Abstract of the thesis

Title of the thesis: "Thermophilic Adaptation of Phylogenetically Diverse Microbial Groups"

Terrestrial hydrothermal systems located in discrete geographical areas vary widely in their physicochemical characteristics. Commensurately, the diversity of microbial communities in such habitats also varies significantly. However, most of our concepts on hot spring microorganisms and their ecology are based on (1) springs discharging low pH, hot sulfurous fluids, generally at low flow rates, e.g. Frying Pan Spring of the Yellowstone National Park (YSNP); or (2) circum-neutral to alkaline hot springs that are typically rich in sulfide, chloride, carbonate and bicarbonate, and have overall high levels of salinity, e.g. Angel Terrace and Mammoth Hot Springs of the YSNP. Counter to theses environments, little or no microbiological information is available from relatively rare circum-neutral spring systems that discharge hot water characteristically poor in TDS (total dissolved solids), sulfide, silicate and chloride but rich in sodium, sulfur, thiosulfate, and sometimes sulfate. The main objective of this study, therefore, was to investigate the microbial diversity associated with the latter type of hot springs, both in the vent-waters as well as the vent-adjoining outflows and aprons. For this purpose, high throughput metagenomic approaches were used in tandem with pure culture and microscopic techniques. Results obtained in the course of these investigations revealed that hydrothermal vents are not thermophilic taxa-only zones, and phylogenetic relatives of mesophilic bacteria are also present near the vent mouths, and often so in proportions higher than the phylogenetically-ancient thermophilic taxa. Attempts were made to elucidate how bacteria having no thermophilic background survive and grow in near-boiling vent-waters. This led to two important revelations on the thermophilic adaptations of phylogenetically diverse bacteria: (i) the composition of the outer membranes of thermophilic bacteria have some yet-unknown characteristic feature(s) that invariably ensures the entry of such relatively-hydrophilic large molecules; (ii) habitability of hot spring environments is constrained in the same biophysical way as that for hypersaline habitats dominated by chaotropic solutes: thus in situ physico-chemical parameters, such as presence of kosmotropic solutes in the spring-waters, can help diverse bacteria, including phylogenetic relatives of mesophilic taxa, overcome thermal constraints to various degrees of success (by entropically stabilizing biomacromolecules and cell-systems), and thereby inhabit various high-temperature zones of hydrothermal ecosystems.

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