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Extremophile Dormancy: Using targeted metagenomics to identify microbial community composition in hypersaline and freshwater lakes

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Abstract

From acid seeps and deep-sea thermal vents to glacial ice and hypersaline lakes, extreme environments contain relatively simplified communities consisting of organisms that evolved to survive and thrive under adverse environmental conditions. Although microbial dormancy is thought to be a survival mechanism for microbes in extreme environments, it is unclear if microbial dormancy rates differ between extreme and neutral environments. Using salinity, pH, and dissolved oxygen levels as measurements of 'extreme,' we hypothesized that bacterial and archaeal taxa in hypersaline lake communities will exhibit lower levels dormancy than bacterial and archaeal communities in geologically similar freshwater lake controls. For our study, we defined dormancy as the difference between DNA-based communities (i.e., all microorganisms present in the community) and RNA-based communities (only the microbes which are active) and used targeted metagenomics to analyze the 16S rDNA and rRNA extracted from five hypersaline and freshwater lakes across the western United States. We also hypothesized that dormancy of the communities will be contingent on the extremity of the environment. As hypothesized, DNA-based and RNA-based bacterial communities were more similar in hypersaline ($F = 1.121$; $P = 0.09$) than freshwater lakes ($F = 19.605$; $P < 0.001$), demonstrating that hypersaline communities had more DNA-RNA overlap and therefore more activity/less dormancy compared to the freshwater controls. Salinity was the strongest environmental indicator of dormancy ($R^2 = 0.982$ $P < 0.001$) and as the salinities of the lakes increased from 0.02% to 29.87%, dormancy declined. The hypersaline lake conditions were as follows: salinity = 2.8-30%; pH = 7.8-9.8; dissolved O_2 = 59-88%; in comparison to freshwater lake conditions: salinity = 0.01-0.53%; pH = 6.6-7.5; dissolved O_2: 87-97. Our results suggest that, although bacteria living in hypersaline lakes do experience dormancy, extreme environments may create stable conditions for the majority of the bacterial and archaeal taxa to thrive.