

Investigating mechanisms explaining coexistence in microbial communities: focusing on ecological interactions

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Short project Description

Controlling microbial communities may have enormous benefits for human health, bioremediation, land use or biofuel production. It is recognized that some important challenges could be addressed with a rational management of complex natural communities. This has motivated a surge in the interest for the mathematical modelling of microbial communities, following different approaches. The development of models using ODEs in which both species and metabolites are monitored throughout the dynamics have been the focus of intense research. However, models differ in their assumptions, and the consequences of these assumptions are often ignored. In this project, the student will study different models to understand how different assumptions lead to different results. We are particularly interested in understanding how these assumptions may influence the relative role of competitive vs. mutualistic interactions in the stable coexistence of model ecosystems. This is an intriguing question, given the vast biodiversity observed in natural microbial communities. The student will follow a strategy we exploited in the past for macroscopic organisms, where we found remarkable results explaining the architecture of biodiversity (see e.g. [1, 2]). The project can also follow different avenues to explore how these models can be expanded to study specific questions, such as antibiotic resistance or pathogenesis.

[1] Pascual-García, A. and Bastolla U. (2017) Mutualism supports biodiversity when the direct competition is weak *Nature Commun.*, 8, 14326

[2] Bastolla, U., Fortuna, M. A., Pascual-García, A., Ferrera, A., Luque, B. and Bascompte, J. (2009). The architecture of mutualistic networks minimizes competition and increases biodiversity. *Nature*, 458(7241), 1018-1020

Scope: Master Project. Fair programming skills are required, and being comfortable with the analysis of differential equations is desirable.