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From Pairwise to Community-Level Interactions: Insights from Engineered Bacterial Strains

Microbes thrive in diverse communities of hundreds to thousands of species, interconnected through a complex network of interactions. These interactions are fundamental to ecosystem stability, environmental health, and climate regulation. While pairwise microbial interactions have been extensively studied, a key open question in ecology is how these interactions evolve within complex communities comprising multiple species. Here, we combine numerical simulations and experiments to investigate the mechanisms underlying interactions among three bacterial species. Using a custom-designed microfluidic device, we track the spatiotemporal dynamics of a community composed of mixed single and double amino acid auxotrophs. Specifically, we examine how pairwise interactions between single auxotrophs shift in the presence of a third species that is either auxotrophic for both exchanged amino acids or for a complementary amino acid. By tracking community dynamics and spatial organization, and integrating our findings with simulations, we infer the mechanisms linking community dynamics to single-cell leakage and uptake of metabolites. In this talk, I will introduce our experimental setup for studying interactions among three bacterial strains and present observations highlighting how dynamics in three-species communities differ from simple pairwise interactions. Specifically, I will show that introducing a third species alters resource exchange and spatial organization in ways that cannot be explained by a straightforward combination of pairwise outcomes.

Role

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