ISHPSSB 2013, Montpellier, July 7–12, 2013

Symposium: Microbes as Model Systems

Date: Wednesday, July 10, 2013, Time: 11h00–12h30, Location: Colloque 2

Chair and facilitator
Arnon Levy
Van Leer Institute, Jerusalem

(11h00-11h20) What microbes can model
Jessica Bolker
Department of Biological Sciences, University of New Hampshire
We can learn much from microbial models. They are a powerful tool for studying evolution and ecology, because they enable studies of large populations over thousands of generations, and correlation of changes in ecological roles, individual phenotypes, and genomes. Microbes can model developmental phenomena that occur at cellular and intercellular levels within more complex organisms. Microbes can be selected or engineered to exhibit specific behaviours or functions that take place naturally in embryos; these phenomena can then be analysed in a simpler, more accessible context. Finally, *in vitro* populations that represent naturally occurring microbial communities (especially those of clinical significance) offer a substrate for experiments that enhance understanding of natural microbiota. What we learn about these populations in the laboratory can inform clinical strategies to monitor and manipulate microbial communities with key roles in health and disease. Each of these cases highlights specific questions about how we use models in different contexts; microbial models thus offer tractable, powerful systems not only for biological research, but also for framing epistemological issues common to all model-based science. One is the balance between tractability and representation: although the simplicity of microbial models makes them tractable, it constrains their ability to represent the full complexity of larger-scale organisms and ecosystems. Microbes' predominantly clonal reproduction offers practical advantages, but limits their power to model evolutionary processes that entail sexual reproduction. Exploring the tradeoffs between tractability and representation in microbial systems can yield generalizable insights: microbes thus serve as models for epistemological as well as biological research.

(11h20-11h40) How general is social evolution?
Gregory Velicer
Eldgenössische Technische Hochschule Zürich (ETH Zürich)
Social microbes have been promoted in recent years as powerful model systems for empirical investigations into basic principles of social evolution.

Microbes exhibit many traits that are demonstrably or putatively social in character and which range in complexity from the simple production of individual extracellular compounds that act as public goods (or semi-private goods in the case of compounds that remain attached to the producing cell's surface) to genetically and behaviourally complex traits such as aggregative multicellular fruiting body development. The reach and limits of microbes as models for social evolution in animals will be considered, particularly with reference to the myxobacteria, which exhibit some of the most sophisticated cooperative traits found among prokaryotes.

(11h40-12h00) Experimental Evolution of Multicellularity
Michael Travisano
Department of Ecology, Evolution and Behavior, University of Minnesota
The evolution of development (evo-devo) has been the focus of intense interest for over three decades, and important conceptual, theoretical and empirical advances have been made. These advances, however, have not been based upon direct observation of the evolution of development, because the appropriate model systems were absent. Experimental evolution and new appreciation of microbial model systems now provide tools to investigate the evolution of development as it occurs. An abundance of new studies into evo-devo using microbial selection experiments are underway. Using Baker's yeast, we are observing rapid evolution of complex development during an evolutionary transition from a single celled organism to a multicellular form. The evolution of juvenile and adult life history stages, stochastic differentiation, changes in cell shape and increased hydrodynamic morphologies are all readily observed within a single year of selection. These results challenge current thinking on the tempo and mode of the evolution: developmental complexity can easily evolve under appropriate conditions.

(12h00-12h20) Beyond Tractability: Microbes as Model Systems
Maureen O'Malley
University of Sydney
Tractability is a good reason to use microbes as model systems in evolutionary and ecological experiments. It is not the only reason, however, and I will explore in this talk other reasons – several of which should be of particular relevance to philosophers. Microbes are the most numerous, ancient and physiologically diverse forms of life on the Earth. The ways in which they survive, reproduce and evolve are multiplicitous. Often, when philosophers discuss general properties of living systems, they begin with multicellular organisms and work backwards from them, with the consequence that large organisms become the exemplars of units of reproduction, selection, evolution and biodiversity. I will take three such cases and compare what happens when the analysis starts with microbes against what happens when it starts with macrorganisms (specifically animals). The three cases are the notion of organism (including modes of reproduction), multicellularity (with relevance for developmental processes), and evolutionary transitions (specifically the evolution of eukaryotic characteristics such as sex). In all three cases, I will suggest philosophers at least are better off starting with microrganismal consortia than they are starting with macrorganismal ‘individuals'.