M25 Community Evolution

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Topic description

Understanding the structure of present day ecological communities requires knowledge about the process that created them. Presumably, evolution has played and still plays a major role, but the question is how. How does coevolution in the long term create complex systems of interacting species? What is the feedback between coevolution on the one hand and ecological interactions on the other hand? What types of traits are typically conserved during an adaptive radiation and what traits are evolutionary labile? Is it possible to infer past processes from current phylogeographic patterns? With this symposium we aim to highlight current theories, ranging from micro- to macro-evolution, aiming at a more synthetic view on community evolution.

Program in brief (abstracts below)

Monday June 16, 11.40 – 13.00
Chair: Jörgen Ripa

11.40 – 11.45 Introduction

11.45 – 12.10 F. Massol, “Community dynamics and the evolution of dispersal"

12.10 – 12.35 M. Pontarp, "The biogeography of adaptive radiations and the geographic overlap of sister species"

12.35 – 13.00 C. Rueffler, "Does Organismal Complexity Favor the Evolution of Diversity?"

Monday June 16, 14.10 – 15.00
Chair: P. Lundberg

14.10 – 14.35 A. Birand, "Patterns of Species Ranges, Speciation, and Extinction"

14.35 – 15.00 J. Ripa, "Niche conservatism through species turnover"

Abstracts

Francois Massol

Title: "Community dynamics and the evolution of dispersal"

Affiliation:
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Abstract:
One of the tenets of modern community ecology is that dispersal might affect, positively or negatively, the coexistence of species. This can occur e.g. when species have different abilities to compete (the so-called competition-colonization trade-off) or when the environment is heterogeneous and different species fare best in each type of environment (species sorting and source-sink effects). Here, I will present recent advances linking the evolution of dispersal to community dynamics and structure. In particular, I will focus on the effect of environmental heterogeneity on the evolution of dispersal, and how this evolution of dispersal might in turn affect biodiversity patterns.

Mikael Pontarp

Title: "The biogeography of adaptive radiations and the geographic overlap of sister species"

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Abstract:
We simulate adaptive radiations of a single clade in a spatially explicit environment. We investigate the geographical overlap of lineages during and after evolutionary branching (speciation). The spatial overlap at speciation varied continuously from complete ("sympatry") to none ("allopatry") depending on the ecological circumstances (local and regional environmental heterogeneity, dispersal rate, and species richness in the communities). The frequency distribution of the geographical overlap at speciation was strongly bimodal regardless of ecological circumstance. The mean overlap, however, varied considerably during the course of a single radiation, in some cases with a consistent negative trend. The relationship between mean geographical overlap of sister species and time since speciation was surprisingly flat, i.e., old sister species tended to have roughly the same overlap as young ones. However, if local heterogeneity was relatively low (few local niches) and dispersal rate high, then the mean overlap increased with time since speciation. Post-speciation range shifts and the changes in geographical overlap at speciation with time during the cladogenesis lead us to the conclusion that the relationship between current sister species overlap and time since speciation is of limited use for inferring the mode of speciation.

Claus Rueffler
Title: "Does Organismal Complexity Favor the Evolution of Diversity?"
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Abstract:
It has recently been proposed (Doebeli & Ispolatov 2010, Science 382:494-497) that, on theoretical grounds, one should expect a positive correlation between organismal complexity and diversity. This conclusion is based on the finding that in a Lotka-Volterra competition model, so-called evolutionary branching points are more likely to exist the more quantitative traits determine the carrying capacity function and the competition coefficient of an evolving species. We present two results elaborating on this finding. First, the prediction can also be derived in a model independent manner based on properties of the fitness landscape in a multidimensional trait space. Second, in order to get a more mechanistic understanding of this finding we analyze an explicit Lotka-Volterra consumer-resource model in which consumers and resources are both characterized by several quantitative traits and in which the fitness landscape emerges from the interaction between these traits. This analysis supports the results by Doebeli and Ispolatov and our generalization with the addition that not only increasing consumer complexity but also increasing resource complexity facilitates evolutionary branching.

Aysegul Birand
Title: "Patterns of Species Ranges, Speciation, and Extinction"
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Abstract:
The exact nature of the relationship among species range sizes, speciation, and extinction events is not well understood. The factors that promote larger ranges, such as broad niche widths and high dispersal abilities, could increase the likelihood of encountering new habitats but also prevent local adaptation due to high gene flow. Similarly, low dispersal abilities or narrower niche widths could cause populations to be isolated, but such populations may lack advantageous mutations due to low population sizes. Here we present a large-scale, spatially explicit, individual-based model addressing the relationships between species ranges, speciation, and extinction. We followed the evolutionary dynamics of hundreds of thousands of diploid individuals for 200,000 generations. Individuals adapted to multiple resources and formed ecological species in a multidimensional trait space. These species varied in niche widths, and we observed the coexistence of generalists and specialists on a few resources. Our model shows that species ranges correlate with dispersal abilities but do not change with the strength of fitness trade-offs; however, high dispersal abilities and low resource utilization costs, which favored broad niche widths, have a strong negative effect on speciation rates. An unexpected result of our model is the strong effect of underlying resource distributions on speciation: in highly fragmented landscapes, speciation rates are reduced.

Jörgen Ripa
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Title: "Niche conservatism through species turnover"
Abstract:
The rate of trait evolution within a clade varies depending on the organism and the trait. Some traits are evolutionary conserved, some are more labile. If traits related to habitat adaptation are conserved it leads to phylogenetic clustering, i.e. that local coexisting species are more closely related than species drawn randomly from the regional species pool. I have used eco-evolutionary models of an adaptively radiating clade to theoretically study the origin and maintenance of such phylogeographic patterns. Of particular interest is what type of traits are conserved during and after an adaptive radiation, i.e. what part of an organism's niche that are expected to be conserved. One conclusion is that patterns of niche conservatism become successively more pronounced through cycles of extinction and speciation events, such that old clades are predicted to show stronger patterns than young clades. The underlying mechanism can be described as habitat monopolization, or more generally niche monopolization. These results are discussed in relation to extant well-studied adaptive radiations.