Principles for Successfully Engineering Microbial Community Functioning

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Project Goals

1) Test the relative importance of the environment, inoculation frequency, inoculation dose, the resident consortia, and the introduced consortia in driving microbial composition and functioning after microbial community introductions
2) Establish predictive links between microbial composition and functioning, in particular with relation to carbon flow during decomposition

Abstract

With increasing frequency, humans are manipulating microbial communities, introducing microbial consortia to new locations to achieve desired functional outcomes. Examples include modification of human gut flora for better human health, bioreactor microflora to improve waste degradation, and agricultural soil microbes for pest and disease control and/or increased carbon sequestration. Feasibility depends on the predictable establishment, persistence, and performance of inoculated microbial communities. However, the parameters for successfully engineering microbial community functioning are not well understood. Consequently, manipulation of microbial consortia continues to be a trial-and-error endeavor with low success rates. Here, we targeted the application of microbial control of plant litter decomposition, a focus of the LANL SFA program in Microbial Carbon Cycling, which aims to inform climate modeling and enable carbon management in terrestrial ecosystems. In this study we used a high-throughput laboratory microcosm experiment to test the relative importance of the environment, inoculation frequency, inoculation dose, the resident consortia, and the introduced consortia in driving microbial composition and functional outcomes after microbial community introductions. We found that fungal and bacterial introduction dynamics differ, where resident consortia played a larger role in shaping bacterial communities, while introduced consortia were more important in fungal community assembly. In terms of functional outcomes, CO_2 production was driven by dose, as well as both resident and introduced consortia, but not their interactions, while dissolved organic carbon (DOC) production was driven primarily by the environment and to a lesser extent by dose, and invader consortia. In addition, greater CO_2 production was correlated with increased bacterial richness and decreased fungal richness. Overall, identifying general ecological principles surrounding the establishment and resilience of introduced microbial communities can be used to advance applications in engineering microbial communities.

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