70. Soil Metabolomics to Decipher the Metabolic Foodwebs in Biological Soil Crusts

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https://portal.nersc.gov/webofmicrobes/

Project Goals: The goal of this project is to understand the small molecule composition of biological soil crust organic matter and the specificity of soil microbes towards specific soil metabolites.

Biological soil crusts (biocrusts) are communities of organisms inhabiting the upper layer of soil in arid environments. The crust itself is essentially microbial exopolysaccharide (EPS) linked sand particles and is critical to soil stabilization. Biocrusts persist in a dessicated dormant state for extended periods with rare pulsed activity events following precipitation. Microcoleus vaginatus, a non-diazotrophic filamentous cyanobacterium, is the key primary producer in bacterially dominated biocrusts in the Colorado Plateau and is an early pioneer in colonizing arid environments. Over decades, biocrusts proceed through developmental stages with increasing complexity of constituent microorganisms and macroscopic properties. Since Microcoleus vaginatus does not fix nitrogen, metabolic interactions with other biocrust microorganisms in the Microcoleus vaginatus-associated 'cyanosphere' presumably play a key role in the cycling of soil organic matter and in determining biocrust community dynamics.
Mass spectrometry-based soil extraction methods were developed in order to characterize the metabolite composition of biocrust. Chloroform fumigation of soil prior to extraction with water allowed the detection of the broadest range of intracellular and extracellular metabolites (amino acids, carboxylic acids, nucleotides, sugars, sugar alcohols, and fatty acids). To determine substrate preferences of key soil bacteria, exometabolomics analysis was performed using liquid chromatography coupled to mass spectrometry. Sixteen bacterial isolates were incubated in minimal media containing biocrust extracts and metabolite profiles were compared to uncultured fresh media to identify uptake and release of metabolites by specific microbes and these data are made available through our new exometabolomics data repository, the Web of Microbes (webofmicrobes.org).
Ultimately we anticipate that linking exometabolite cycling to specific microbes will prove to be invaluable datasets for both functional genomics and understanding soil carbon cycling.

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