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Cross-feeding dynamics in microbial communities under different environmental

Microbial communities are known to play an extraordinary role in maintaining life on our planet. Such communities are characterized by a complex network of interactions and typically reside in environments that fluctuate over time. For example, natural bacterial isolates positively interact by exchanging building blocks: bacteria are often unable to produce one or more amino acids (auxotrophs). The current understanding is that the auxotrophs rely on the production and leakage from partner cell types to grow (cross-feeding). However, many aspects of how such interactions are maintained under fluctuating environmental conditions and what the role of the partner cells is are currently not understood. Here, we adopted a bottom-up approach by studying simplified consortia composed of either bi- or uni-directional crossfeeding auxotrophic partners in spatially structured systems. We coupled microfluidics experiments to extract single-cell growth dynamics over space and time with mathematical models. We found that cross-feeding bacteria interact locally and the range of interaction changes over time in response to fluctuations in environmental conditions. Intriguingly, our mathematical model provided predictions on the environmental conditions that foster and promote cross-feeding interactions. This work deepens our comprehension of microbial symbiosis and sheds light on the intricate strategies employed by these communities to navigate the ever-changing landscapes they inhabit.

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