell signalling or quorum sensing prevents sequence-based identification of these genes, our approach involves novel functional genomic screens that access the vast genetic and chemical diversity of these systems. A biosensor plasmid was employed that facilitates the intracellular screening of quorum sensing genes [6].

Results presented here from both genomic and physiological analyses identified specific mechanisms of halophilic adaptation using compatible solutes. Candidate genes were identified that were involved in the uptake of osmoprotectants, and funationality was confirmed by complementation studies. This work has increased our understanding of how microorganisms co-exist in fluctuating environments in response to solubilisation/precipitation or dilution/evaporation processes, resulting in a hypersaline environment. Furthermore, our work confirmed preliminary data that suggested this novel archeon produces signalling molecules. A range of established bioassays were tested, and the most reliable was a biosensor plasmid that incorporated a fluorescent marker. A number of other stromatolite isolates (including cyanobacteria and hetrotrophic bacteria) as well as environmental samples (microbial mats and stromatolites of varying macro-morphology), were also screened for signalling molecules though these results were inconclusive.

This study will set the platform for further in-depth work on adaptation and communication in the Shark Bay microbial communities, and from an astrobiological perspective this is important to provide a better understanding of essential processes affecting ecosystem function in modern stromatolite systems. Furthermore, as part of a recent Climate Change Review the impact on World Heritage Sites was assessed, and specific mention was made of Shark Bay (effects of rising sea levels/temps and ocean acidification) and the potential threats to the stromatolites. Thus obtaining a solid genomic and biochemical baseline is also intrinsic to the conservation of such a fragile and unique ecosystem.

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