Stress mediates relative importance of deterministic and stochastic assembly in groundwater microbial communities

Daliang Ning[1]*(ningdaliang@ou.edu), **Jizhong Zhou**,[1] Zhili He,[1] Ping Zhang,[1] Joy D. Van Nostrand,[1] Liyou Wu,[1] Renmao Tian,[1] Eric J. Alm,[2] Terry C. Hazen,[3,4] Dwayne Elias,[3] Matthew W. Fields,[5] Michael W. W. Adams,[6] Romy Chakraborty,[7] David Stahl,[8] Judy Wall,[9] Adam P. Arkin,[7,10] and **Paul D. Adams**[7,10]

[1]University of Oklahoma, Norman; [2]Massachusetts Institute of Technology, Cambridge; [3]Oak Ridge National Laboratory, Oak Ridge, Tennessee; [4]University of Tennessee, Knoxville; [5]Montana State University, Bozeman; [6]University of Georgia, Athens; [7]Lawrence Berkeley National Lab, Berkeley, California; [8]University of Washington, Seattle; [9]University of Missouri, Columbia; [10]University of California at Berkeley, Berkeley.

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Project Goals: Understanding the mechanisms controlling community diversity, distribution and succession is a central, but poorly understood, issue in ecology, particularly in microbial ecology. Although both stochastic and deterministic processes are believed to play roles in shaping community diversity and distribution, their relative importance is hotly debated. The importance of ecological stochasticity in shaping microbial community composition and structure is far less appreciated. Moreover, despite recent intensive studies on ecological community assembly, the factors mediating the relative importance of deterministic vs stochastic processes in shaping community composition and structure remain elusive. Thus, the major goal of this study is to illustrate the relative roles of deterministic and stochastic processes in shaping community structure and the factors controlling their relative importance.

To determine whether and how environmental factors mediate community assembly processes, about 100 wells representative of no or low, medium, high and extremely high stress were sampled and more than 200 environmental variables were measured. Null model analysis based on phylogenetic diversity of 16S rRNA gene revealed that the groundwater microbial communities at control or low stress wells without contamination were largely stochastic (~67%). As environmental stresses increased, the communities became less and less stochastic, with 41% of stochasticity at the extremely stressed wells. Also, quantitative analysis showed that variable selection (24~49%) and dispersal limitation (25~57%) played dominant roles while homogeneous selection (7.6~10%), homogeneous dispersal (0~1.6%), and undominated (or drift) (3.9~14%) play minor roles. Environmental stresses had strong positive correlation with variable selection (r=0.96), and negative correlations (r=-0.93) with dispersal limitation. Interestingly, drift (e.g. undominated) were higher at both low (8.6%) and extremely (14%) stressed wells than medium (4.7%) and high (3.9%) stressed wells. The spatial patterns of various processes were consistent with spatial distributions of various contaminants. In addition,

further statistical analyses indicated that selection on the groundwater microbial communities was largely imposed by heavy metals, oxygen, pH, and some anions (e.g., phosphate), whereas dispersal limitation was significantly correlated with geographic distance. Collectively, our results revealed stress mediates relative importance of deterministic and stochastic assembly in groundwater microbial communities.

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