Feedback loops between traits under selection and the environment in batch experimental evolution: a mathematical analysis

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Non transitivity of fitness and the emergence of correlations between traits in seasonal environments: a modeling approach.

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In complex environments, such as seasonal environments, adaptation relies on several traits interacting with the environment. In particular, selected populations may affect the environment, leading to eco-evolutionary feedbacks.

Using an ordinary differential equations model of a batch experimental evolution of the yeast *Saccharomyces cerevisiae* (Spor et al, Evolution, 2014), we explored the link between selection, traits and environmental changes and their potential consequences on evolutionary dynamics of traits. Our model integrates a fermentation season where glucose is consumed and ethanol produced, a respiration season where ethanol is consumed, and finally a mortality phase when resources are exhausted. Competition between strains is modeled as competition for resources and production of ethanol which is both a resource and a toxic compound. The length of each season depends on the population density and metabolism of the yeast strains via the consumption and release of resources. Hence, our model includes both population phenotypic variations and demography. To investigate the relation between traits and environment, we proposed a decomposition of the fitness function into terms related to season length and transition between seasons. We showed that a long season increases selection on the growth rate during that season and that traits driving responses to environmental changes are also under selection. This decomposition offers a simple tool to explore the outcome of competition between strains and to highlight different types of feedbacks between environmental changes and selection pressures. We will present these different feedbacks and discuss their impact on life-history traits evolution, notably including (i) **non transitivity** of relative fitness and (ii) the possible **emergence of relations** between life-history and metabolic traits during evolution.