MEP project: Conceptual mapping of the relation between self-organization and natural selection in evolution

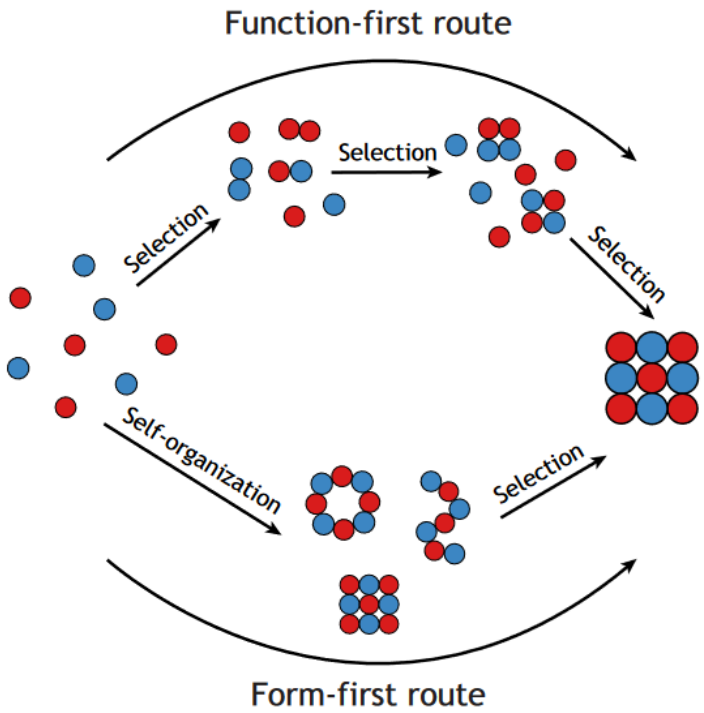
Goal: Formulating falsifiable statements regarding the possible relationships between self-organization and natural selection as creative forces in evolution, specifically related to polarization in budding yeast

Methods: Literature study, conceptual analysis

Introduction

In the traditional Darwinian perspective on evolution, all biological form emerges by means of natural selection acting on phenotypic variation existing within a population. Since the development of the modern central dogma of biology, this phenotypic variation has been thought to arise from random mutations in the genome. Following this line of reasoning, phenotypic change on a species-wide level should occur mostly gradually, as beneficial mutations are accidentally 'discovered'. Hence, ordered structures can be understood as functional units that contingently form as a consequence of sequential random mutations, each of which happen to increase the fitness of the individual.

However, since Darwin, our molecular understanding of order and form in biological systems has increased massively. In particular, it has been shown many times how complex systems can spontaneously favour ordered states over disordered states through energy-dissipating mechanisms (Halatek et al., 2018). This process, where interactions at the microscopic level give rise to global patterns on the macroscopic level, is known as self-organization. The increasing amount of attention for self-organized patterns in biological systems has sparked an interesting debate in the field of evolution: what if not natural selection, but self-organization is the driving force behind the creation of ordered structures throughout evolution (Glazenburg and Laan, 2023)?



Over the past decades, many different positions in this debate have been defended, from the extremes (either natural selection OR self-organization is fully responsible for evolutionary change) to more intermediate positions (both can play a role in different scenario's) (Batten et al., 2008; Mewdina, 2010; Swenson, 2010; Weber and Depew, 1996). However, there seems to be a disconnect between these theoretical endeavours and experimental research: theoreticians remain highly abstract and hardly make observable predictions, while experimentalists often fail to position their work in a broader conceptual context.

Project description

In this project, you will attempt to bridge this gap by focussing on the field of expertise in our lab, being polarization in budding yeast (Bi and Park, 2012). You will map out and clarify the different stances regarding self-organization and natural selection, while continuously relating these to our specific system of interest. Furthermore, you will try to extract observables and formulate falsifiable hypotheses supporting each of these stances. If this turns out to be impossible within the current state of both theoretical and experimental research, you will examine whether this is due to a lack of certain knowledge or expertise, or perhaps a more fundamental issue in reconciling theory and experiment in this field.

Requirements

An analytical mindset, affinity for language and some background in philosophy would be highly beneficial for this project. Specific microbiological knowledge is of secondary importance.

Contact

If you're interested in this project or if you have questions/suggestions, feel free to contact me (Marieke Glazenburg) at m.m.glazenburg@tudelft.nl.

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