Microbial Commnity Structure and Lake Chemistry in Lake Fryxell, Antarctica

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A steep oxygen concentration gradient affects microbial community structure in Lake Fryxell, Antarctica, a salinity-stratified, lake with high biologic productivity. The 3-5 m of perennial ice cover inhibits wind mixing and prevents gas equilibration with the atmosphere. Water just below the ice is supersaturated with oxygen due to gas exclusion during ice formation. Oxygen is produced via photosynthesis to a depth of about 10.4 m, and is consumed via respiration and oxidation of hydrogen sulfide and manganese at depth. Because chemical transport is diffusion-limited, these processes create chemical gradients in the water column and within benthic mats. The absence of physical disturbance, grazing animals, and zooplankton allow the mat communities to accumulate over decadal timescales in response to persistent, highly seasonal environmental gradients.

In 2012, mat morphology in co-varied with oxygen, light, and salinity gradients. Along the lake bottom, microbes grew in thick, layered mats. Pigmentation and morphology transition with depth in the lake and into the mat. Dissection of purple-ridged mats that grew just above the oxycline revealed consistent lamination. Their metagenomes correlate with oxygen concentration with depth in the mat, showing significantly different taxonomic and metabolic distributions. Superficial, oxygen-saturated laminae had greater abundance and diversity of photosynthetic genes, as compared to intermediate and deeper laminae. Similar correlations are expected for surface mat laminae with increasing depth in the lake. Results to date suggest that microbial populations physiologically adapt to oxygen gradients at via selection for both species and metabolic strategy, as is frequently seen in mats. Extension of analyses to spatial variations of surface mats will highlight differences and similarities in microbial responses to environmental gradients of light, oxygen and redox-sensitive ions versus depth within mats. Gradients produced in these two ways both produce selective pressure on microbial communities, constraining the spatial distribution of taxa and metabolic genes.