International Conference on Ecological Sciences



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Title of symposium

Does Evolution Matter for Ecosystem Ecology?

Main organizer of the symposium

GOUNAND Isabelle, Eawag / University of Zürich
isabelle.gounand@eawag.ch

Co-organizers of the symposium

JACQUET Claire, Eawag / University of Zürich
claire.jacquet@eawag.ch
FRONHOFER Emanuel, ISEM (Institut des Sciences de l'Evolution de Montpellier)
emanuel.fronhofer@umontpellier.fr

Session description

This year, *the French Society of Ecology* becomes *the French Society of Ecology and Evolution*. This transition is worth celebrating by highlighting the synergies emerging from the junction of the two fields.

Evolution and ecology have long developed independent research with very little interactions between the disciplines. The main explanation given to this eco-evo impermeability was that ecological and evolutionary processes were assumed to occur at different scales (short versus long, comparatively). However, evidence for evolutionary dynamics occurring on short time scales has opened a prolific research field tackling eco-evolutionary dynamics and feedbacks. Rapid evolution has been demonstrated to influence species traits on ecological time scales, and selection processes being in turn influenced by species interactions (for instance in predator-prey or host-parasite systems). Beyond the species level, researchers recently started to work on the consequences for higher organisational scales, from communities to ecosystems. In a context of a high societal demand to predict ecosystem responses to global changes, it becomes crucial to understand the role played by evolution and adaptation in ecosystem functioning and stability.

In this symposium, we aim at presenting and discussing the on-going research on whether evolutionary dynamics might – or might not – affect ecological processes at the scale of ecosystems. Invited speakers will cover the effects of evolution on a wide range of ecosystem types and properties, from structure and diversity in food webs with Korinna

Allhoff (talk1), grassland functioning with Claire de Mazancourt (talk 2), nutrient cycling in lakes with Andrès Lopez-Sepulcre (talk 3), productivity and stability with Nicolas Loeuille (talk 4) and the risk of ecological tipping point with Vasilis Dakos (talk 5).

A panel discussion will follow the presentations, allowing the speakers and the audience to interact on the relevance of integrating evolutionary processes to understand ecosystem functioning and predict their response to changes.

Speakers

Talk 1. ALLHOFF Korinna, University of Tübingen
korinna.allhoff@uni-tuebingen.de

"Interplay of evolution and invasion determines food web structure, diversity and stability"

A critically important challenge in theoretical ecology is to better predict responses of ecological networks to changing conditions, such as increasing rates of species invasions. Invaders have been widely observed to trigger changes in species' abundances and sometimes even cause catastrophic extinction cascades. Classical food web models have focused on explaining and predicting such ecological responses on relatively short time scales. These models typically fail to consider evolutionary responses to invaders triggered by changes in the selection pressure on native species. We address this issue using an eco-evolutionary model containing both invasion and mutation events. It integrates classical assembly models, which describe the emergence of a food web via sequential invasions, with so-called evolutionary food web models, which describe food web emergence via small mutations. We base our model on body masses and diets as the key traits that determine metabolic rates and species interactions. We vary the frequency of invasion events in relation to mutation events and the relatedness between local species and invaders. We then analyse the size and structure of the emerging network, its ecological and evolutionary stability, and its species turnover pattern. Our results show that the most diverse and stable networks emerge in systems with frequent invasions of species relatively similar to the local ones.

Talk 2. DE MAZANCOURT Claire, Centre for Biodiversity, Theory and Modelling, Moulis
claire.demazancourt@ecoex-moulis.cnrs.fr

"Evolutionary dynamics and grassland ecosystem functioning"

How does ecosystem functioning depend on community composition and evolutionary dynamics? To explore this question we look for a simple species interaction model that mimics dynamical patterns of real communities. Parameterizing a competitive Lotka-Volterra model with data from plant grassland systems, we find that realistic parameters result in chaotic dynamics, characterized by very dynamic community compositions (high species turnover). We compare this output with long-term grassland data. We explore the

contributions of immigration, community composition and evolution to ecosystem functioning: total biomass, temporal stability and biodiversity.

Talk 3. LOPEZ-SEPULCRE Andrès, Institute of Ecology and Environmental Sciences of Paris alopez@biologie.ens.fr

"From life history evolution to nutrient cycling: case study on Trinidadian guppies"

Eco-evolutionary theory, which acknowledges ecology as both cause and consequence of evolution, has received major attention in the last decade. This renewed interest puts a particular emphasis on the ecosystem-level effects of evolution and how it may be possible to integrate two historically independent sub-disciplines: evolutionary and ecosystem ecology. In this talk I will review progress from a long-term evolutionary experiment in wild populations of Trinidadian guppies (Poecilia reticulata), aimed at understanding the interactions between rapid life-history evolution and ecosystem dynamics. My emphasis will be in understanding how resource limitation and nutrient cycling may be linked to life-history evolution. I will then discuss ongoing research on the development of quantitative tools to research the effects of guppy evolution on nutrient cycles through tracer addition experiments.

Talk 4. LOEUILLE Nicolas, Institute of Ecology and Environmental Sciences of Paris nicolas.loeuille@upmc.fr

"Effects of evolution on the productivity and stability of ecological systems"

The productivity and stability of ecological systems have often been understood as constrained by abiotic forces or by ecological dynamics (ignoring evolution). For instance, variations of total productivity are most often presented on continental or world scale maps, emphasizing climate or energy inputs as key constraints. Similarly, stability is often understood based on models of ecological interactions (eg, predator prey models) possibly accounting for energetic constraints (eg, the paradox of enrichment). However, natural selection favors different traits in productive and non-productive systems, and abiotic (eg, climate) as well as ecological interactions also alter key phenotypes that may constrain productivity or stability. In this presentation, I will discuss, based on simple models, how eco-evolutionary dynamics may alter the functioning of ecosystems by (1) altering the structure of ecological systems, (2) affecting the relative strength of top down vs bottom up controls, (3) changing the resilience of ecological systems. I will then discuss how such an evolutionary perspective may alter our view of ecosystem management.

Talk 5. DAKOS Vasilis, Institute of Sciences of Evolution of Montpellier vasilis.dakos@umontpellier.fr

"Effects of eco-evolutionary dynamics on the risk of ecological tipping points"

There is increasing evidence that evolution can affect ecological processes at much shorter timescales than previously expected. One consequence of rapid evolution is that populations

might successfully overcome the negative effects of environmental changes and avoid extinction (evolutionary rescue). However, in some cases, theory suggests that adaptive evolution can move population traits towards evolutionary attractors, causing them to cross ecological tipping points leading to collapse. Tipping points are points where the behavior of an ecological system can abruptly shift from one state to an alternative contrasting state. Such abrupt shifts can be the collapse of a fisheries population, the competitive exclusion of green algae by cyanobacteria in a lake community, or the collapse of vegetation to desertification in a semi-arid ecosystem. Although concern for crossing tipping points in populations, communities, and ecosystems is rising, it is still unclear whether rapid phenotypic changes can influence the responses of populations experiencing previously unknown environmental conditions. Here, I discuss how accounting for eco-evolutionary dynamics, may help us better understand ecosystem tipping responses to stress.

Talks will be 20 minutes each including the questions, and the symposium will end with a 20 –minute discussion around the topic.