Title: TEAMS: Advancing microbiome science through high-throughput, automated EcoFAB experiments

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Project Goals: Short statement of goals. The vital role soil and plant microbiomes play in ecosystems is increasingly apparent, yet the lack of standardized and reproducible experimental systems represents a major challenge for microbiome science. Fabricated ecosystems (EcoFABs) are sterile devices that provide unique capabilities in the control and measurement of simplified microbial communities with tremendous potential to advance a mechanistic understanding of soil and plant microbiomes. The Trial Ecosystems for the Advancement of Microbiome Science (TEAMS) project is creating, validating, and disseminating EcoFAB technologies, complete with standardized model microbial communities, that are tailored for users of DOE's unique resources and user facilities such as EMSL, JGI, KBase, and NMDC, as well as other DOE stakeholders. EcoFAB technology is being distributed as EcoFAB kits that have been validated through multi-laboratory reproducibility studies, through development the EcoBOT which automates EcoFAB experiments for the highest degree of standardization, and online resources. Together, these standardized and reproducible experimental capabilities will help advance mechanistic microbiome science.

Abstract text: We have developed a new EcoFAB device, 'EcoFAB 2.0' to facilitate widespread EcoFAB studies including those performed on secure, automated platforms. EcoFAB 2.0 is largely constructed out of injection molded polycarbonate and has the same footprint as a 96 well plate that makes it compatible with robotics platforms and many instruments. Like the original EcoFAB devices[1], the EcoFAB 2.0 has a root/soil growth area that allows for visualization of the plant roots and rhizosphere including microscopic analyses to track fine changes in root morphology and microbial colonization. Injection molding provides improved reproducibility (vs. 3D printing), enables use of higher performance materials, and can easily produce parts for thousands of devices. In addition to these features, EcoFAB 2.0 also has a built-in plant chamber with external sampling ports so the plant remains in a sterile environment during imaging and collection of plant exudates. EcoFAB 2.0 and a customized EcoFAB developed at PNNL to provide microenvironments will be used in a series of multi-laboratory microbiome ring-trials to assess the reproducibility of observations made when studying defined microbial communities. The TEAMS project is also developing the EcoBOT, an automated platform for high-throughput, standardized EcoFAB studies. The EcoBOT integrates a liquid handling unit with a plant growth chamber that will house over 150 EcoFAB devices, an

epifluorescence, inverted microscope and a hyperspectral imager. The EcoBOT will accelerate mechanistic plant microbiome studies by enabling highly standardized EcoFAB experiments.

References/Publications

1. Gao J, Sasse J, Lewald KM, et al. Ecosystem Fabrication (EcoFAB) Protocols for The Construction of Laboratory Ecosystems Designed to Study Plant-microbe Interactions. J Vis Exp. 2018;(134):57170. Published 2018 Apr 10. doi:10.3791/57170

Funding statement: This material by TEAMS – Trial Ecosystems for the Advancement of Microbiome Science is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Biological & Environmental Research under contract number DE-AC02-05CH11231 to Lawrence Berkeley National Laboratory.