Phenolic acid-degrading populations of *Paraburkholderia* prime decomposition in forest soils

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Project Goals

Our project aimed to characterize the microbial populations involved in the metabolism of plant-derived carbon (C) and their influence on soil carbon cycling. We targeted the ecological and functional traits of phenolic-acid degrading bacteria, since phenolic acids are a major component of plant root exudates and lignin. These populations have also been recently identified as contributing to the soil priming effect, in which exogenous C stimulates the mineralization of endogenous soil organic carbon (SOC). We used stable isotope probing, metagenomics and culturing to link the ecology of phenolic-acid degrading bacteria with soil C-cycling.

Abstract

Plant-derived phenolic acids are metabolized by soil microorganisms whose increased activity can prime the decomposition of SOC. We characterized bacteria that enhanced SOC mineralization in forest soils when primed with ^{13}C-labeled *p*-hydroxybenzoic acid (PHB). We investigated whether PHB-induced priming could explain differences in SOC content among mono-specific tree plantations in a 70-year-old common garden experiment. A set of closely related *Paraburkholderia* and *Caballeronia* phylotypes dominated PHB degradation in all soils despite large differences in community composition with respect to tree species and soil type. We isolated the principal PHB-degrading phylotype (*Paraburkholderia* sp. RP11^{T}) and found it encoded a large number of oxidative enzymes (laccase, peroxidase and dioxygenase) and confirmed its ability to degrade phenolics. RP11^{T} uniquely encoded paralogs of the enzyme responsible for PHB oxidation (*pobA*). The RP11 phylotype (RP11^{ASV}) increased dramatically in relative abundance (23-fold) after PHB amendment, corresponding with the priming of 3 - 13 µmols C g^{-1} dry wt soil of native SOC. In contrast, glucose amendment reduced SOC mineralization by -3 to -8 µmols C g^{-1} dry wt soil. RP11^{ASV} abundance and *pobA* expression correlated with PHB respiration rates and were inversely correlated to *in situ* SOC accumulation. The metabolic state of RP11^{T} cells was critical for priming, which occurred solely during PHB respiration. We conclude that the metabolism of plant-derived phenolic acids stimulates soil priming with potential impacts on SOC cycling.

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