Biological Diversity of Microbial Structures in Antarctic Ice Covered Lakes. Emily D. Matys[1*], Florence Schubotz[2], Dawn Y. Sumner[3], Jonathan Eisen[4], Tyler Mackey[3], Megan Krusor[3], Kate Wall[3], Anne Jungblut[4], Ian Hawes[5], Roger E. Summons[1], [1]Massachusetts Institute of Technology, Cambridge, MA 02141, USA, [2]University of Bremen & MARUM, Bremen, Germany, [3]University of California, Davis, Davis, CA 95616, USA, [4]Natural History Museum, London, UK, [5]University of Canterbury, Christchurch, New Zealand

Introduction: Microbial membrane lipids are commonly used as molecular proxies for evaluating the composition of microbial communities [1-3]. Intact polar lipid (IPL) analysis is a rapid and non-selective method, which, in contrast to gene-based techniques, does not require prior knowledge of the community structure. Diagnostically useful lipid compound classes include cell wall and interior membrane constituents essential to the structural integrity and physiology of cells; bacteriohopanpolyols (BHPs) are a prime example [4]. To fully realise the diagnostic potential of these and other lipids, we must first understand their structural diversity, biological sources, physiological functions, and pathways of preservation.

Particular environmental conditions likely prompt the production of different membrane lipids by individual species and, ultimatly, entire communities. The McMurdo Dry Valleys host numerous ice-covered lakes with sharp and persistant physical and chemical gradients that vary in illumination, geochemical structure, sedimentation, and benthic mat morphologies. The benthic microbial communities, some of which bear a resemblance to conical stromatolites preserved in Archaen and Proterozoic strata, include novel organisms structured by nutrient availability and water chemistry. The study of these extreme environments and the organisms that inhabit them provide compelling insights into the diversity of "life as we know it", with implications for the evolution and search for life in the Universe.

We investigated the richness and diversity (taxonomic, phylogenetic and functional) of benthic microbial communities and associated accumulated organic matter in Lake Vanda, an ice-covered lake in the McMurdo Dry Valleys. We identified diverse glycolipids, aminolipids, sulfolipids and phospholipids in addition to the presence of many unknown compounds that may be specific to these particular environments. Light levels fluctuate seasonally, from continuous light in the polar summer to continuous dark in the winter, favoring low-light-tolerant cyanobacteria and specific lipid assemblages, including unusual pigments such as chlorophylls d and f. Adaptations to nutrient limitations are reflected in contrasting intact polar lipid assemblages. The abundance of membrane-forming lipids that do not contain phosphorus is of particular interest given P-limitation in Lake Vanda. Under P-limiting conditions, phospholipids are subsidiary to ornithine lipids, betaine lipids and sulfolipids.

The bacteriohopanepolyol (BHP) composition is dominated by bacteriohopanetetrol (BHT), a ubiquitous BHP, 2-methyl bacteriohopanetetrol (2-Me BHT), and X-methyl-bacteriohopanetetrol pentose (Me-BHT Pentose). The relative abundance of 2-methylhopanoids is unprecedented and may reflect the unusual seasonal light regime of this polar environment [5-7]. Minor BHP structures such as cyclitol ethers are often associated with marine sources while aminotriol, anhydroBHT, and adenosylhopane are typically associated with terrestrial communities [8]. BHPs are most abundant in the mat surfaces and decrease toward the base of the structure, probably reflecting a diagenetic profile and their relative stabilities (e.g. anhydrobacteriohopanetetrol and adenosylhopane) [9]. By establishing correlations between environmental conditions, microbial mat morphologies, microbial community composition and the lipid assemblages of microbial structures in ice-covered lakes of Antarctica's McMurdo Dry Valleys, our data will provide important ecological and evolutionary insights into these unique and fragile environments.

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