

Field and Diving Exploration of the Highest Lakes on Earth: Analogy of Environment and Habitats with Early Mars and Life Adaptation Strategies to UV

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We investigate the limits of life in several of the highest lakes on Earth located in volcanic craters in the Andes. Environment, habitats, short and long-term effects of ultraviolet (UV) radiation on life in shallow waters are studied. The physical and environmental conditions of these lakes are uniquely analogous to ancient martian lakes c.a. 3.5 billion years ago: 480-600 mb atmospheric pressure; -40°C to $+12^{\circ}\text{C}$ temperature range; high-UV radiation, 9-25% humidity; seasonal ice cover; volcanic environment, hydrothermal input; low precipitation; partial O₂ pressure 48-58% of sea level, and fast evaporation. They are open windows into the habitability and biological potential of ancient Mars. The 04' expedition explored and documented the Licancabur volcanic lake (6,014 m) and three neighboring lower lakes (4,500 m). We present results including: the diving expedition at the summit lake with the exploration of an ecosystem composed of red copepods; the wide distribution of cyanobacterial species found in different sub-environments at the lower lakes. A high percentage of these are heterocystous forms which show orientation and pigmentation adaptations to high UV conditions; the documentation through one year of data collection of the extreme UV environment (UVA, UVB, PAR and temperature); and the geological and geochemical environment of rapidly changing aqueous habitats sustaining high-evaporation reminiscent of the conditions on Mars at the boundary of the Noachian and Hesperian eras.