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PROJECT

Cooperation, Conflict, and the Evolution of Networks

Networks of interacting entities occur throughout the natural world and at all levels of biological and physical organization. Examples include genetic and biochemical networks within cells and organisms, networks of interacting cells (in colonies and multicellular organisms), neural networks, social and economic networks among interacting organisms (animal and human), communities of interacting organisms including symbioses, and ecosystems of interacting biotic and abiotic factors influencing weather, climate, nutrient cycling, and other geochemical processes. How do networks "evolve"? Are there unifying principles and also key differences that shape the evolution, stability, and dynamics of networks at different levels of organization? These are the questions that I wish to explore during my stay at Wiko. More specifically, I wish to investigate (a) the role of conflict and cooperation in shaping network structure and function, (b) the extent to which selection at different levels of organization (gene, individual, social group, species community, ecosystem) shapes network evolution, and (c) how parasitism and mutualism at these different biological levels shape the function, stability, and evolution of networks.

Recommended Reading

Loehlin, D. W. and J. H. Werren (2012). "Evolution of shape by multiple regulatory changes to a growth gene." Science 335: 943-947. DOI: 10.1126/science.1215193

Werren, J. H. (2011). "Selfish Genetic Elements, Genetic Conflict, and Evolutionary Innovation." Proc. Natl. Acad. Sci. 108: 10863-10870.

Werren, J. H., S. Richards, C. A. Desjardins, O. Niehuis, J. Gadau, J. K. Colbourne, et al. (2010). "Functional and evolutionary insights from the genomes of three parasitoid Nasonia species." Science 327: 343-348.

COLLOQUIUM, 11.06.2013

Cooperation, Conflict & the Evolution of Interactions

Interactions occur throughout the natural world and at all levels of organization, from sets of interacting genes, to interacting cells (in colonies and multicellular organisms), social and economic networks among organisms (both animal and human), communities of interacting species (including symbioses), and ecosystems of interacting biotic and abiotic factors that influence climate, nutrient cycling and geochemical processes. How do these interactions evolve? Are there unifying principles and also key differences that shape the evolution, stability, and dynamics of interaction networks at different levels of organization?

One recurring theme in nature is the tension between "individual" and "group". Traits that are beneficial at the individual level can be detrimental for the group (and vice versa). Indeed, selection on traits can operate at multiple levels of organization, either in concert or antagonistically across different levels. This is a feature of all biologically based systems, whether they be cells, social groups, communities of species, or ecosystems.

For example, it is commonly believed that an organism is composed of "cooperating" sets of genes (the genome), the sole function of which is to produce a healthy and fit organism. This is not exactly correct. Our DNA is replete with "parasitic" elements, as are those of nearly all animals and plants. These elements gain a replicative advantage over other genes and are often harmful to the individual. Yet they persist and proliferate. Over longer evolutionary time scales these parasites can have profound effects due to antagonistic coevolution with the rest of the genome. They can also become "domesticated" - evolving into functional genes. A similar (although not identical) theme repeats itself among cooperating and competing cells, individuals in social groups, species, et cetera.

In this talk, I will explore how conflict and cooperation, parasitism and mutualism, shape the function, stability and evolution of biologically based systems. The first part of the talk will describe the realm of genetic parasites and their consequences to the evolution of organisms. Then the topic of cooperating and competing cells will be explored. The second part of the talk considers interacting species, including cooperation and conflict in symbiotic relationships. A brief trip to theories on the origins of life will be made, where the theme of mutualism and parasitism is also prominent. The last part of the talk will be a foray into topics of ecosystems and human social structures.

Throughout the talk, a strong emphasis will be placed on the distinctions between cause and consequence, and the importance of distinguishing these when formulating evolutionary hypotheses. I have benefited much from discussions on these topics with colleagues at the Wissenschaftskolleg zu Berlin - many thanks for your insights and perspectives.

PUBLICATIONS FROM THE FELLOW LIBRARY

Werren, John H. (San Francisco, Calif.,2014)

Dobzhansky-Muller and wolbachia-induced incompatibilities in a diploid genetic system

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1046355759

Werren, John H. (2013)

Cuticular hydrocarbon divergence in the jewel wasp Nasonia : evolutionary shifts in chemical communication channels?

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1046354981

Werren, John H. (2013)

Function and evolution of DNA methylation in Nasonia vitripennis

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1043661972

Werren, John H. (San Francisco, California, US,2013)

Characterization of an ancient lepidopteran lateral gene transfer

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=751435163

Werren, John H. (Pittsburgh, PA,2013)

Fine-scale mapping of the Nasonia genome to chromosomes using a high-density genotyping microarray

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=75143480 9

Werren, John H. (2012)

Evolution of shape by multiple regulatory changes to a growth gene

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=751510297

Werren, John H. (2012)

Symbionts provide pesticide detoxification

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=751415936

Werren, John H. (Washington, DC,2011)

Selfish genetic elements, genetic conflict, and evolutionary innovation

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=751436291

Werren, John H. (2010)

Evolution of sex-specific wing shape at the widerwing locus in four species of Nasonia

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=751510858

Werren, John H. (2010)

Non-coding changes cause sex-specific wing size differences between closely related species of Nasonia

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=751509450