Impact of Corrinoids on Soil Community Assembly in a Grassland Soil

Zachary F. Hallberg (zhallber@berkeley.edu),[1] Zoila I. Alvarez-Aponte,[1] Alexa M. Nicolas,[1] Mary K. Firestone,[1,2] Hans K. Carlson,[2] and **Michiko E. Taga[1]**

[1]University of California, Berkeley
[2]Lawrence Berkeley National Laboratory, Berkeley, CA

http://tagalab.berkeley.edu

Project Goals: The overall goal of this research is to gain a deeper understanding of the microbial interactions that drive soil community structure. This research leverages a model group of key metabolites related to vitamin B_{12}, known as corrinoids, to investigate microbial interactions. Corrinoids are a structurally diverse nutrient class shared between different bacterial species, as they are produced by only a subset of the bacteria that use them. Based on the inherent specificity of bacteria for particular corrinoids, the hypothesis driving this work is that corrinoids are keystone nutrients in shaping soil microbial communities. To test this hypothesis, we are examining the effects of corrinoid addition on community composition and function across multiple levels of complexity. By investigating cycling of a key nutrient in soil at levels spanning the whole community to individual isolates, this work will reveal an unprecedented view of metabolic interactions in a soil microbial community.

Nutritional interactions in the soil microbiome drive critical environmental and ecological processes including biogeochemical cycling and plant growth. Identifying key nutrients that could predictably modulate soil communities is an attractive way to impact these processes. Nevertheless, the complexity of the soil milieu and diverse microbial community composition make it impossible to experimentally analyze all microbe-microbe interactions simultaneously using current analytical methods. We aim to identify key microbe-microbe interactions by unraveling the nutrient network produced by corrinoids, a group of structurally diverse metabolites used by a majority of the community. Exemplified by its flagship member, Vitamin B12, corrinoids are essential cofactors produced only by a fraction of the bacteria that use them, and thus are shared metabolites. Unlike other shared nutrients, corrinoids are structurally diverse: at least 16 distinct corrinoids have been described. Our group and others have shown that bacteria that play central roles in bioremediation, plant-bacteria symbiosis, and elemental cycling possess preferences for distinct corrinoids. Thus, corrinoids appear to be an ideal nutrient by which we can pinpoint specific microbial interactions.

Here, we test the hypothesis that corrinoids are a key nutrient family that shape soil microbial ecosystems, by determining the impact of corrinoids on soil-derived enrichment community assembly. We find that vitamin B12 is the primary corrinoid present in grassland

soils. Reflecting this, B12 addition causes marked changes to enrichment culture assembly over extended time periods. Further inquiry demonstrates that inoculation conditions drastically alter the corrinoid dependence of enrichment cultures. Enrichment communities at high inoculation levels remain stable to nutrient shifts, whereas low inoculation levels begin to impart stochastic effects. Our work identifies a subset of corrinoid-limited taxa that can be leveraged to understand nutritional networks in soils, and empowers the future study of *in vitro* soil-derived enrichment communities to further understand nutrient sharing.

This research is funded by the DOE Genomic Sciences Program Grant DE-SC0020155 (to MET).