m-CAFÉs EcoFABs: Model Ecosystems to Advance Microbiome Science I

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http://eco-fab.org

Project Goals: To derive mechanistic understandings of plant-microbe-soil interactions using reproducible, simplified ecosystems

The m-CAFÉs program is a collaborative, coordinated and integrated, mission-driven program to interrogate the function of soil microbiomes with critical implications for carbon cycling and sequestration, nutrient availability and plant productivity in natural and managed ecosystems. One of the major challenges for generalized understanding of microbiomes in these complex ecosystems is extreme variation in microbiomes and environmental conditions. In many fields, simplified model systems have been developed and adopted by many researchers to accelerate the study various aspects of biology. In contrast, there is no agreed upon model system for studying soil microbiomes, and thus, nearly every researcher in the field is studying a different soil system. This heterogeneity of study systems and an inability to replicate experiments in different laboratories limits determination of causal mechanisms and the ability for scientists to build on each other's work.

Beneficial plant-microbe interactions offer a sustainable biological solution to potentially boost low-input food and bioenergy production. However, to maximize the benefit of these plant-microbe interactions, better mechanistic understandings of these complex ecosystems are needed. Here, we present a detailed description for the production of controlled laboratory habitats (EcoFABs - http://eco-fab.org/) for creating and manipulating plant-microbe ecosystems under specific environmental conditions. EcoFABs consist of an autoclavable microfluidic chamber and modular, expandable housing units to accommodate a variety of plant species that are produced using widely accessible materials and technologies (i.e., PDMS structures from 3D-printed molds) which allows for reproducible construction of these devices without a large investment in specialized equipment. These flow-through devices allow for controlled manipulation and sampling of root microbiomes, root chemistry as well as imaging of plant root zones to examine root morphology and localize its microbial communities. This protocol includes details for the construction and sterilization of the EcoFAB system as well as methods for the manipulation of the EcoFAB chamber to vary the media, including soils, sand and liquid growth media. The versatility in the analyses methods and environmental composition available in these systems enable dynamic and detailed investigation of plant and plant-microbial consortia

including manipulation of microbiome composition (including mutants), monitoring of plant growth, root morphology, exudate composition, and microbial localization under controlled environmental conditions.

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