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Title of symposium

Biotic Interactions Under Abiotic Constraints: from Molecular to Ecosystem Level

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Session description

One pivotal question for ecologists is to quantify and predict the impacts of increasing abiotic constraints/stresses on biodiversity. For example, in the context of climate change, mechanistic models link thermal physiological limits of species to overall increase of global temperatures to predict future species distribution. However, organisms are not isolated in their environment, and experimental and/or predictive studies are often biased because they do not take into account interactions with other species of the same or different trophic levels. In the context of global change, the consequences of abiotic constraints/stresses (e.g. heat, drought, anthropogenic contaminants) on biotic interactions influencing the community structure and ecosystem functioning is still not sufficiently understood.

Abiotic constraints/stresses may indeed impair biotic interactions by affecting traits (molecular, physiological, morphological) involved, at the organism level, in the strategy of resource use and energy allocation into major functions (growth, reproduction, defense). Such response traits to abiotic stresses represent effect traits on biotic interactions, leading to altered responses (including perception/signalisation of biotic environment) in interaction networks. Responses to abiotic constraints/stresses can thus change intraspecific and interspecific resource sharing within the same trophic level (niche partitioning) or modify interactions with other trophic levels (e.g. investment in symbioses or defense systems). Such effects may finally alter the functional diversity of communities and affect fundamental

ecosystem processes (e.g. production, decomposition, biological control of populations by natural enemies).

Based on the hypothesis that abiotic and biotic stressors may interact to modulate organisms' responses to their environment, this symposium aims at highlighting the role of abiotic (e.g., climate and anthropogenic-related) constraints/stresses as modulators of biotic interactions. These mediating effects will be reviewed at different levels (from population to community) and for different types (trophic and non-trophic) of biotic interactions (Talk 1-3). This review will also lead to the development of a statistical modelling approach aiming to highlight the potential to develop predictive models (Talk 4). Finally, integration of multiple stressors (abiotic-abiotic, abiotic-biotic) in organism, community, and ecosystem responses to environmental constraints will be transposed to the problem of ecotoxicological risk assessment (Talk 5).

Speakers

Talk 1. GROSS Elisabeth, UMR LIEC 7360 CNRS - Université de Lorraine, France
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"Are abiotic constraints affecting response to pollutants and biotic interactions in an aquatic plant?"

Plants are facing multiple abiotic and biotic constraints, acting at different spatial and temporal scales. This is not different for plants growing under water, so called submerged macrophytes; they are often facing light and/or carbon limitation in addition to various other stress factors such as competition or herbivory, but also pollution. Our model system *Myriophyllum spicatum* is a widespread, competitive species, invasive in some ranges, and is since 2014 used as OECD test system in ecotoxicology. This dicotyleous species produces high amounts of bioactive hydrolysable polyphenols, and we have been testing in various factorial design experiments the effect of diverse abiotic constraints on plant chemistry and possible effects on biotic interactions. Recent studies on the impact of selected pollutants (herbicides, metals) under abiotic constraints show that *M. spicatum* will react with a specific "fingerprint", reflected by distinct changes in physiological and morphological traits towards individual and combined stressors or constraints.

Talk 2. VAN BAAREN Joan, Université Rennes 1, UMR 6553 ECOBIO
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"Plasticity in a changing world: Behavioural responses to human perturbations. Is behavioural plasticity sufficient to cope with human perturbation?"

Most species are affected by Human Induced Rapid Environmental Changes (HIREC) which include variable threats like climate change, habitat fragmentation, habitat loss, human harvesting, and pollution. HIREC generally impact negatively the species. However some species cope well with HIREC and their populations increase to a point where they become

themselves a threat to other species. Multiple responses to HIREC are observed in animals, such as modifications of their morphology, physiology, behavioural strategies or phenology. Most of the responses involve phenotypic plasticity rather than genetic evolution. Moreover, when genetic changes or shifts in demography, distribution or phenology occurred, these were generally preceded by a modification involving phenotypic plasticity. Thus, behavioural plasticity appears important in explaining variation in the success of species to resist HIREC. Here, we review how behavioural plasticity modifies social behaviour and inter-specific interactions in the context of HIREC with the aim to understand in which cases it could be sufficient for the species to cope with human perturbations. This review showed that although important, behavioural plasticity is rarely sufficient to cope with HIREC. An increasing number of studies find species to respond maladaptively or insufficiently to various anthropogenic disturbances, and less often is large degree of plasticity linked to success.

Talk 3. CASTAGNEYROL Bastien, UMR BIOGECO INRA – Univ. Bordeaux, France bastien.castagneyrol@inra.fr

"How does climate mediate tree diversity effects on insect herbivores"

The identity and diversity of plant neighbours have well documented effects on insect herbivores. They range from associational resistance (i.e., less damage in presence of heterospecific neighbours) to associational susceptibility (i.e., more damage in presence of heterospecific neighbours). However, there is no consensus in the literature on the mechanisms driving these associational effects. Discrepancies among published studies may result from the overlooked mediating effect of climate. By using a large scale tree diversity experiment in which we manipulated water stress, we investigate how drought differentially affects leaf traits and ultimately the likelihood and strength of associational resistance and susceptibility.

Talk 4. DAMGAARD Christian Frølund, Department of Bioscience Plant and Insect Ecology, Aarhus University
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"Estimating competitive interactions in semi-natural plant populations in an agro-ecosystem"

The effect of nitrogen and glyphosate on the competitive interactions between *Festuca ovina* and *Agrostis capillaris* is estimated in controlled competition experiments and using growth data in semi-natural plant populations. Based on the observed changes in competitive interactions, the effects of the anthropogenic drivers on plant community dynamics are predicted. The needs for plant growth data for estimating competitive interactions in natural populations are discussed.

Talk 5. VAN GESTEL Kees, Department of Ecological Science, Vrije Universiteit, Pays-Bas
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"How to improve ecological realism of soil ecotoxicological testing?"

Ecotoxicological testing for the risk assessment of pesticides and other chemicals traditionally uses only few standardized test species which are exposed for a fixed (short) period of time under standard conditions. In nature, conditions however, are rarely standard, leading to dynamic exposure conditions in fluctuating environments. It therefore is questionable whether the standard single species-tests are fully indicative of possible effects of chemicals under dynamic field conditions, e.g. with varying temperatures and humidities, and of effects on relevant endpoints like functioning of the ecosystem. This presentation will discuss some alternative approaches that may help understanding ecological consequences of chemical exposure. It will address the relevance of using toxicokinetics/ toxicodynamics approaches, the application of non-standard environmental exposure conditions, the use of multi-generation testing and the potential of multispecies tests to assess the effects on structural and functional endpoints in soil. Examples will be given on studies with metals, nanoparticles and pesticides, and possible consequences for ecological risk assessment will briefly be discussed.